CONCERTED ACTION
ENERGY PERFORMANCE
OF BUILDINGS

Co-funded by the Intelligent Energy Europe
Programme of the European Union

2016

Implementing the Energy Performance of Buildings Directive (EPBD)

FEATURING COUNTRY REPORTS

www.epbd-ca.eu

Lisbon, September 2015
ISBN 978-972-8646-32-5

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Co-funded by the Intelligent Energy Europe
Programme of the European Union

*This book is **Co-funded under the Intelligent Energy - Europe***
Programme of the European Union
under the contract IEE/CA/10/002 SI2.588732

More details on the IEE Programme can be found at
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Foreword
by

Drs S.A. Blok
Minister for Housing and the Central Government Sector

The Energy Performance of Buildings Directive (EPBD) is an instrument for enhancing the building regulations on energy performance of the building stock in the EU member states. The directive sets binding targets that have to be transposed into national law and implemented via national regulations.

To enhance the sharing of information and exchange of experiences from national adoption and implementation of this Directive, the European Commission established a joint initiative with representatives of the national implementation bodies: Concerted Action EPBD. Since 2005, this Concerted Action EPBD has been the meeting place for national representatives working on the implementation of the EU directive into national measures and policies. Experience shows that the Concerted Action have substantially contributed to a better understanding of the implementation challenges and the pro and cons of various strategies to implement the EPBD requirements in a cost effective way into the national context of member states. Moreover, this exchange has resulted in more convergence in the national approaches towards the implementation.

I welcome this report, which demonstrates again the positive effect of the dialogue and exchange of best practices of implementation of regulations between the Member States, on topics in the field of certification schemes, inspection themes, training, nearly zero-energy buildings, compliance and control, support initiatives and energy performance requirements and cost-optimum methodology.

The Member States are now working hard to improve the energy performance of residential and commercial buildings. But we still face a big challenge in the renovation of the vast existing buildings stock into zero energy buildings. This revolution can’t be realized by only formulating new EPBD legislation. This achievement needs a much broader perspective on energy transition. Therefore it is inevitable to take forward the new strategy of implementing the European Energy Union to reach a single European energy market. The challenge for the new recast of both the Energy Performance Directive and the Energy Efficiency Directive is to give Member States their freedom to facilitate and realize energy transition in a way that fits with the wide diversity of national developments. In this process the European Commission can give important guidance on this new approach through the Strategy on Heating and Cooling.

Even more then in former phases Concerted Action EPBD will be important for Member States to exchange experiences with each other, contributing to the development into an energy neutral European building stock.

I look forward to the next report in two year’s time, which without a doubt will reflect a further progress along the road towards 2020 and beyond.

Drs S.A. Blok
Minister for Housing and the Central Government Sector

Editor’s message

This book marks 10 years of implementation of the EPBD. This is my fourth and last editorial for a series of books that started in 2008 and that I had the privilege to compile and edit. I would like to use this editorial to state a few personal views about these 10 years of remarkable evolution on energy efficiency of buildings in Europe. I will highlight the many positive aspects that the EPBD brought along, but I also take the liberty to point out a few things that did not develop as well as it might have been expected. This is thus a small personal contribution towards solutions for tackling the challenges for a yet better future EPBD.

It has also been 10 years since MSs (and Norway) started to collaborate in the Concerted Action (CA) EPBD to find the best ways to implement the EPBD. There has been a huge progress since then. Early efforts concentrated on the Energy Performance Certificates (EPCs), its form, contents, who could issue them, even on how to keep track of them after they were issued, and how to take advantage of them for better informed policymaking. Few countries implemented central databases at the beginning of the process, and this was one of the first lessons learned from the CA EPBD, later included as a mandatory requirement in the Directive 2010/31/EC that replaced Directive 2002/91/EC. Calculation methodologies, how to recognise and train Qualified Experts (QEs) and how to ‘sell’ EPCs to the general public, the professionals and the building industry were also among the first challenges tackled by the CA EPBD.

With its recast in 2010 (Directive 2010/31/EC), new challenges were faced by MSs. Foremost among them, the cost-optimal calculations for setting minimum requirements and the path towards Nearly Zero-Energy Buildings (NZEBs) by 2020. While the first issue seems to be well solved by almost every country by now, NZEB continues to be a major challenge and it is yet unclear how much progress will be reached by 2020, especially for the much needed rennovation of the huge stock of existing buildings with poor energy performance. Once again, the CA EPBD tackled these issues head-on during the last 5 years. The problems, possible solutions, conclusions and recommendations are well described in part A of this book.

New issues gradually emerged during this decade. For example, the EPC became a focus of controversy: how good and reliable was it? Could it be used for informed decisions for investments? Was there any quality control and enforcement by authorites, or was it just another piece of paper that someone needed to obtain and include in a purely administrative check, if any? Gradually, many MSs started to implement more effective enforcement and quality control procedures, as the EPBD also required them to do so after Directive 2010/31/EC, but, from reading the chapter on “Compliance and Control” in part A of this book, as well as consulting the various country reports in part B, it is easy to conclude that there is still much room for improvement.

The EPCs were designed as an important information source for consumers and authorities alike. The inclusion of the energy rating in advertisement, ensuring that the information was available to consumers from the very first stages of the market, was one of the measures with great impact that Directive 2010/31/EC brought along. EPCs were (and still are) meant to include recommendations for improving energy efficiency in buildings. But it was soon concluded that a ‘good’ EPC, suitable for making investment decisions, would be rather expensive. To lower the cost of the EPCs, and make them more acceptable by the citizens and the building market, most of the EPCs, especially for existing buildings, are produced using a range of default values that may prevent the final product from conveying a fair picture of the reality. In most cases, banks will not accept an EPC as the basis for an informed loan application for renovation works. An energy audit, as defined by the Energy Efficiency Directive (EED - Directive 2012/27/EU), would be normally required. So, an apparent contradiction evolved: EPCs should offer accurate information, but they would then be rather expensive; thus, compromise solutions with much lower costs were adopted in many countries and EPCs lost their announced value as a source of valuable recommendations for improving the energy efficiency of a building or an apartment. In many countries, recommendations became vague standard statements that can be produced without even having a QE visiting the building. This clearly calls for an evolving concept for EPCs, meant solely for comparing buildings according to some standard typical pattern of use and according to what it would be expected to perform under default conditions, regardless of its actual present status.You will also find a good discussion about these issues in part A of this book.

Mandatory inspections of heating and air-conditioning (AC) systems are also part of the EPBD. These have always been a problematic issue, as their cost-effectiveness soon came into question, even in countries with demanding climates. Alternative measures, allowed since Directive 2010/31/EC came into force for both heating and AC systems, are becoming more and more popular among MSs. Proof that these alternative measures are as effective as a real inspection system is however another area that warrants careful consideration. 'Proof' might even be a scientifically incorrect word to use in this context, as so many assumptions are called for that there is ample room for imagination and creativity around. Is this really the best way? Would good regular maintenance together with replacement of obsolete units produce the same or even better results? What is the role for regular monitoring of large systems? Readers will be able to find a good discussion on these issues in the chapter on "Inspections" in part A of the book, and the country reports in part B shall certainly be the best proof of how much progress would still be needed to reach full compliance with the inspection requirements of the EPBD.

From this short introduction, it is clearly evident that the EPBD is a success story in many respects:

- MSs improved their minimum energy efficiency requirements for buildings, taking into account cost-optimality for a long (ca 30 years) life-cycle approach;
- MSs introduced certification and EPCs are now becoming common place, even present in advertisements like any other consumer item, e.g., a washing machine, an air-conditioner or an automobile;
- combined with EED requirements, EPCs became a tool to identify priorities for renovation of existing building stocks, public or private;
- there are some meaningful plans for the energy renovation of the existing building stock.

But the EPBD has also shown quite a few shortcomings. Some of them resulted from good ideas that MSs simply failed to implement, e.g., enforcement and quality control, taking advantage of EPC databases, namely for policy making, display of EPCs in public buildings, etc. Others clearly raise cost-effectiveness issues, e.g., inspections of heating and AC systems, or even requiring demanding NZEB levels, particularly in the renovation of the existing building stock. Yet others simply need to evolve to become fit for purpose, or to redefine the purpose, e.g., the role of recommendations in EPCs and the role of EPCs for financial instruments and incentives.

This book describes and discusses all these aspects in good detail:

- in part A, experts in each thematic area offer good technical discussions of the issues, provide statistics, and list possible solutions and recommendations;
- in part B, country reports describe the status of implementation in all 28 EU MSs and in Norway. Readers can get valuable information about how each country dealt with each EPBD requirement, taking into careful consideration what is said, how it is said, and, also, by identifying what is not said.

I hope that you will find this book a valuable source of information. I also hope that the facts and lessons it describes will enable the European Commission, the European Parliament and Member States to produce a third, more effective and more realistic version of the EPBD in a year or two from now, fully obeying the principles of the 'better regulation' initiative: forward looking and as demanding as possible; not losing sight of the overall goals of sustainability and economy; fully open to new ideas and innovation, but fit for purpose, realistic and avoiding undue burden on MSs and their citizens; consolidating and only introducing minor improvements on what is working well; forcing better compliance where it is clearly lacking, but also having the courage to drop the ideas and requirements that have simply proven themselves to be innefective or unrealistic.

The CA EPBD shall continue in the next few years under the leadership of an esteemed colleague, Jens Laustsen. We were both part of the group that came up with the idea of using the Concerted Action instrument to tackle the EPBD and get its improved implementation throughout Europe when the EU Commission timely and wisely proposed the new instrument back then. I am sure the CA EPBD will continue to be an effective instrument under Jens's leadership. I look forward for the next update of this book in a not so distant future. It has been my privilege to lead this Concerted Action for a decade, and I wish to thank all the many representatives from every participating country, as well as the many EC officers and other EU and foreign experts with whom I had the honour and pleasure to interact during this decade. Without everybody's outstanding collaboration, these books, and the contributions towards a better and more effective implementation of the EPBD in Europe, would never have been possible. Thank you very much.

Eduardo Maldonado
Professor, University of Porto, Portugal

Part A – Core Theme Reports

Certification

OVERVIEW AND OUTCOMES

AUGUST 2015

1. Introduction

The Energy Performance of Buildings Directive (EPBD, Directive 2010/31/EU) aims to steer the building sector towards ambitious energy efficiency standards and increased use of renewable energy sources. The Energy Performance Certificate (EPC) plays a key role in this process, as it informs potential tenants and buyers about the energy performance of a building unit (e.g., an apartment or office) or of an entire building, and allows for comparison of buildings and building units in terms of energy efficiency. The underlying idea is that the EPC should influence the demand for buildings with excellent energy efficiency performance and a high proportion of energy from renewable sources, increase their market value, and thus influence building owners to renovate their buildings.

This report provides an overview of the developments and achievements accomplished from 2011 to 2015 regarding EPC-relevant topics of the EPBD, including: advertising requirements and the role of real estate agents, mandatory provision of recommendations for improving energy performance as part of the EPC, and the obligatory display of the EPC in non-residential buildings occupied by public authorities and frequently visited by the public.

The report attempts to include the relevant information from every Member State (MS) in the EU. However, as this was not possible for every aspect, the total number of MSs covered by some of the statistics included in this report may be lower than 28 (or 29 including Norway).

2. Objectives

According to the EPBD, EU MSs shall ensure that an EPC is issued for buildings or building units which are constructed, sold or rented out to a new tenant, along with periodic certification of buildings which are occupied by public authorities and frequently visited by the public. This report summarises lessons learned regarding the certificate's content (layout and information included, acceptance of the certificate by the real estate sector, use of the certificate data for monitoring processes, etc.), the certification process itself, and the use of the certificate in advertising buildings offered for sale or rent, or frequently visited by the public.

The key objectives of this report are described below.

2.1 Key objective 1: Providing an overview of existing solutions

The first key objective is to summarise the approaches of MSs that have successfully dealt with the challenges of the EPBD regarding certification and making use of the EPC, in order to provide positive examples for other MSs to follow.

2.2 Key objective 2: Providing an overview of aspects MS should pay more attention to

The second objective is to identify areas which need further attention, in order to tap the full potential of the EPBD and especially of building certification.

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3. Analysis of insights

This report presents an overview of the following topics, summarising opinions, solutions, challenges, and opportunities for future development:

> the EPC and the real estate sector, including advertising requirements and the role of real estate agents, display of energy certificates, and making the EPC more user-friendly for the general public;
> validity of EPCs, including use of default values and calculation of realistic energy savings, mandatory inclusion of recommendations for improving energy efficiency, and the trade-off between EPC cost and content;
> making the best use of EPCs, including examples of how MSs use EPC databases, and the EPC as a supporting document for subsidies related with energy efficiency.

3.1 EPC and the real estate sector

According to Article 12 of the EPBD, an EPC must be presented and handed over to the prospective tenant or buyer. The role of the EPC is strengthened by mandatory publication of the energy performance indicator contained in the EPC, according to the national legislation valid at the time for advertising a building for sale or rent. According to EPBD Article 13, EPCs must be displayed on buildings occupied by public administration and frequently visited by the public, and on buildings frequently visited by the public in general, if an EPC has been issued according to Article 12.

The publication of the energy performance indicator of a building or building unit in advertisements in the commercial media is important for creating awareness of buildings' energy performance among potential buyers or tenants, as is the obligation to display EPCs in frequently visited buildings. Since publication and advertising of EPC indicators have become mandatory, the public has frequent encounters with energy indicators and related information. This is one way to boost awareness. Transaction studies show that, under similar location conditions, energy efficient buildings sell or rent faster and at a better price than buildings with low-grade energy efficiency performance. For example, in the case of The Netherlands, Brounen, Kok and Menne[1] suggest that an otherwise identical house with an A-rating retails for about 12% more compared to a house with a G-rating. Although the housing market, like most other sectors, has been affected by the economic crisis, and results need to take the latest developments into account, this tendency has been confirmed in more recent work building on the initial study described above[2] and on other work carried out in this field[3]. These factors reinforce the importance of the quality of information real estate agents provide at the point of sale, and the importance of compliance in two respects: first, the actual publication of the required type of energy indicator, and second, the publication of the correct energy indicator number.

3.1.1 Requirements of advertising and the role of real estate agents

The publication of EPC indicators in advertisements is crucial for making a building's energy performance visible. The MSs' legal frameworks require the publication of selected EPC information, while also specifying how this information has to be published, for example in the form of the specific energy class (e.g., A, B), or numerical values (e.g., kWh/m².year or CO_2 emissions). Some countries allow several options, and the majority requires the building's energy class.

In practice, there is still room for improvement:

> Experiences suggest that mandatory publication must be combined with clear and proportionate sanctions that can and must be enforced, in order to

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[1] *Dirk Brounen, Nils Kok, Jaco Menne. Energy Performance Certification in the Housing Market. April 2009. www.dgbc.nl/content/energy-performance-certification-housing-market (2015-09-07)*

[1] *D. Brounen, N. Kok, On the economics of energy labels in the housing market, J. Environ. Econ. Manage. (2011), doi:10.1016/j.jeem.2010.11.006*
Quarterly Report Q3 2013, Dirk Brounen (2013) - in Dutch, in English: www.tias.edu/en/knowledgeareas/area/real-estate/article/energy-label-most-popular-in-non-urban-areas (2015-03-23)

[2] *Energy performance certificates in buildings and their impact on transaction prices and rents in selected EU countries. FINAL REPORT, European Commission (DG Energy), 19 April 2013*

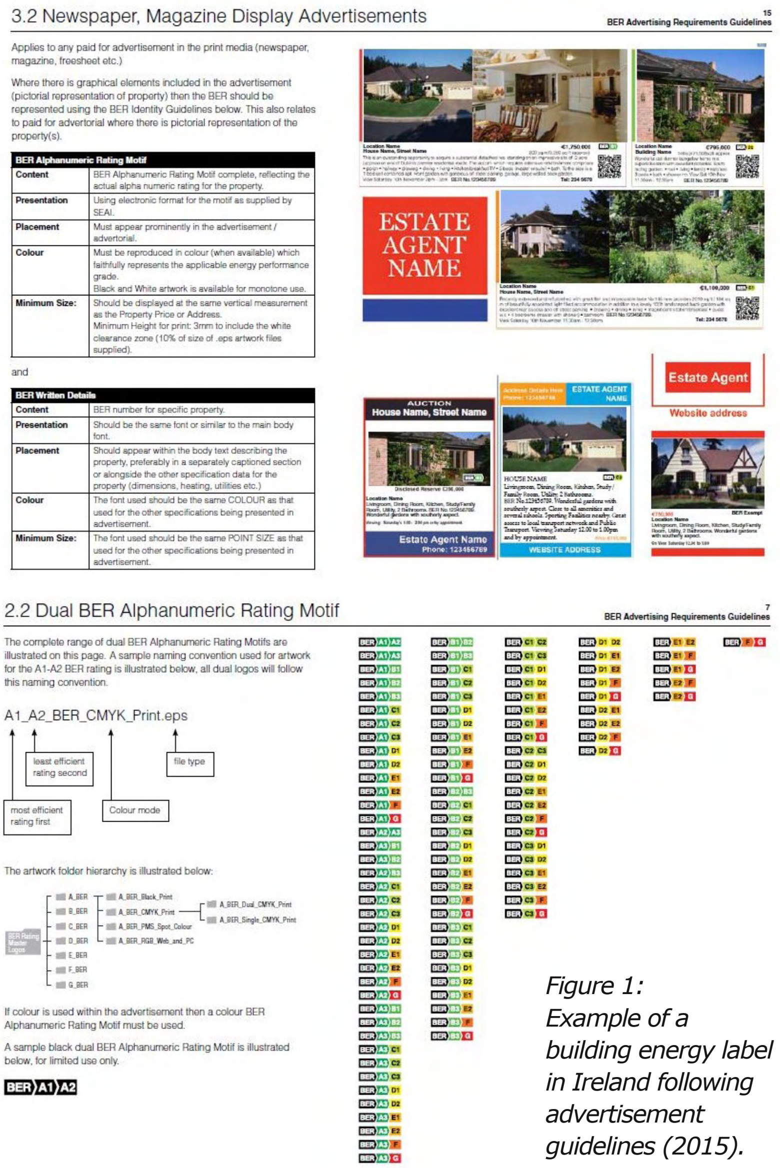
[3] *For example: F. Fuerst, P. McAllister, A. Nanda, P. Wyatt (2013): An investigation of the effect of EPC ratings on house prices. A report for the Department of Energy and Climate Change www.gov.uk/government/uploads/system/uploads/attachment_data/file/207196/20130613_-_Hedonic_Pricing_study_-_DECC_template__2_.pdf (2015-10-02)*

achieve a substantial increase in publication of energy indicators and subsequent market impact. This systematic compliance check is not consistently enforced in the majority of MSs and needs serious improvement.

> Only in a few MSs (Belgium-Flemish region, Portugal and Ireland) have guidelines been developed for the use of EPC data in advertisements, in collaboration with real estate agents, for either mandatory (Ireland – Figure 1) or voluntary (e.g., Portugal – Figure 2) utilisation. These guidelines ensure that the energy indicators can be easily identified, that energy information does not get lost among the rest of the advertisement, and that additional expenses are avoided by exactly specifying the requirements for publication in print media and internet media, either displayed on the computer screen or on the mobile phone.

The publication of the EPC reference number as part of the advertisement allows for a convenient comparison of the published information with the respective information stored in the EPC database, to check whether the published information is correct, or whether an error has occurred. EPC databases can also provide services to real estate agents by offering quick and easy access to the general building information they need for advertising, as in Portugal for example. Services and compliance checks are based on the availability of an EPC database that is at least partly accessible to the public. The concept of permanent but limited access is based on the consideration that not all data stored in the databases needs to be accessed by all stakeholders. Limited access could also mean access only to specific information of the datasets, complying with data protection and/or privacy requirements.

However, in some countries, e.g., Germany and Austria, there are serious data protection concerns, so access to the EPC database is only allowed for directly-involved experts, and occasionally for policy makers and researchers working on specific projects. Therefore, other solutions for co-operation with real estate agents and compliance checks might be necessary. Nevertheless, countries with strong data privacy concerns should be aware that denying access to EPC databases to all or certain stakeholders might ensure data protection, but limits transparency and the effort to create energy efficiency awareness.



3.2 Newspaper, Magazine Display Advertisements

BER Advertising Requirements Guidelines

Applies to any paid for advertisement in the print media (newspaper, magazine, freesheet etc.)

Where there is graphical elements included in the advertisement (pictorial representation of property) then the BER should be represented using the BER Identity Guidelines below. This also relates to paid for advertorial where there is pictorial representation of the property(s).

BER Alphanumeric Rating Motif	
Content	BER Alphanumeric Rating Motif complete, reflecting the actual alpha numeric rating for the property.
Presentation	Using electronic format for the motif as supplied by SEAI.
Placement	Must appear prominently in the advertisement / advertorial.
Colour	Must be reproduced in colour (when available) which faithfully represents the applicable energy performance grade. Black and White artwork is available for monotone use.
Minimum Size:	Should be displayed at the same vertical measurement as the Property Price or Address. Minimum Height for print: 3mm to include the white clearance zone (10% of size of .eps artwork files supplied).

and

BER Written Details	
Content	BER number for specific property.
Presentation	Should be the same font or similar to the main body font.
Placement	Should appear within the body text describing the property, preferably in a separately captioned section or alongside the other specification data for the property (dimensions, heating, utilities etc.)
Colour	The font used should be the same COLOUR as that used for the other specifications being presented in advertisement.
Minimum Size:	The font used should be the same POINT SIZE as that used for the other specifications being presented in advertisement.

2.2 Dual BER Alphanumeric Rating Motif

BER Advertising Requirements Guidelines

The complete range of dual BER Alphanumeric Rating Motifs are illustrated on this page. A sample naming convention used for artwork for the A1-A2 BER rating is illustrated below, all dual logos will follow this naming convention.

The artwork folder hierarchy is illustrated below:

If colour is used within the advertisement then a colour BER Alphanumeric Rating Motif must be used.

A sample black dual BER Alphanumeric Rating Motif is illustrated below, for limited use only.

Figure 1: Example of a building energy label in Ireland following advertisement guidelines (2015).

Figure 2: Example of building energy label in Portuguese following advertisement guidelines (2015).

3.1.2 Display of energy certificates

Display of the EPC is important for creating awareness of energy efficiency: buildings occupied by public authorities and frequently visited by the public must display their EPC, as must other buildings frequently visited by the public for which an EPC should have been issued. Observations in MSs indicate substantial room for improvement in many countries.

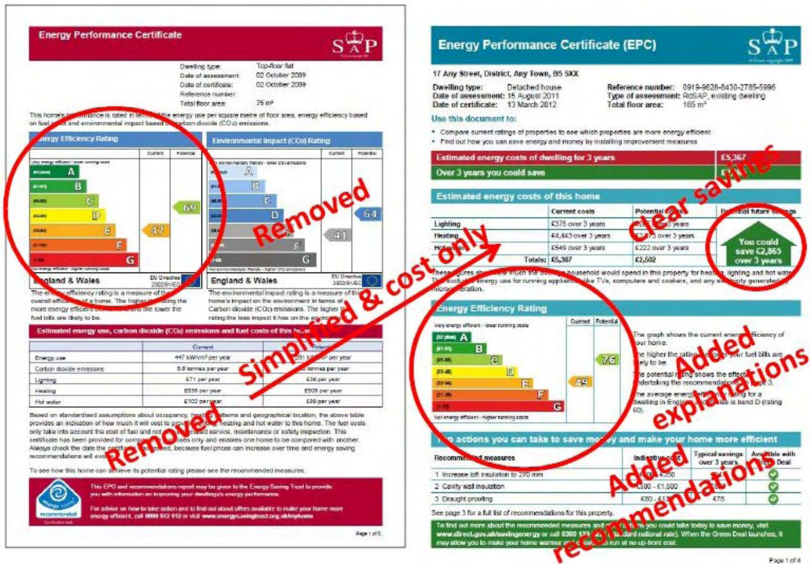
A 2015 survey of MSs about the display of EPCs showed that only four MSs have collected numbers on the buildings displaying the EPC: in two countries less than 10%, in one country more than 50% and in another one more than 90% of these buildings display their EPCs. Only six MSs indicated that there are penalties for not displaying the EPC. However, enforcement in these countries is also lacking.

There is a general lack of EPCs that are visibly displayed, and compliance checks are difficult, mainly due to insufficient definition of the terms “frequently” and “visited by the public”. A closer look at frequently visited buildings occupied by public authorities and their possible reasons for not displaying the EPC reveals an issue with long-term leases: if, for lack of obligation, an EPC has not yet been issued, the leasing public authority would have to commission the calculation of the EPC, resulting in additional costs. Avoiding these additional costs is one explanation of why the obligation to display the EPC is ignored in MSs without any clear enforcement procedure in place. This demonstrates the importance of compliance checks.

In order to be able to check and ensure compliance, either more definitions and explanations, or a radical simplification and clarification of the existing Article 13 would be necessary. In this respect there are good examples from European countries such as Norway. In Norway, the law was simplified and all non-residential buildings with net useful area above 1,000 m² must display the EPC. In addition, a strict enforcement procedure should be in place whereby, for example, a person is appointed responsible for the display of the EPC in a specific building, and an inspection of all relevant buildings takes place. Consequences (penalties) should be specified in case of non-compliance.

Buildings occupied by public authorities are expected to set a good example and play a leading role in terms of energy efficiency, and to showcase this by displaying the EPC. Presently, it seems that public authorities in most MSs do not comply, in practical terms, with the obligation to display the EPC, even if it is written into the law. This might have a negative impact on general awareness, as well as on compliance from the private sector.

Figure 3: Example: The old (before 2012) and new EPC in The UK.



3.1.3 Making the EPC more user-friendly for the general public

Although there is more awareness of energy efficiency among consumers thanks to the EPC, much improvement is still necessary. Regarding the market impact of increased demand for energy efficient buildings, a German study shows that consumers’ expectations about the EPC are still partly wrong, with the conclusion that the EPC is too technical and complicated for consumers to understand it. These conclusions are shared by most of the MSs represented at the Concerted Action EPBD. The UK, Germany, and Portugal have already

Figure 4: Example of the 2014 EPC and the draft of the new Italian EPC (2015).

undertaken efforts to make the EPC more user-friendly. Taking into account the interests of the general public, the use of technical language has been reduced to a minimum on the first pages of the EPC and more self-explanatory icons are used, whereas the technical sections, addressing experts and authorities, have been moved to the end. In Italy, a new and improved layout for a national EPC has been designed based on the lessons learnt. Figures 3 and 4 show the previous version and the improved EPC in parts of The UK and in Italy.

Regarding user-friendliness, the majority of MSs chose, at least for the present, not to explicitly show the Nearly Zero Energy Building (NZEB) level on the EPC front page. This may be due to MSs not linking the NZEB levels to an energy performance class in their EPC system, or because NZEBs are not yet common in those MSs and, being a technical term, it is considered difficult to explain. On the other hand, showing the NZEB level could be an element for promotion, as is the case in Germany, where the term NZEB is not explicitly used either, but comparable terms like *"Energieeffizienzhaus-Plus"* are used, which people are familiar with due to awareness campaigns and funding schemes. More information on these aspects is available in the chapter "Towards 2020 – Nearly Zero-Energy Buildings" in this book. In any case, user-friendliness of EPCs must be a priority.

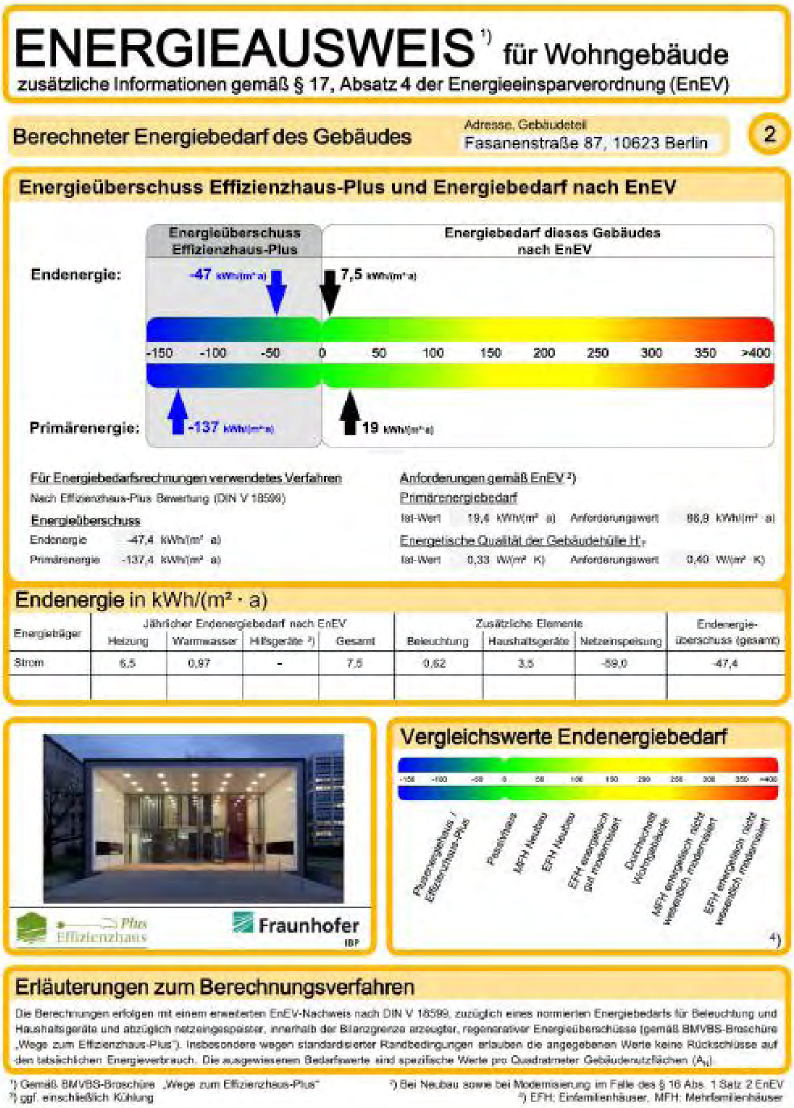
Clear guidelines are needed on how to include energy information in advertisements to ensure visible and meaningful publication.

Allowing partial access to certain sections of the EPC databases allows real estate agents to easily access the information required for advertisements. It also allows clients to check the published information.

Displaying EPCs in public buildings visited by the public is important for creating awareness of energy efficient buildings, but is often lacking in practice in most MSs. There is significant room for improvement.

User-friendliness of EPCs must be a priority, and some MSs have started to identify weaknesses and to improve and clarify the EPC presentation.

Figure 5: Example of a German EPC with indication of the requirements for "Passivhaus", "Effizienzhaus Plus", "Plusenergiehaus") (2015).
Legend:
- Energieausweis für Wohngebäude: Energy Performance Certificate for residential buildings
- Berechneter Energiebedarf des Gebäudes: Calculated energy demand of the building
- Energieüberschuss Effizienzhaus-Plus und Energiebedarf nach EnEV: Energy surplus of energy efficient house-plus and Energy demand according to (German) energy saving regulations
- Endenergie: Final energy
- Primärenergie: Primary energy
- Vergleichswerte Energiebedarf: Comparative values of energy demand
- Erläuterungen zum Berechnungsverfahren: Explanation of calculation method



3.2 Validity of EPCs

Article 11 of the EPBD requires MSs to establish a system of certification for the energy performance of buildings and specifies the content and the purpose of the EPC. Among other things, EPCs should allow for the energy-related comparison of buildings and building units, and thus empower potential buyers or tenants to make an informed choice, taking energy efficiency into account.

Higher quality of certificates makes schemes more credible, so quality assurance of the EPC is necessary for its use as an information tool for customers, as a supporting document for subsidies related with energy efficiency, and for reporting obligations towards energy efficiency targets. A well-developed Quality Assurance (QA) scheme allows for improving the whole certification system (including feedback to policy makers), and there are clear procedures and sanctions.

During the process of certification there are mainly two elements that determine the quality of the final result and how the public will perceive it: the input data used for calculation and the framework of quality assurance that is applied.

Possible QA actions can address and improve different aspects of the whole EPC process. These aspects include: (1) training, (2) accreditation, (3) development of method/procedure, (4) on-site inspection, (5) software use, (6) presentation/content of the certificate, (7) quality control and (8) market response. Other important elements for the most effective use of the EPC are a central EPC database and appropriate software. This report does not discuss all these aspects (they are discussed in other reports), and is instead concentrating on three specific aspects:

> use of default values and calculation of realistic energy savings (related to the development of the method / procedure);
> mandatory provision of recommendations for improving energy efficiency (related to presentation / content of the certificate);
> trade-off between EPC cost and content (related to method/procedure and market response).

More information on quality aspects is available in the chapter "Compliance and Control of Regulations and Certificates" in this book.

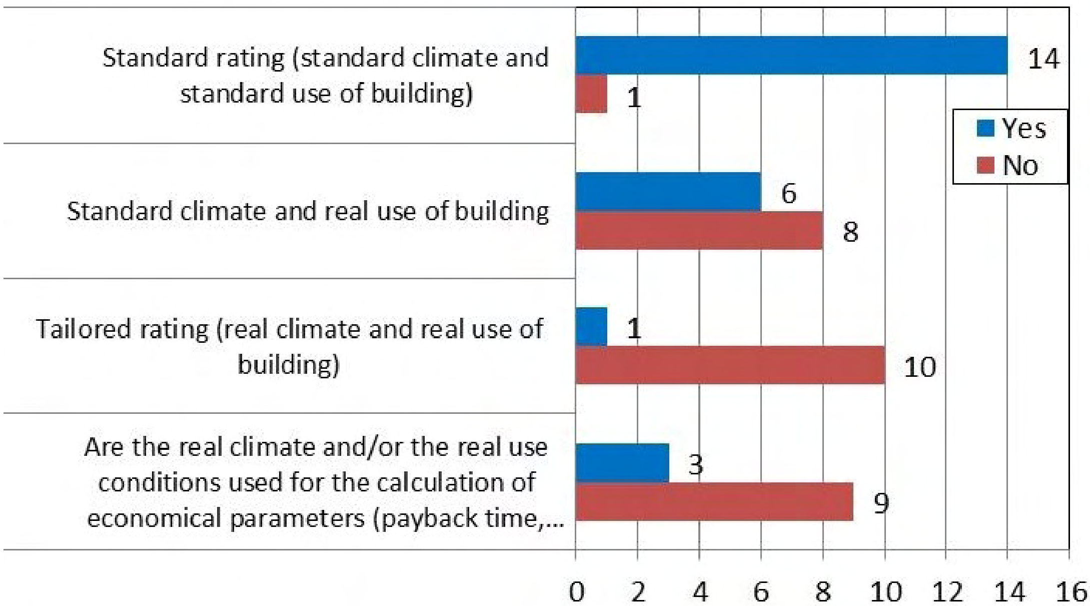
Concerted Action EPBD (CA EPBD) participants identified regular mandatory training for EPC assessors as one of the most effective methods to ensure EPC quality and to avoid mistakes. This training should include knowledge transfer on specific matters related to testing and site visits to evaluate the procedures.

3.2.1 Use of default values and calculation of realistic energy savingss

The EPC serves two different purposes:

1. It shows the energy performance of the building and reference values (e.g., minimum energy performance requirements) in order to make it possible to compare it with other buildings.
2. It informs homeowners of energy savings potential, in order to motivate them to invest in improving the energy efficiency of the building.

Figure 6: Operational conditions used for the calculation of energy indicators and energy classes on energy certificates; based on a 2013 survey.



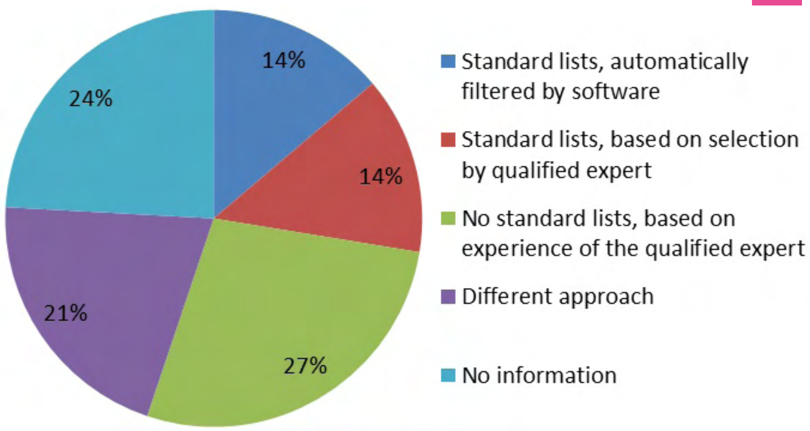


Figure 7: Options for selecting recommendations; based on national reports 2014.

The EPC rates the building and not the way it is used. Elements in the calculation, e.g., payback time, cost-optimality, and cost-effectiveness of recommendations, depend on the actual energy performance in which the users play a significant role. In many countries (Figure 6), calculation is based on a standard climate, standard user behaviour, and other default values, which might deviate more or less from the actual situation, depending on each specific case/building. While for the first purpose of the EPC, which is to show a building's energy performance, it is appropriate to use default values to achieve comparable calculation results, this might result in the calculation of seemingly distorted energy savings and thus compromise the second purpose of the EPC, i.e., to inform about the energy savings potential. As a result, it is necessary to strike a balance between these two objectives.

One of the challenges is how to obtain realistic values rather than simply using possibly unrealistic default values without increasing the cost of data collection, bearing in mind that building documentation is not available for the majority of the building stock in need of renovation. Therefore, in existing buildings the focus should be on further developing default values to allow for the comparison of buildings and on coming closer to realistic energy savings calculations at the same time. A good example is the publication of detailed building typologies at the regional level, thus providing default values that are closer to reality (e.g., Germany and Luxemburg). There are also other suggestions for possible solutions, such as ensuring that recommendations accompanying the EPC relate to actual climate and energy consumption (e.g., as Norway and The UK require).

3.2.2 Mandatory provision of recommendations for improving energy efficiency

EPC recommendations enhance awareness of the potential to improve buildings' energy efficiency.

The quality of the recommendations for improving energy efficiency is determined by the technical suitability and cost-effectiveness for the specific building. The way these recommendations are presented to the building owner can play a decisive role in the subsequent decision to take action. There is a trade-off between tailor-made, building-specific recommendations and recommendations taken from a standard list. While tailor-made recommendations will be most appropriate for actual building renovations, standard lists of recommendations reduce the cost of the EPC and may provide the basis for easier monitoring of the implementation of EPC recommendations (see Figure 7).

It is important to monitor the implementation of recommendations in order to receive feedback on their success and to quantify the energy savings achieved. The refurbishment rate can be documented more easily and strategic actions, such as support mechanisms for improving energy efficiency, can be optimised on a regular basis. However, as of 2014, only a few countries have succeeded in implementing a system for monitoring the implementation of recommendations, among them Lithuania, The Netherlands and France.

To summarise, there is a clear distinction between EPC recommendations providing guidelines for potential energy savings, EPC tailor-made recommendations, and the detailed energy audit providing detailed and specific data for renovation planning of complex buildings. The detailed energy audit is not regarded as part of the EPC scheme, but as a necessary next step after having completed the EPC. This distinction is necessary for clients' acceptance: an EPC cannot substitute for detailed refurbishment planning, nor has it been designed to do so.

3.2.3 The trade-off between EPC cost and content

The EPC is the most visible part of the EPBD. In several MSs, the EPC has become one of the most-discussed building documents: EPCs should be easily affordable whilst providing a maximum of specific information in order to meet various expectations, resulting in a trade-off between cost and content. However, it is clear that the EPC is first of all a policy instrument and an information tool, and it cannot be a substitute for other detailed technical documents used in the construction and real estate sector.

The majority of MSs declare that the cost for single-family houses is between 100 € and 400 € per EPC (see Figure 8). EPCs for multi-unit residential buildings cost more. Several MSs provided information on EPC cost for non-residential buildings, typically in the range of 1-2 €/m^2, and in one country up to 5 €/m^2. Information on lump sums is around 1,500 € per non-residential building. The reasons behind the variety of EPC costs are unclear and should be explored. A country's economic strength does not seem to have a strong influence on the EPC cost.

Figure 8: Cost of EPCs for single family homes, based on national reports 2014.

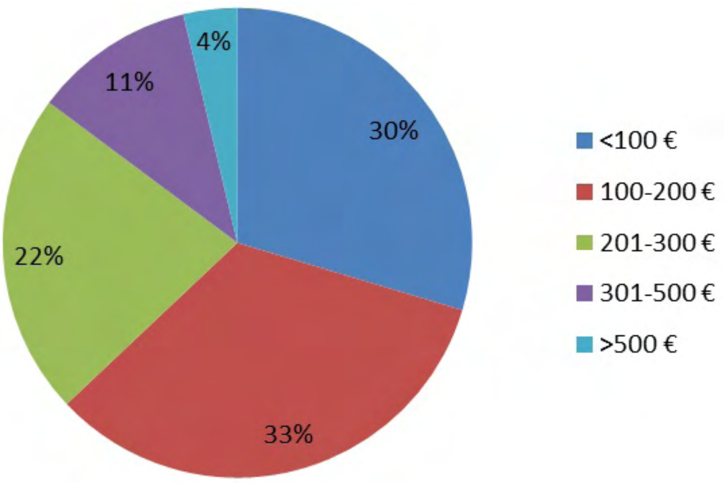
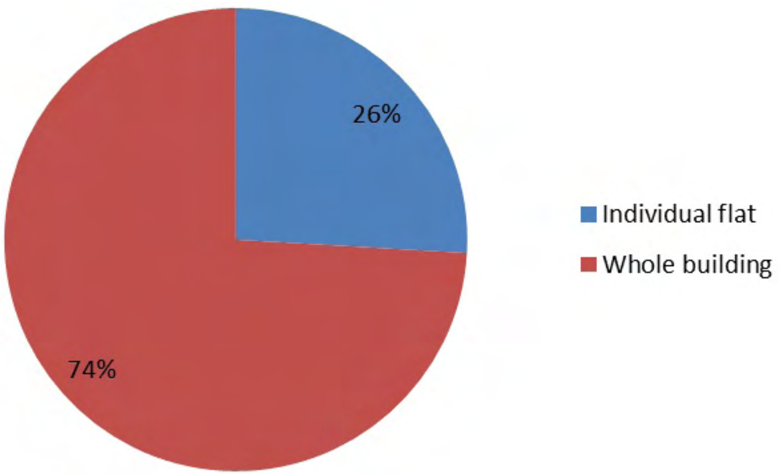


Figure 9: Certification of apartments and blocks of apartments; based on national reports 2014. Note: "Whole building" includes also a whole building EPC valid for the individual apartments in a specific building.



The trade-off between cost and content of recommendations for improving energy efficiency, also came to the fore during the discussion of certification methods for multi-unit residential buildings: there are certification systems in place certifying either individual apartments or whole buildings, or allowing for both approaches to be alternatively applied (see Figure 9).

It is difficult to have a simple and affordable certification method and at the same time provide useful information for both the whole building and each apartment. The certification of an individual building unit could provide tailor-made measurements for its refurbishment, especially when there is an individual heating system and the cost of the EPC is borne by the owner. However, it is difficult to provide suggestions for measurements concerning the whole building, e.g., roof insulation or replacement of a common boiler. The certification of the whole building, on the other hand, provides recommendations for the building envelope, and the heating system and its costs are divided among the owners. However, the energy indicators relating to the whole building can be different from the energy indicators for single units, depending on their location in the building. It would be best to have a certificate for both the building as well as for the individual apartment, but this is considered to be too expensive.

EPC quality as a term is composed of objective elements (e.g., correct calculation according to standard recommendations) and subjective elements (e.g., users' expectations about the kind of information the EPC provides or should provide).

There is a clear trade-off between the demand for affordable EPCs on the one hand and the manifold purposes the EPC should or could serve on the other hand, requiring technical accuracy and thus more effort, resulting in higher EPC cost. However, as the EPC lasts 10 years, higher EPC cost might be acceptable and worth the effort.

Across the EU, the EPC cost for a single-family house is typically between 100-400 €, and for a non-residential building between 1-2 €/m^2.

3.3 Making the best use of EPCs

The EPC and its recommendations provide information and advice to owners and tenants of buildings on how to assess and improve a building's energy performance. The EPC database delivers useful information for energy-related policy assessment and development, such as for reporting energy savings due to energy efficiency measures carried out in the building sector, or for launching investment strategies for increased energy efficiency standards in building renovation.

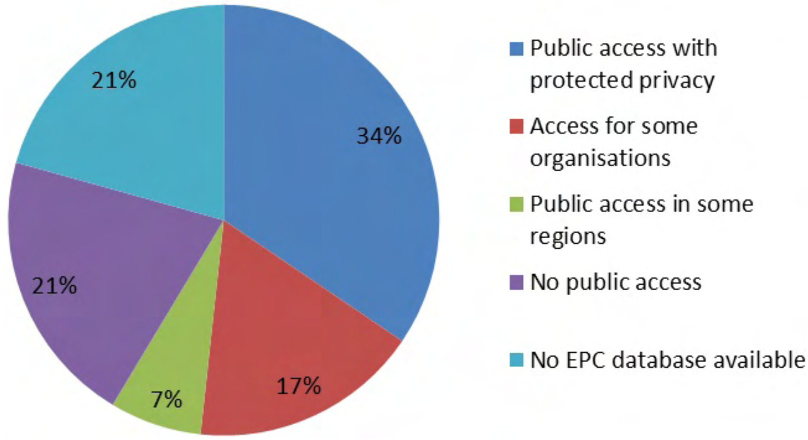


Figure 10: Public access to EPC databases, based on results from the IEE project REQUEST2ACTION, http://building-request.eu/ (2015).

Apart from EPC information stored in the central database, EPCs can be used in various other contexts, e.g., as adding the EPC as a supporting document to the national Green Building Council assessment scheme (e.g., in The Netherlands, Austria), using the EPC for specific programmes (e.g., "fresh schools" programme in The Netherlands), or as a supporting document for subsidies rewarding improved energy efficiency (e.g., Cyprus, Austria).[4]

3.3.1 Examples of Member States making use of EPC databases

MSs have set up EPC databases to monitor EPBD implementation, to control the energy certification process, and to collect data on the building stock in order to provide data for decision making. Utilisation opportunities depend on how access to the EPC database is regulated and whether EPC information can be linked with other data. Many MSs have chosen an open access system to limited or selected EPC information, while in other MSs access is only possible for the authorities, or granted to selected organisations, such as research entities (see Figure 10).

The information extracted from the EPC register can be useful to check if the energy labels on the advertisements for buildings offered for sale or rent are correct. An automatic quality check during the uploading of EPCs and their input data[5] to the database identifies common mistakes in EPC calculation, and thus supports the adaptation of training courses addressing energy experts. Apart from specific purposes like those explained above, another effective use of the EPC database lies in combination with other databases. For example, in Scotland the local authorities need effective data on the housing stock to plan their energy saving programmes. They focus on areas with high levels of fuel poverty. Reliable information on buildings' energy performance, in combination with the data from other relevant databases in these areas, enables them to negotiate with energy suppliers accordingly.

3.3.2 EPC as a supporting document for subsidies related with energy efficiency

EPCs can be used as an objective evidence of the quality of energy-related renovation of the final construction in order to engage stakeholders in achieving the policy targets for European energy and climate protection. In the residential sector, the EPC is already being used in many countries as a document necessary to obtain financial support and subsidies for increased energy efficiency. In 2015, EPCs are required in 10 countries as eligibility for such schemes, most often both before and after the renovation, but there are also 11 countries with subsidy systems that do not require an EPC. In this context, EPC quality assurance plays a key role in a growing number of MSs.

In the non-residential building sector – both commercial and public – because of lack of awareness, information and motivation, followed by lack of confidence in the return of investment, energy efficiency has not yet fully penetrated the market. In general, public buildings should be exemplary for private commercial buildings, although, in fact, it is more difficult for them to access financing. In the private sector, short payback periods and the investor-user

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[4] *For more information see also www.buildup.eu/financing-schemes and "Towards improved quality in energy efficient buildings through better workers' skills and effective enforcement - A view of the Concerted Action EPBD on Challenges and Opportunities" at www.epbd-ca.eu/ca-outcomes/2011-2015*

[5] *More information on these aspects is available in the chapter "Compliance and control" of the EPBD in EU, in this book.*

dilemma still hinder investments in energy efficiency. The life cycle cost approach is a method for assessing the total cost of facility ownership and a motivation to convince investors constructing for their own use. However, for wide application, there are still open challenges, such as how to take into account user requirements changing over time, and how to deal with lifetime of components and intensity of maintenance in the calculation.[6]

To overcome the challenges of financing energy efficiency measures in non-residential buildings, EPCs could become a supporting tool, as has already happened in some countries (e.g., The Netherlands). However, in the commercial sector, the EPC as an asset rating is often not regarded as an investment grade instrument by financing institutions. More information on this topic is available in the chapter on the Effectiveness of Support Initiatives, in this book.

The European Investment Bank (EIB) could play a unique role in strengthening the EPC as it is owned by the MSs and should support them to achieve the 20-20-20 targets. Projects would be eligible for funding from the EIB only if there is proof that they will result in a significant amount of energy savings, CO_2 savings, or use of renewable energy. The EPC can be used as proof, but at present it is not a mandatory condition. If the EIB would also explicitly require an EPC, this would help to consolidate the position of the EPC.

Making the best use of the EPC occurs at two levels: EPC data stored in the central database can be used for policy making and for complying with national reporting obligations.

In case of public accessibility to parts of the database, stakeholders in the real estate and construction sector as well as the general public can make use of EPC information for their own purposes.

The EPC itself could be used not only for obtaining a building permit, but also for getting financial support for increased energy efficiency.

4. Main outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Requirements of advertising EPC indicators	There is an established co-operation with real estate agents and guidelines for using EPC information in advertisements in only a few MSs.	Voluntary or mandatory guidelines for publication of EPC indicators in advertisements are useful to make sure that important information is appropriately presented.	MSs should develop their own guidelines together with the real estate sector, based on the experience of innovators in the area of advertising guidelines (Ireland, Portugal and Belgium-Flemish region).
Access for real estate agents and the public to EPC databases	Space in ads is limited, but an Internet link to the EPC database provides more information: real estate agents can access building data for advertising and clients can check the published EPC information.	Co-operation with real estate agents is essential as they provide the EPC information at the point of sale or rent.	Publicly accessible parts of EPC databases are necessary. MSs with prevailing data protection concerns should find ways to overcome this limitation.
Display of Energy Certificates	EPC display is important for creating awareness of buildings' energy efficiency. The definitions of EPC display requirements in the EPBD allow for different interpretations by MSs.	At the end of 2014, most MSs did not check nor enforce compliance with display requirements. There is room for improvement by public authorities.	EPBD definitions and requirements for EPC display must be clarified in national laws. One solution is to extend the requirement to all non-residential buildings with more than 250 m^2 of floor area.

[6] *Further information on Life-Cycle Cost Analysis (LCCA): www.wbdg.org/resources/lcca.php, https://ec.europa.eu/energy/intelligent/projects/en/projects/lcc-data#results*

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Use of the EPC and meaning of the indicators	EPCs should serve several purposes, and an asset rating alone will not be useful for calculation and recommendation of energy efficiency improvement measures.	The potential of the EPC has to be reconsidered in the context of identifying economically viable recommendations for improving energy efficiency and in the context of financing renovations.	MSs must make the EPC more user-friendly: what kind of information is provided and how target groups can make use of it should be clear and self-explanatory.
Making the EPC user-friendly	It is important to adapt the EPC (layout and content) according to the needs of the users (authorities, experts, the general public and building owners).	The layout and user-friendliness of the EPC is crucial. Using less technical language and icons makes it easier for the owners and general public to understand it.	Text should be short and retrofit recommendations should be on the first pages. The more technical information should be moved to the second part of the EPC.
The estimation of buildings' realistic energy consumption	Default values are useful (in terms of cost and liability) to produce comparable calculation results, but may result in distorted energy savings calculations (when applied to certain buildings/uses).	More realistic setting of boundary conditions and further developing of default values is crucial for calculating more realistic potential energy savings.	Trainings and national guidelines are necessary to enable experts to determine realistic default values for energy savings calculations that are closer to reality.
Trade-off between high degree of standardisation (low cost EPC) and tailor-made EPCs (high cost EPC)	Standard lists of recommendations are a basis for easier monitoring of the recommendations, but they do not substitute for detailed energy audits needed for renovation planning of complex buildings.	Monitoring the implementation of recommendations is important to assess policies and report energy savings.	EPCs must include good recommendations for improving energy efficiency. MSs should monitor the implementation of recommendations to reshape energy efficiency policies.
The EPC as a supporting document for subsidies	In many countries, EPCs are used as required evidence of increased building energy efficiency to reward building owners e.g., by means of subsidies or tax reduction.	In this case, making use of the EPC with an asset rating is appropriate because what is awarded is the building energy efficiency, and not the way the building is used.	Quality assurance is crucial: it must be ensured that EPCs are calculated correctly and that the building is constructed as designed.
Examples of good use of data from the national/ regional EPC databases	EPC-databases are being used intensively in several MSs for developing policy documents, improving building regulations, conducting research on building stock, preparing statistics or training energy experts.	The EPC database provides a good overview of the building stock and is more useful in combination with other relevant databases.	MSs should link the EPC-databases with other energy related databases, in order to tap the full potential for decision-making and policy development.

5. Lessons learned and recommendations

The EPCs' potential to create sustainable awareness depends mainly on two aspects: first, that an EPC is actually issued, and second, that EPC indicators are correct, in order to build trust in the EPC as a reliable information tool. Thus, quality assurance and user-friendliness of the EPCs are crucial. Display of an EPC in public buildings and buildings frequently visited by the public is also important, but there is still a long way to go for most MSs to improve in this respect.

The presence of energy indicators in the media contributes to customers' awareness of and demand for energy efficient buildings. In this context, cases have been seen where poor energy indicators have been hidden in advertisements, which sometimes include creative solutions such as A (not yet rated), C+ or D-, which do not exist as part of the national legislation but allow the building performance to appear better than it actually is. Such deviations might concern honest errors, but they could also happen intentionally, e.g., because studies show that buildings with good energy performance sell or rent more quickly. In order to prevent not just mistakes but also fraud, some countries (e.g., Portugal, Belgium and Ireland) have developed mandatory or voluntary guidelines on how energy-related information should be presented in the media.

The experiences of these countries show how important it is to engage the stakeholders, namely real estate agents and their associations, but also print and electronic media, in the process of developing guidelines. This involvement assures that guidelines will be accepted, information is placed correctly, and mistakes regarding energy labelling are avoided.

Concerning access to EPC databases, data privacy issues are important in some countries and must be dealt with with care. However, accessing EPC databases and making use of EPC data offers interesting opportunities, which have to be considered as well. Investment in building renovation opens new opportunities for new services. For this purpose, it could be useful to provide at least limited access to EPC databases because new services can only be developed if comprehensive data analysis is possible. This has triggered a ‘rethinking’ process in Denmark, and other countries should also consider following suit.

The reliability of the EPC is crucial for its acceptance. Calculating the EPC based on actual building components and technical systems data instead of using default input values will result in a more realistic picture, but may increase the cost of the EPC. While data availability is good for new construction projects, existing buildings lack specific information for EPC calculation. Instead of carrying out costly data collection exercises, it is recommended to further develop default values to arrive at more realistic EPCs while keeping costs modest. Combined EPCs consisting of asset rating and operational rating represent a cost-efficient approach to provide realistic information about the actual building energy consumption. This is an essential precondition for the recommendation of cost-effective renovation measures.

The EIB, which is owned by the MSs and will support them in achieving the 20-20-20 targets, should request EPCs as mandatory proof for the projects that they finance, before and after the renovation, as the EPC indicates the building-related energy demand, CO_2 emissions, and renewable energy use. The EIB’s use of the EPC will contribute to the EPC’s solid reputation and will also provide an added incentive for MSs to comply with the EPBD. The same principle is already required by the EPBD for national support of building renovation, though not all MSs have fully applied this requirement yet either.

Inspections

OVERVIEW AND OUTCOMES

AUGUST 2015

AUTHOR

Bruce Young,
BRE

1. Introduction

This report covers regular inspection of heating and air-conditioning (AC) systems and the alternatives to it that are allowed by the Energy Performance of Buildings Directive (EPBD). It has been extended to include technical building systems (TBS) as well. The subject matter comprises:

- *inspection schemes themselves (how they are set up and operated, frequency of inspection, the inspection procedure to be followed, and the reporting of results and recommendations);*
- *alternative measures that can produce an equivalent impact in terms of saving energy;*
- *how equivalent impact should be demonstrated and reported;*
- *electronic monitoring and control systems that can be recognised as a partial substitute for inspection;*
- *the regulatory requirements for technical building systems in existing buildings.*

The first version of the EPBD (Directive 2002/91/EC) had to be transposed by January 2006. For heating systems with boilers there were two options: regular inspection or alternative measures having an equivalent overall impact. Member States (MSs) who already had compulsory regular maintenance schemes were able to adapt them, but for others this was a new and unfamiliar task. In addition to developing the technical content of procedures and reports, it was necessary to build up a suitably qualified and/or accredited workforce, introduce scheme operating procedures with quality controls, and create codes of conduct and arrangements for handling complaints and appeals. For AC systems, inspection was obligatory as there was no option to adopt alternative measures.

The current version of the EPBD (Directive 2010/31/EU) had to be transposed by 9 July 2012 at the latest. It changed the scope of the inspection requirements, and allowed alternative measures for AC as well as for heating. All existing schemes had to be adapted to meet the new scope. Directive 2010/31/EU also introduced a new requirement for regulations concerning TBS in existing buildings, the scope of which extended to design, installation and control as well as energy performance. The Directive requires penalties to be imposed for any infringements of the national provisions.

Two of the CEN standards written for the EPBD cover inspection of heating and AC systems. Others have some relevance to the performance of TBS. However, the first set of CEN standards written for the EPBD was delivered too late to be fully used in national transpositions of Directive 2002/91/EC (the first version of the EPBD), and they were unsuitable for inclusion in transpositions of Directive 2010/31/EU (the second version) as the scope had changed. The CEN standards are being re-written to match Directive 2010/31/EU and are expected by 2016.

2. Objectives

The objectives of the Concerted Action EPBD (CA EPBD) work on inspections and TBS were:

- To develop a wider understanding of the detailed requirements and options in the EPBD concerning inspection of heating and AC systems. Variations can be introduced according to system type, fuel, power rating, monitoring, and control.

> To consider regulations for existing buildings with newly installed, replaced, or upgraded TBS. Regulations are needed not just for energy performance but also for proper installation, dimensioning, adjustment, and control. Regulations must also encourage intelligent metering.
> To understand feasible alternatives to inspection and their effect on the energy used by heating and AC systems.
> To develop the methodology whereby it can be shown that alternative measures have an equivalent impact to inspection, and examine ways in which equivalence is reported to the EC.

Ongoing technical and legislative developments and new standards for the energy performance of Heating Ventilation and Air-Conditioning (HVAC) systems are relevant to these objectives. They include system performance measurement, labelling, monitoring and control, and a possible connection with energy auditing for the Energy Efficiency Directive (EED – 2012/27/EU).

Figure 1: Intervals between inspection of heating systems.

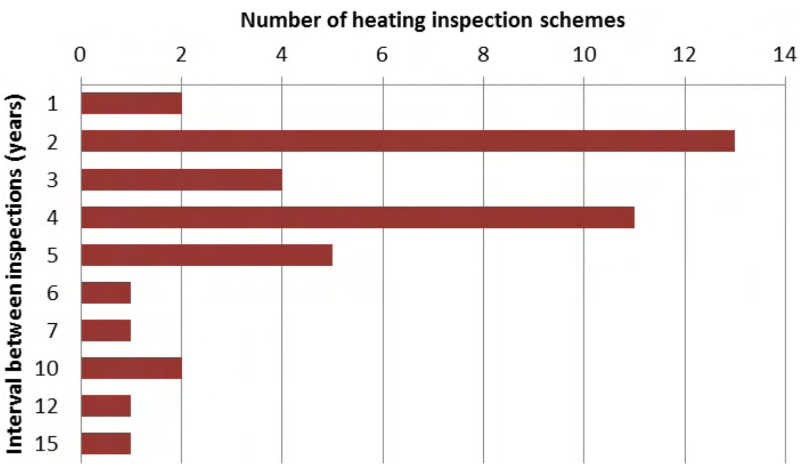
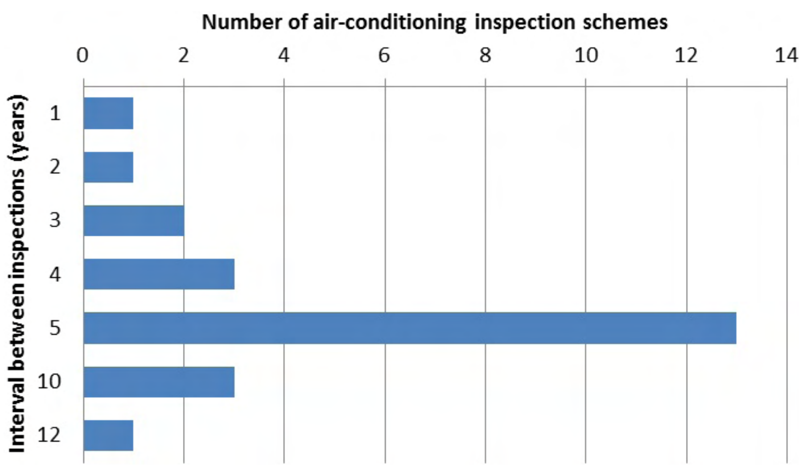


Figure 2: Intervals between inspection of air-conditioning systems.



3. Analysis of insights

3.1 Understanding the options

3.1.1 Scope and frequency of inspection

Regular inspection stands apart from other requirements of the EPBD, and many options are allowed. Schemes can be designed with different intervals between inspection for the various types of heating and cooling plant, their rated output, and the fuel used. Other factors that can be taken into consideration are the likely costs and benefits of inspecting each type, and whether or not an electronic monitoring and control system has been installed.

A comparison between MSs shows that they have made widely different choices, as permitted by the Directive. Their choices reflect variations in national conditions, customs, and practices, as well as ideas about relative costs and benefits. The overall cost of inspection is strongly affected by the frequency and intensity of inspection. No formal cost-benefit studies of inspection schemes in operation are required by the Directive, and enquiries made by the CA EPBD have not found any. Although inspection can be lightened or reduced when electronic monitoring and control is installed, so far only one MS is intending to take advantage of this option.

3.1.2 The meaning of "regular"

The interpretation of "regular inspection" has been clarified by the Commission services, saying that it should occur at least twice within the typical lifetime of the system. As the typical average lifetime of modern boilers is around 15 years, a reasonable maximum interval between inspections of heating systems (where not already fixed by the Directive) would, in that case, be 7 years. In practice, all MSs with inspection schemes have different inspection intervals depending on plant type and size. These are shown in Figures 1 and 2 (for MSs that adopted inspections rather than alternative measures). It can be seen that there is a wide variation for heating systems to allow for different fuels and boilers sizes, whereas for AC the most common inspection interval is 5 years.

3.1.3 Synergy with energy auditing

Energy auditing is a requirement of the Energy Efficiency Directive (EED). It applies to the buildings of large enterprises (businesses), but also has to be available as an option to smaller enterprises and the residential sector. As both inspection and audit involve visits to site by an independent qualified expert, there is an interest in the extent to which the two Directives overlap. There is also the building certification requirement of the EPBD, making a third activity in which a qualified expert has to visit a building.

Taken together, there may be opportunities to combine these activities within a single operating scheme. In four MSs, the regulations are shared, while still distinguishing the technical activities. Following the procedures and producing the reports for energy auditing and regular inspection are separate specialised activities, but some of the necessary skills and some of the data may be the same. Sharing of organisational arrangements (the Code of Conduct, for example) is likely to be feasible. This is a relatively new area for investigation, and has only been examined by the national representatives in the CA EPBD in late 2014 / early 2015.

3.1.4 Alternatives to inspection

Alternatives to inspection (known as "alternative measures") are chosen by MSs who consider that physical inspection is too expensive relative to the likely benefits, or is unworkable for other reasons. They are more common in MSs that did not already have an established compulsory maintenance regime and workforce (such as regular boiler safety inspections, or the chimney sweeps). Figure 3 shows which MSs have chosen alternative measures.

Reasons for their choices are given in individual country reports. They include high cost relative to benefits, the small number of individual boilers compared with district heating, and that regulations already ensure high standards beyond which there is little scope for improvement. Other factors influencing the decision are that inspection is intrusive and unpopular, has doubtful benefits as there is no obligation to follow the recommendations in the inspection report, and the risk that it becomes simply a 'compliance exercise' with little value.

Figure 3: Implementation of inspection or alternative measures.

It is notable that all the MSs who have an inspection regime for heating systems have also chosen to inspect AC systems. Speculative reasons are that some MSs have a greater ‘propensity to inspect’ than others, and that there is a stronger case for alternative measures for heating than AC because there are large numbers of small heating installations in residential premises.

The selection of alternative measures carries the obligation to produce a report every 3 years demonstrating that the impact is equivalent to what would have been achieved if a regular inspection scheme had been operating instead. The report is often described as the “equivalence report”.

There is no restriction on what can be chosen as alternative measures, other than that they must deliver reductions in energy usage by heating and AC systems, and they must not be double counted with measures introduced to comply with other parts of the EPBD or with other Directives (e.g., the obligations set on the energy suppliers by the EED).

Member States can make many different choices when deciding how to implement regular inspections under the Directive, and have taken advantage of this flexibility.

Thirteen (13) have chosen alternative measures in place of inspection of heating systems. Seven (7) have chosen alternatives to air-conditioning inspection, this being a new option available since transposition of Directive 2010/31/EU in 2013.

Figure 4: A guide on inspection procedure (TM44).

3.2 Inspection methods and their impact

3.2.1 Standards

Two CEN standards were written for inspection of heating[1] and inspection of air-conditioning[2] systems to meet the requirements of Directive 2002/91/EC. They are being re-written to match the changes in Directive 2010/31/EU and revised versions have been produced for public consultation in summer and autumn 2015.

Earlier CA EPBD work has indicated that 87% of MSs do not use the CEN standards or only use them selectively, extracting parts rather than citing the whole document. Interpretation into practical guidance at a working level is necessary, such as the CIBSE Technical Memorandum[3] which preceded EN 15240 and influenced its development. At working level, it is necessary for each step of a robust overall procedure to be defined, explaining what has to be done, what has to be recorded, and how to deal with difficult and exceptional circumstances.

MSs have requested that revised CEN standards are made more straightforward and procedural, focusing on the simpler options, so that they can be referenced in legislation without the need to produce accompanying guidance and interpretation.

3.2.2 Review of schemes

After 6 years of experience, at least 5 inspection schemes have been reviewed. Changes were needed partly to meet the new requirements of Directive 2010/31/EU, partly to improve the way schemes worked, and partly as a result of other alterations to the structure or scope of national regulations. Difficulties to be overcome included collection of data, how to deal with incomplete inspections, rules for distinguishing between “simple” and “complex” systems, and how reports could be made more suitable for non-expert building owners. The lack of data about installed equipment and the amount of time required to collect it is a widespread difficulty, especially for complex systems. This indicates that better methods of information management are needed.

3.2.3 Assessment of efficiency and capacity

Inspection requires examination of all accessible parts of the system, which is relatively straightforward though some defects will not be visible. The more difficult aspects of inspection are reporting on system efficiency and capacity relative to the demand of the building. These call for a level of

[1] *EN15378: Heating systems in buildings — Inspection of boilers and heating systems*

[2] *EN15240: Ventilation for Buildings – Energy Performance of Buildings – Guidance for inspection of air-conditioning systems*

[3] *CIBSE Technical Memorandum TM44: Inspection of air conditioning systems*
www.cibse.org/Knowledge/CIBSE-TM-%281%29/TM44-Inspection-of-Air-Conditioning-Systems

engineering knowledge beyond that normally held by maintenance technicians. Yet it is unnecessary to estimate efficiency and capacity with great precision, as a heating or cooling system has to be very inefficient or very severely mis-matched to the building before a recommendation to replace it becomes cost-effective. The conclusion is that simple methods would be sufficient, without extensive calculations, and they could be based on available information such as manufacturers' test results, data from EPCs, and tables of building characteristics based on a simple classification system. Frequently the methods are not prescribed by regulation, being left to the decision of the inspectors. Although, in theory, the heat demand of the building might be obtainable from an Energy Performance Certificate (EPC), none of the MSs has said that EPCs may be used as input to the assessment of suitable capacity.

3.2.4 Advice following inspection

The essential purpose of inspection is to recommend improvements to energy performance that are cost-effective, but deciding what is cost-effective is not straightforward. Many inspection reports tend to be over-complicated and poorly suited to the needs of non-expert building owners; this means they are at greater risk of being ignored. Advice on building improvements is already being given in EPCs, where much more attention has been paid to making reports 'user-friendly' (more readily understood), though the opinion of MSs is that the information produced for EPCs is not sufficiently detailed for heating and AC systems.

For heating systems, the IEE project MOVIDA[4] (completed in 2013) studied the prospect of generating advice systematically, with computer assistance. The project developed an inspection software tool, in an attempt to rationalise, and partly automate, advice given in inspection reports. Practical difficulties prevented its widespread adoption; the reasons were legal or organisational barriers, and a lack of commercial incentives. However, MOVIDA reports were liked by customers and the tool remains available for national adaptation, with the potential to improve consistency of advice.

Inspection schemes have been running since 2009 and, in at least 5 cases, reviewed.

Missing information is the biggest impediment to speedy inspection.

Inspection reports tend to be overcrowded with technical detail, rather than focusing on important messages for non-technical building owners.

Little has been done so far to evaluate the wider impact and cost-effectiveness.

3.3 Alternative measures with equivalent impact

3.3.1 Allowable alternatives

Alternative measures always include advice in some form, though not specific to each installation. In addition they comprise publicity and promotional campaigns, grants and financial incentives, tax relief, voluntary inspection and voluntary agreements, compulsory maintenance, regulations to replace old and inefficient components, and energy company obligations in excess of those needed to meet EED targets.

There is no uniformity in approach to advice or other alternative measures, as the EPBD does not require it. Nor is there any consistency in the impact assessments and preparation of what have come to be called the "equivalence reports". There are a number of questions about alternative measures without conclusive answers, such as:

> What type of advice can be considered to fulfil obligations under the EPBD? For example, must it be limited to advice about the systems themselves, or can it be expanded to changes to the building that would reduce demand?
> How is the impact of advice to be measured, and over what periods?
> What data is required to do so?
> What would have been the impact of inspection if that had been carried out instead?

The first two equivalence reports under Directive 2010/31/EU were due in June 2011 and June 2014 and, for heating systems at least, the reports are starting

[4] *MOVIDA ("MOVing from Inspection to Domestic Advice by service companies") – www.movida-project.eu*

to deal with these questions more specifically. For AC systems no experience has yet been built up by MSs. Directive 2010/31/EU, unlike 2002/91/EC, includes forecasting for a period ahead in addition to reporting the preceding period.

3.3.2 Demonstration of equivalent impact

The equivalence reports sent by MSs to the EC in 2011 were unsatisfactory in many respects and unacceptable to the EC, leading to demands for further information within the 9 month additional limit allowed by the EPBD. Expectations on reporting were clarified in letters sent to MSs in August 2012, in which the EC set out the information needed to demonstrate equivalent impact. Requested information includes a description of the alternative measures, a description of a hypothetical inspection scheme which they replace, a statement of the methodology used together with its sensitivity to critical assumptions, and results from the assessment of each scenario expressed in units of energy.

The principal components of the impact assessment are shown in Figure 5. As there is no inspection regime in a country that has chosen alternative measures, comparison with what an inspection scheme would have achieved can only be speculative. Comparison with other countries that do operate an inspection regime may have some limited validity, but the EPBD does not require the impact of an inspection regime to be evaluated and MSs have not done so. Consequently there is no body of data (albeit in other countries) with which comparison can be drawn.

Figure 5: Components of the impact assessment study.

Scenarios	no intervention
	inspection
	alternative measures
Data	building stock model
	boiler system or air-conditioning system stock model
	energy usage by these systems
Assumptions	improvements that might be recommended
	the energy-saving value of each type of improvement, and its duration
	how many of each type were recommended, and how many were carried out

3.3.3 A reporting framework

The CA EPBD has done a lot of work exploring what is relevant and necessary in an equivalence report for heating systems, and how data for it should be gathered and analysed. A working group has produced a reporting framework, intended to encourage greater uniformity by using a structured approach. The framework describes two principal methods, known as 'top-down' and 'bottom-up' (Figures 6 and 7). They formalise what has already been done in some countries. The choice of which to use depends mainly on the type of data available: 'bottom up' is more suitable where there is a reasonable set of data on buildings and heating or AC systems, whilst 'top down' can be used where only national energy usage data is available.

Outline requirements for the information needed to demonstrate equivalent impact have been provided by the EC, and the CA EPBD developed a reporting framework and a public report on comparing alternative measures with inspection.

So far, experience is available only in regard to equivalence reports for heating systems. More experience needs to be accumulated from MSs for equivalence reports for air-conditioning systems.

3.4 Electronic monitoring and control systems

Automatic building monitoring and control is recognised by the EPBD and can be used to develop benchmarks and reduce inspection frequency. European projects show that it has the potential to find energy saving opportunities more cheaply and effectively than regular inspection alone. But MSs have not yet decided what technical characteristics of monitoring systems are essential, and how regulations should allow monitoring to be combined with inspection effectively.

3.4.1 Experience with monitoring

Physical inspection is necessary to assess the age and condition of equipment, and its suitability for purpose. Monitoring can show whether systems are using energy in line with the expected demand from a building of comparable type, size and occupancy. It also reveals demand patterns, and alterations in performance consequent to changes such as maintenance, operation, replacement of components, or adjustment to control settings.

Figure 6: Framework for top-down analysis.

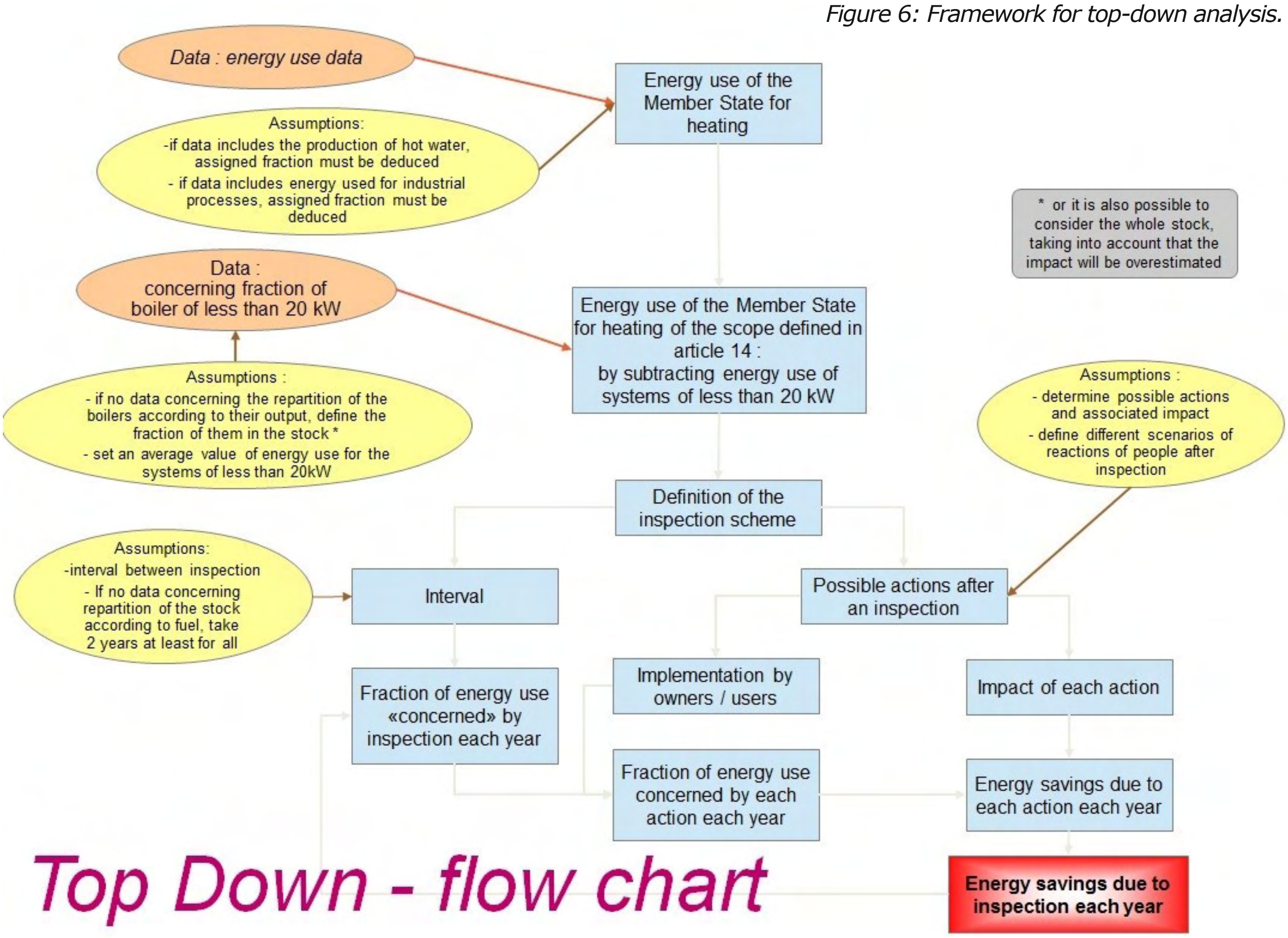
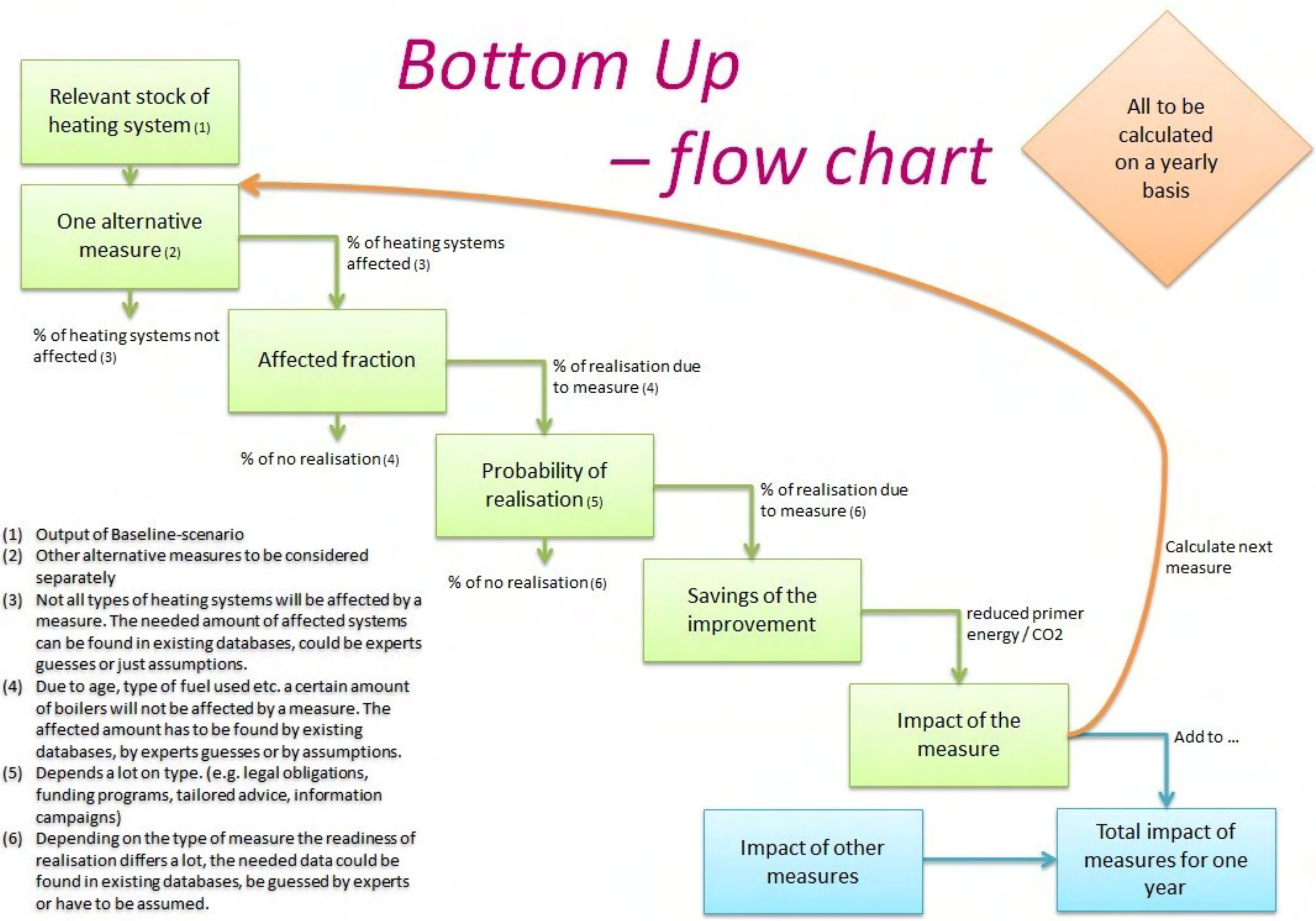


Figure 7: Framework for bottom-up analysis.

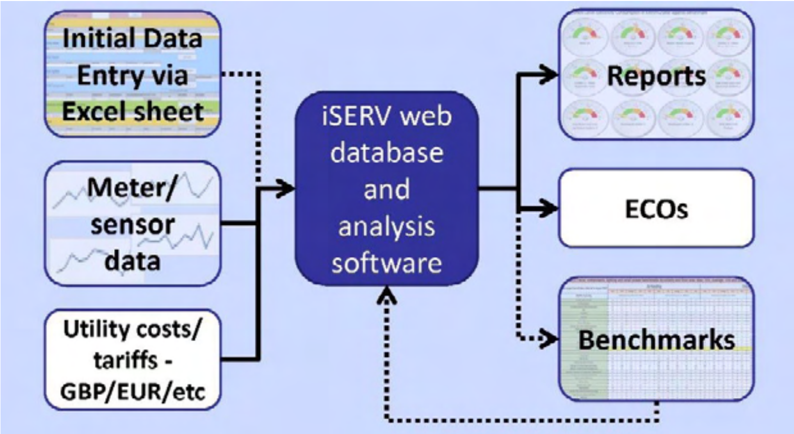


The CA EPBD participants have explored the capabilities and potential for electronic monitoring and control of heating and AC systems, and in particular how allowance might be made for it in regulations. The European HARMONAC[5] project (completed in 2010) had found that the average energy savings potential for individual AC systems was 35-40% of their measured consumption and indicated that monitoring was more likely to be cost-effective than universal inspection. A later European project, iSERV[6] (completed in 2014), was designed to look at the prospects for automatic monitoring of buildings on a larger scale. The iSERV project acquired data from 733 systems in 16 countries.

These projects concluded that automatic monitoring schemes should offer continuous feedback on performance over long periods, and that monitoring revealed many installations had much greater potential for savings than the inspections had suggested. Monitoring identifies "energy conservation opportunities" (ECOs) and produces national benchmarks, as illustrated by the general concept (Figure 8). The combination of inspections and monitoring helps to find measures that an inspection on its own would not be able to identify. However, some measures become ineffective after a while (filter changes, control adjustments, etc.) and continuous monitoring can show when they need to be repeated. MSs will have to decide what characteristics are required of an acceptable monitoring scheme so that it can be recognised as a partial substitute for inspection.

One MS is following these recommendations (see 3.4.2).

Figure 8: Monitoring to find 'energy conservation opportunities' (ECOs) and develop benchmarks.



Economies of scale may be achievable through cooperation between MSs. An example is sharing the evidence of the impact of building-related measures carried out for the EED.

Furthermore, there are two areas in which the EED and EPBD call for similar activities (although there are important differences in scope and results). The first is energy auditing and regular inspection, as discussed in 3.1.3. The second is smart metering and billing for the EED, and intelligent metering and active control of TBS for the EPBD, as discussed in 3.5.3. In these areas there would be advantages in developing the same methods and working practices for both the EED and EPBD.

3.4.2 Monitoring to facilitate or replace inspection

In the context of regulations for the EPBD, a way of handling cases of apparently bad performance would need to be developed and legally supported. Regulations would have to be framed so that inspection is required of those installations provisionally identified as inefficient by the monitoring scheme. Selection of badly performing installations should be by specified objective criteria, but may still require expert engineering judgment. Difficulties arise not so much at technical level (e.g., availability of monitoring equipment, transmission of data) but on defining the concepts (e.g., what is a monitored building, how does the level of performance change the defined frequency of inspections) and how to frame this in legislation.

In short, MSs did not feel confident on putting these ideas into law. At present, only one MS is preparing regulations that will recognise monitoring as a partial substitute for inspection. Nevertheless, doing so more widely would allow inspection requirements to be relaxed, creating a financial incentive to join an approved monitoring scheme. Presentation of the case for building this option into national legislation requires convincing evidence and further thought, and the CA EPBD has produced a report[7] suggesting how to approach this. Even if not feasible at present, it is important that national legislation does not block the opportunity for automatic monitoring in future.

[5] *HARMONAC – Energy Consumption in European Air Conditioning Systems and the Air Conditioning System Inspection Process www.harmonac.info*

[6] *iSERV – Inspection of HVAC Systems through continuous monitoring and benchmarking www.iservcmb.info*

[7] *Concerted Action EPBD Report www.epbd-ca.eu/outcomes/Report_Automatic_Monitoring.pdf*

3.4.3 Building management systems as contributors to monitoring

More recently there has been interest in building management systems (BMS) as another means of continuously collecting data about system performance. European Standard EN15232:2012 was created to establish conventions and methods for estimating the impact of building automation and control systems on energy performance and energy use in buildings. A building control assessment scheme implementing EN15232:2012 and a rating label (Figure 9) has been developed by the trade association (eu.bac) to facilitate this. The assessment scheme and label are concerned with control capability rather than measured energy performance of systems and buildings, but they may have a role to play in determining how relevant data can be captured and transmitted to automatic monitoring schemes for continuing long-term analysis.

Before BMS can be used in the wider concept of schemes for automatic monitoring and analysis by a central service, further work has to be done to agree on standard data formats and transmission protocols. Such developments could be pursued at EU level as technical projects or in standards committees. No MS has yet implemented any measure including BMS in relation to inspection requirements.

Intelligent Energy Europe (IEE) projects show that electronic monitoring and control has the potential to find energy saving opportunities more cheaply and effectively than regular inspection alone.

A large number of buildings can be monitored continuously, with reports generated automatically when certain conditions are detected.

MSs have yet to decide what technical characteristics of monitoring systems are essential, and how regulations should allow monitoring to be effectively combined with inspection. This could be facilitated by work at EU level.

The increasingly wide use of BMS may be the key to further progress, though standard data formats and transmission protocols will have to be agreed to ensure interoperability between devices and equipment from different manufacturers and the networks infrastructure.

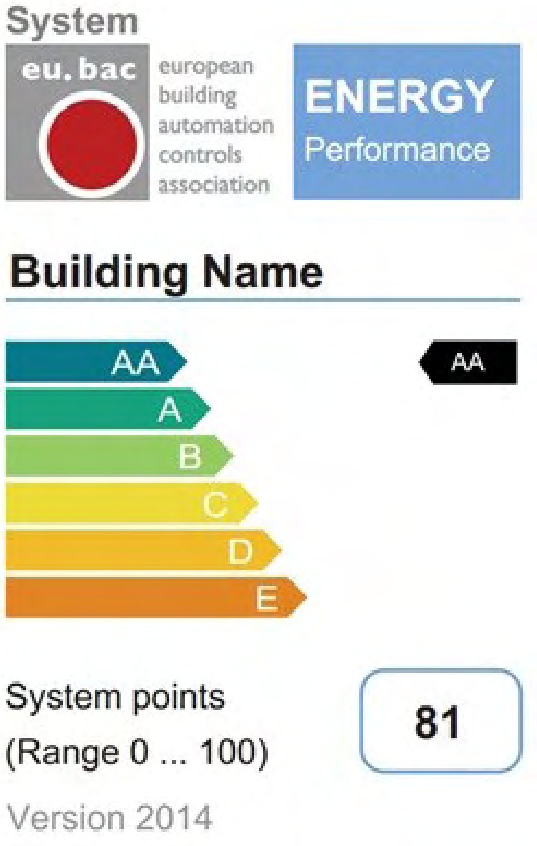


Figure 9: eu.bac label for building automation and controls.

3.5 Technical Building Systems (TBS)

3.5.1 System performance

The EPBD defines 'Technical Building Systems' and the need to regulate them when they are newly installed, replaced or upgraded, in existing buildings. In new buildings, regulation is optional. Confusion has arisen about the interpretation of "existing buildings", which is sometimes taken to mean only buildings that are undergoing renovation. The EPBD makes clear that regulations are needed for all TBS installations, whether or not the building is undergoing renovation.

The EPBD requires that the regulations cover energy performance, proper installation, dimensioning, adjustment, and control. TBS must be considered at the system level, which is distinct from whole building performance (as measured for EPCs) and individual product performance, as measured for minimum standards and energy labelling under other Directives, e.g., the Ecodesign Directive (Directive 2009/125/EC).

Analysis of systems needs building data, as the service demand from the building affects dimensioning and performance. Calculations are usually required.

Designers and installers need established procedures to follow, which are technology dependent; e.g., there should be separate methods for boilers, warm air units, heat pumps, and other types of heating systems.

Some MSs have now developed practical methods for this purpose. In 5 MSs, calculations are needed to ensure the installation will meet a minimum standard of energy performance. Methods are not necessarily the same as for new buildings, as comprehensive data is not likely to be available, but in 3 cases MSs expect the same calculations to be performed. Calculations may hamper rapid replacement in circumstances where building data is not available and restoration of the service (especially heating) is urgent, although it has been reported that this does not cause serious problems and very few requests for exemption are received.

All MSs who have responded to surveys have some regulations in place for TBS, and at least 13 set minimum standards for energy performance of TBS. However, coverage of all the technologies, including installation, dimensioning, adjustment, and control, is a significant challenge. There is more work to be done, especially for combinations of systems (explicitly mentioned in the EPBD). Common examples are integrated systems for heating and hot water, and for heating and cooling. Comprehensive coverage, and comparability between MSs, are subjects that remain to be explored.

3.5.2 TBS in new buildings

Regulations for TBS are not obligatory in new buildings. Nevertheless, at least 18 MSs apply TBS regulations to new as well as existing buildings, and in 12 cases the same regulations apply to both. The position is summarised in the Table of Key Implementation Decisions[8]. The Table shows that 13 MSs have minimum performance requirements of some kind in new buildings for heating, 10 for hot water, 6 for AC, and 6 for large ventilation systems. Such requirements may apply to generation, distribution, thermal emission, control, specific fan power, and heat recovery.

3.5.3 Intelligent metering of TBS

Each of the EPBD, the Electricity Directive (2009/72/EC) and the Energy Efficiency Directive (2012/27/EU) have requirements for intelligent metering systems or smart meters. They can be summarised as:

- EPBD: Article 8(2) - encouragement to install intelligent metering systems whenever a building is constructed or undergoes major renovation. This must be in line with Annex 1(2) of the Electricity Directive (intended to assist the active participation of consumers in the electricity supply market), and the further encouragement where appropriate to install active control systems for TBS such as automation, control and monitoring systems (intended to save energy).
- Electricity Directive: Article 3(11) - introduction of intelligent metering intended to optimise the use of electricity; also Annex 1(2) - intelligent metering intended to assist the active participation of consumers in the electricity supply market.
- Energy Efficiency Directive: Article 9(1) - installation of smart meters for final customer's electricity, natural gas, district heating, district cooling, and domestic hot water, intended to show actual energy consumption and actual time of use.

There is some scope for integration of all these at the technical level for interoperability, data collection, and transmission and display of data. In the context of a proper implementation of EPBD Article 8, without detriment to the requirements of the other Directives, intelligent metering could apply as well to individual TBS, so that their consumption can be monitored and analysed individually.

TBS are clearly defined by the EPBD and regulations must provide for their proper installation and performance in existing buildings, but MSs have given little attention to this part of the EPBD until recently.

While progress has been made, coverage is by no means complete for all the requirements with all the technologies involved.

"Existing buildings" means all such buildings, not just those undergoing major renovation. Regulations for TBS in new buildings are optional, though a significant minority of MS have applied them.

Although the purposes are different, the requirements for intelligent metering systems and smart meters in each of the EPBD, Electricity Directive and Energy Efficiency Directive can be integrated at the technical level.

[8] See www.epbd-ca.eu/countries/indicators

4. Main outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
MSs' decisions on how to implement Directive 2010/31/EU	MS choose inspections or alternative measures (and variants of both) for a variety of reasons.	Thirteen (13) MSs have chosen alternative measures for heating systems and 7 for AC systems.	Evaluation of equivalence reports for alternative measures by the EC.
Frequency of inspections	Changes to scope of inspection. New options to adjust frequency of inspection. Additional requirements for reporting to building owners.	Inspection frequency varies widely among MS.	A better understanding of the trade-off between inspection frequency and the costs/benefits for different system types.
Inspection methods	Review of schemes, which have been in operation since January 2009. Re-writing of the CEN standards for inspection. Possibility of linkage with EPCs to assess demand.	Main problems are collecting data, classifying systems, access difficulties, accuracy, and making reports intelligible to non-technical building owners. Load reduction measures should be treated with greater importance.	Data collection should become a less skilled procedure. Clear classification of system types. Examination of cost-effectiveness. Overlap with energy audit.
Synergy with energy audit	Prospect of sharing some activities with energy auditing (requirement from EED for enterprises).	The scope and intention of regular inspection and energy audit are different: however, some aspects overlap and can be shared.	Rationalisation of the various skills and organisational arrangements needed for experts to visit buildings.
Energy saving impact of inspection and the recommendations following it	Little knowledge about quality and influence of inspection reports. Use of data from inspections to develop national stock models for plant type, age and energy performance.	Impact has not been assessed. Reports are not analysed for usefulness, accuracy, or impact. Follow-up surveys and cost-benefit studies have not been carried out to inform prospective changes.	A standard data structure for reports to permit central storage and analysis. Reporting re-designed to address non-technical building owners. Links to recommendations in EPCs.
Equivalence reports: advice instead of inspection for heating and cooling systems	Information from EC on what is expected. Comparison with hypothetical inspection schemes. Data requirements.	A reporting framework has been developed. A hypothetical inspection scheme has to be defined for comparison.	Better understanding of methodology to produce quantified results. Reports now require forecasting as well as retrospective analysis.
Automatic monitoring and control systems as a means of reducing inspection frequency	Monitoring as an option recognised by the EPBD. Justification for reduced frequency of inspection of monitored systems.	Monitoring not yet implemented by any MS; there is low awareness of its potential. Concerns remain about privacy, security, safety and cost-effectiveness.	Study costs and benefits of automatic monitoring and how to apply it in a regulatory context. Incentives to create monitoring schemes.
Prospects for monitoring (collecting and analysing energy data) of HVAC systems in many buildings across Europe	Comparison with physical inspection. Success at finding energy saving opportunities more cheaply. Production of benchmarks for performance comparison.	Monitoring is more useful for larger buildings, usually with AC but also other TBS. Regulations should allow for future monitoring, even if not ready and proven at present.	Define the qualities required of an 'approved' scheme, inspection being necessary only when poor performance is found. Extend passive monitoring to active control, and link with BMS.
TBS with pre- and post-installation requirements	Experience that lies in areas other than the EPBD (e.g., building codes). Slow progress by MSs in catching up with these EPBD requirements.	A system approach is needed. Calculations using building data are necessary, and may be difficult for installers.	Synergy with product regulations under Ecodesign, which now look more widely at system performance.
TBS in existing buildings	Scope of the regulations: are they wide enough?	Regulations must apply to all new and replacement TBS installations.	Focus must shift towards system installation procedures, rather than requirements on major renovation.

5. Lessons learned and recommendations

The range of permissible implementation options for inspections needs careful thought as the decisions made have a large influence on the cost of an inspection scheme. Member States (MS) of the EU have already made their decisions for transposition and are not likely to change them until the Energy Performance of Buildings Directive (EPBD) is next reviewed, but aspiring members (in the Energy Community[9]) are actively considering all options.

The EC has clarified their understanding of the meaning of "regular" inspection, and has emphasised the revised scope of inspection under the Directive 2010/31/EU. Inspection schemes should be checked to ensure they now include all "accessible parts" and, in the case of heating systems, include boilers using any fuel.

Despite the success of EU projects on automatic monitoring, no MS has yet included an allowance for monitoring within inspection regulations – although the EPBD specifically allows for it. Doing so would help to create an incentive for building owners, and a consequent demand for new commercial monitoring services.

Regular inspection of heating and air-conditioning (AC) systems is similar in operation to other inspection activity, notably building certification for Energy Performance Certificates (EPCs) and energy auditing for the Energy Efficiency Directive (EED). The separate activities might be combined under one organisational structure, while keeping the inspection procedures themselves separate from one another.

The EC has also clarified what information should be provided to demonstrate that alternative measures have an equivalent impact to inspection schemes. The new reporting framework developed by the Concerted Action EPBD (CA EPBD) takes account of this, and can be used to make reporting more straightforward in the future.

Regulations for technical building systems (TBS) in existing buildings are starting to be introduced and may require design calculations. This strengthens the need for better preservation of, and access to, relevant building data (e.g., heat loss figures). Methods used are technology-dependent, and more work is needed to produce a comprehensive set of design and installation procedures for all the technologies used in existing buildings.

Training

OVERVIEW AND OUTCOMES

AUGUST 2015

1. Introduction

Focus on the training of experts is essential in ensuring the transfer of knowledge on issues related to the Energy Performance of Buildings Directive (EPBD). Within the framework of Article 17 of Directive 2010/31/EU, Member States (MSs) must ensure that the energy performance certification of buildings and the inspection of heating and air-conditioning systems are carried out in an independent manner by qualified and/or accredited experts.

From 2013 - 2015, Concerted Action EPBD (CA EPBD) participants discussed the necessity of retraining those experts already authorised to issue Energy Performance Certificates (EPC), in order to tackle the new challenges that will come with the introduction of Nearly Zero-Energy Buildings (NZEB), and in order to assess effective approaches to training new experts. The training discussions were based on lessons learned since the beginning of the EPBD implementation, and took into account the conditions for new constructions, as well as renovation of existing buildings. In particular, the group considered the use of realistic energy saving estimations highly important during the process of preparing the recommendations for improvements to be included in the EPCs. Different areas of energy saving possibilities were considered to create a basis for co-ordinated approaches to training and accreditation of experts.

The CA EPBD also discussed the synergy between inspection (set in the EPBD) and energy audits (set in the Energy Efficiency Directive - EED), including joint training of experts/inspectors for both objectives.

This chapter addresses mainly the issue of training and qualification of experts. The same topics can also be found in other chapters in part A of this book, viewed from different perspectives.

2. Objectives

The principal objectives of the CA EPBD work were the identification of new problems and of those still remaining, connected to the activities of the experts in the process of energy performance certification and regular inspection of heating and air-conditioning systems. The group also explored possible synergies between issuing EPCs, carrying out the system inspections required by the EPBD and carrying out energy audits required by the EED.

2.1 Training requirements

A first group of objectives focused solely on the training of the experts themselves. There was a strong need to develop a wider understanding of the new requirements of the Directive 2010/31/EU related to experts in both areas of activity (EPCs and inspections). The main issues of discussion focussed on trainings based on modular education of experts, identifying the links between energy certification of buildings, inspection of technical systems and energy audits.

2.2 Training subjects

Most experts assessing buildings have been authorised in accordance with the national legislation in individual MSs, directly linked to Directive 2002/91/EC. Directive 2010/31/EU introduced different

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approaches to several topics, requiring a transfer of more knowledge and skills to experts. It was thus necessary to assess if there were additional training needs following the introduction of new concepts, such as NZEBs and cost-optimal levels on *minimum requirements of energy performance of buildings*, as well as the increased focus on integration of Renewable Energy Sources (RES).

Attention was also devoted to discussing the precision required for assessing the technical properties of buildings, building units and building components, as well as technical systems, *in view of the accuracy of the energy rating*.

The group also concentrated on training needs, namely on the need to retrain qualified experts, recognised on the basis of Directive 2002/91/EC, on how experts should be trained to interact with owners, on how to deal with real energy consumption and on how to produce better (more realistic) recommendations for energy efficiency investments.

3. Analysis of insights

3.1 Synergy between inspections (EPBD) and energy audits (EED), including training of experts/inspectors

The EPBD requires regular inspection of heating and air-conditioning systems (Articles 14 and 15). The EED has a requirement for energy auditing that includes reporting on heating and air-conditioning systems in buildings (Article 8). Some of the activities of an energy audit carried out for the EED are similar to those for an inspection for the EPBD, although the purpose and level of detail is different. There is, however, potential for integration or coordination. Therefore, it is necessary to analyse which procedures could be combined or shared, to meet both EPBD and EED requirements.

In most countries, regular inspections and energy audits are managed by different legislation. The inspection procedure is generally well-defined. The audit procedure, however, has not yet been exactly defined in many MSs, and its scope is much wider - it covers building structures, technical building systems and occupants' behaviour. Therefore, energy auditors could possibly prepare EPCs, but the EPC assessors cannot undertake energy audits without further training. Reporting templates for inspections and energy audits are different, reflecting their different purposes and procedures. EPCs, inspections and audits are performed at different occasions and intervals, limiting the opportunity for shared activity. Carrying them out at the same time could offer significant opportunities for reducing costs and achieving more reliable results.

There are differences in the levels of education and length of experience required for the experts carrying out inspections and audits. Energy auditing requires a wider range of professional experience than inspections alone. Energy auditors also must have broader knowledge than the experts undertaking energy performance certification. In addition, the EPC results do not contain enough details to be used for heating and air-conditioning system inspections.

The greatest area of overlap is the requirement that an energy audit draws a reliable picture of overall energy performance and identifies the most significant opportunities for improvement. This is similar to the requirement for heating and air-conditioning system inspections for the EPBD, which must include an efficiency assessment and then make recommendations for the cost-effective improvement of the energy performance of the inspected system. In this regard, EPCs may provide useful input for broader energy audits[1].

In some cases, experts that are authorised to carry out air-conditioning inspections also fulfil the preconditions to issue EPCs. Modular training of experts has some benefits, e.g., experts can be trained specifically in the particular sector they are interested in, and can expand their training as and when they wish, without having to undergo training in the areas where they are already qualified.

CA EPBD participants have identified significant potential interactions or intersections between the obligations and needs to be addressed by provisions in both the EPBD and EED regarding training, accreditation, certification and registration of experts. Experts may be needed for overall energy auditing or building assessment, or for specific assessment or inspection of particular technical systems within the buildings.

[1] *Such synergies are explored in the Commission guidance note on Article 8 of the Energy Efficiency Directive, available at: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013SC0447&from=EN*

The quality and pace of improvement in the energy performance of buildings depends vitally on the number and quality of available experts. There are clear advantages of co-ordinated approaches, mainly to maximise synergies and avoid duplicated efforts. The institutional arrangements for developing and delivering suitable training and accreditation may often be complex and fragmented. Combining the obligations under EPBD Article 17 and EED Article 16 in particular, but also considering EPBD Article 20 and EED Articles 8, 16 and 17, MSs are required to ensure that certification and/or accreditation schemes for the qualification and training of experts are available for energy services providers, energy audits, energy managers and installers of energy-related building elements.

CA EPBD participants concluded that MSs should explore the provisions of Article 17 of the Directive 2010/31/EU with a particular focus on seeking national provisions that ensure the reliability of EPC experts and are coordinated with similar EED provisions for energy auditors. For both processes, the legal basis, methodology and the required level of education of experts/auditors are identical. The content of training should be modular for activities undertaken following the EPBD and/or the EED.

In terms of content, the main barriers are currently the lack of accredited institutions offering the required training at sufficient quality, and also a lack of individual assessors. From the process point of view, the biggest barrier is a conflict of interest, as EPC assessors are often certified by a public compulsory procedure, and energy auditors are normally part of voluntary schemes, so a dialogue is almost impossible. The most important key challenges were that EED auditors can use the EPC as part of the auditing process, the lack of national experience with energy audits in certain areas (e.g., of industrial projects) and, last but not least, the costs of the EPC, inspection or audit, and the consequences that could result from a situation in which the owner is not willing to implement the EPC recommendations.

Regular inspections and energy audits have been kept separate in almost every MS, at least at the regulatory and technical levels. Qualifications of experts carrying out inspections and audits overlap to some extent. There are opportunities for greater cooperation in programme operation, accreditation, codes of conduct, quality assurance, databases and publicity.

Training should be modular since the EPBD only covers one part of the broader boundaries of the EED.

Training programmes should have the same basis but should differ in details.

Energy auditors could possibly create EPCs, but the EPC assessors cannot perform energy audits. It should be possible, however, to have the same person (with adequate qualifications and training) accredited for both EPBD and EED.

3.2 Does Directive 2010/31/EU require retraining the experts?

The question if there is a need for re-training experts arose from the new approaches in the Directive 2010/31/EU, especially those focussing on training related to progress in establishing NZEBs and to updated calculation procedures, and the new control procedures for Energy Performance Certificates (EPC). There are particular issues which may possibly impact the updated calculation procedures and may result in the need for re-training. For example, cost-optimal and NZEB calculations can result in new and more strict requirements in MSs, which in turn can lead to more precise or more detailed methods for calculating the energy requirements, or at least some additional parts of the calculations to deal with solutions involving advanced and innovative technologies.

The analysis and discussion focused on whether the EPBD would require changes in the national training process for EPC issuers or inspectors (where applicable) and on clarifying the actual need for re-training experts who had already qualified according to Directive 2002/91/EC. Twenty-five countries indicated the need for additional training. Nine MSs consider starting with additional training a priority. In most of the MSs, legislation was amended (see Figure 1) and this led to an increase in the number of experts in one third of MSs. Most attention was given to dealing with NZEBs, integration of Renewable Energy Sources (RES) and calculation of alternative Heating Ventilation and Air-Conditioning (HVAC) systems. Cost-effective calculation for different refurbishment options was also an important aspect.

Most countries agree that training for on-site inspections is required. In order to be

Figure 1: Type of legislation used by MSs to establish training of experts.

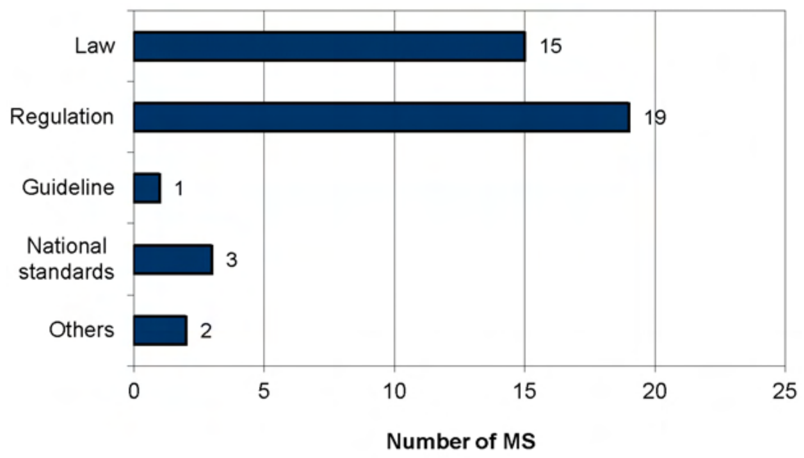
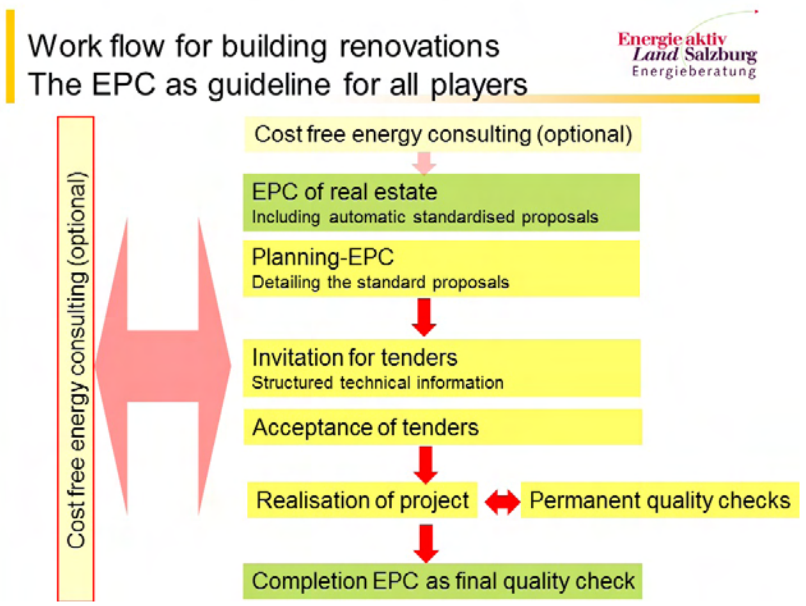


Figure 2: The EPC as final quality check during building renovations, using the "Gecko" EPC tool.



able to properly quantify the heating and cooling needs and to assess the correct sizing of the systems, the experts should have access both to the building and its technical systems during inspections. They need on-site training to be able to correctly identify the main characteristics of the systems (Figure 2).

On the other hand, MSs concluded that a special training on EPCs for NZEB was not necessary (i.e., specific training for producing EPCs or NZEB). Instead, awareness-raising and education for all professionals in the sector is the main policy and measure to support NZEBs in twelve MS (as opposed to training only for already registered experts).

Two examples of MS NZEB plans referring to training and education of experts are described next:

> Cyprus: Examination of the current Vocational Education and Training System for technical occupations concluded that continuous review and upgrading of the existing programmes is an absolute necessity, as is the addition of new, targeted programmes on emerging critical technologies, the training of instructors to renew and enrich their knowledge, and the provision of incentives and measures to increase the flow of Cypriot young people into technical occupations.
> Germany: Finding a well-qualified expert is one of the first steps in a high-quality, energy-efficient refurbishment, or when constructing a new building. The national list of energy efficiency experts for the support programmes of the Federal Government in the field of energy efficiency aims to improve the quality of local energy consulting services by means of uniform qualification criteria, proof of regular advanced training and random checks of the results.

Directive 2010/31/EU does not require significant re-training of experts in MSs, however twenty-five countries indicated the need for additional training.

The experts need to know more about the details of technical problems, how to integrate RES into existing buildings, advanced technologies and new materials.

Training for on-site inspections is required. The experts should be able to access both the building and its technical systems.

3.3. How to produce recommendations based on realistic energy savings in EPCs

As most MSs use fixed or other kinds of default values as inputs for energy performance calculations of existing buildings, it is expected that the calculated energy performance will differ from the measured energy consumption. EPCs are to be used as a means of comparison between buildings or building units, and not as a replacement for precise audits that produce more realistic estimates of energy consumption.

This topic was inspired by the revision of the calculation methodologies for certification that many MSs have been implementing. The discussion focussed especially on the following issues:

> the effect of user behaviour on actual energy performance and the distinction between the real energy consumption and the calculated energy use;
> realistic correction factors to be applied in the monthly method to provide results comparable to those achieved by hourly calculation;
> the increased importance of more precise calculation methodologies to handle the (supposed) increasing number of high performance buildings.

National studies showed that the actual operating hours, actual internal temperature, occupants' behaviour and control strategy have the highest impact on energy performance and/or energy class.

As a consequence, the calculated energy savings from the energy upgrades recommended in the EPC will also deviate from the actual achieved energy savings. Adjusting input boundary conditions to the actual values, will often result in realistic (comparable with measured energy consumption) calculated energy demands. This even happens with simple, quasi-stationary calculation tools using monthly average values.

In existing buildings, the focus should be on further developing default values to come closer to realistic energy consumption calculations. Regarding the default values, U-values are critical, as well as indoor climate conditions and the outdoor climate. EPC recommendations thus need to be carefully considered. However, most MSs have decided to use standard or default values for EPCs or calculation of energy performance. Figure 3 gives some indications of this. For the MSs that use this strategy, training for experts on how to use these values in the calculations is very important (see 3.4).

The technical background of experts needs to be well adjusted to the needs of issuing EPCs, and their training needs to be designed to match the precise needs for energy certification.

Use of building-specific data could be helpful. Experts should be trained to select appropriate boundary conditions.

Time (cost) needed to collect relevant data must be considered.

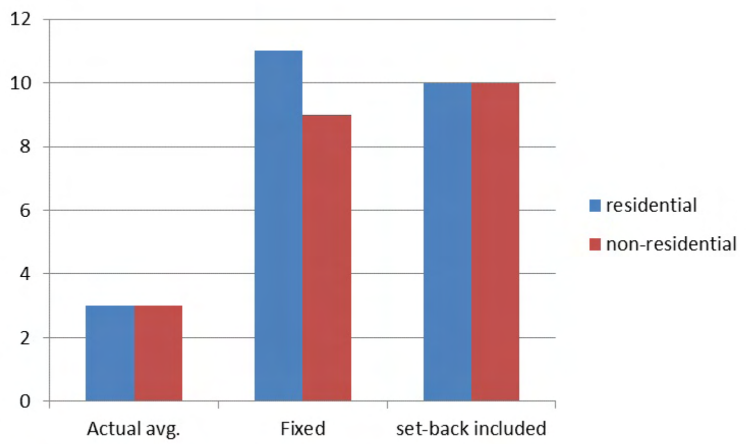
3.4. Training experts on how to take into account real energy consumption in EPC recommendations

Producing good recommendations for energy saving measures for existing buildings is an essential task for the expert when preparing an EPC. The EPBD requires the inclusion of cost-effective recommendations for improvement of the energy performance of a building (or building unit) in the EPCs (Article 11). These recommendations should thus be based on realistic energy savings that can be achieved following their implementation.

The energy performance of buildings is determined by building properties such as U-values, thermal bridges, leakages, solar heat gains, and efficiency of the heating/cooling systems. In addition, the actual energy consumption is influenced by user behaviour. If recommendations for energy efficiency investments are only based on the assessment of the technical building performance based on standard use patterns, energy cost reduction potential might not be realistic. Experience shows that occupants living in very inefficient buildings often do not heat all the rooms in the building/flat, or do so only part of the time, and therefore the actual energy consumption is less than that calculated based on the technical building data (prebound effect). Energy consumption is lower, but hygienic problems might occur.

The EPC has to avoid any influence from occupant behaviour, as it must serve as a neutral tool supporting the market choice of a new owner or renter. However, EPCs should show a realistic impact based on energy improvement recommendations depending on the actual use of the building. Experts must be trained to provide suitable recommendations.

Figure 3: Use of actual average or fixed values in the energy performance calculation in MSs (from a sample of MSs in 2014).



4. Main outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Does the EPBD require the retraining of qualified experts?	The amended national legislation, NZEB requirements and integration of RES and innovative technologies may result in the need for additional training for qualified experts.	In most MSs, retraining is voluntary, but there are retraining opportunities in most MSs.	MSs should consider establishing a mandatory continuous training programme, with regular training necessary to keep the qualified expert accreditation.
Training experts on how to take into account real energy consumption in EPC recommendations and estimate realistic energy savings in EPCs.	In most MSs, the EPC excludes any influence of the occupant behaviour and schemes often use fixed default values as input for energy performance calculations.	The recommendations in EPCs should not create false expectations for building owners and tenants.	Methods of calculation of recommendations should produce more realistic projections of energy savings, unlike the model to calculate the EPC energy indicator.
Training of experts and inspectors to take advantage of the synergies between inspections (EPBD) and energy audits (EED).	Both Directives require recommendations for cost-effective improvements and involve buildings and technical systems. Part of the work for inspections and for producing EPCs is also necessary in energy audits.	Energy auditors could possibly produce EPCs, but the EPC assessors may not be able to carry out energy audits. A clear definition of curriculum and required expertise for each activity is needed.	MSs should develop and offer modular education schemes to train experts that can perform EPBD and EED assessments, leading to substantial cost reduction for building owners.

5. Lessons learned and recommendations

Most of the experts assessing buildings in Europe receive authorisation in accordance with national legislation in the individual Member State (MS); this was directly linked with Directive 2002/91/EC in 2002. Directive 2010/31/EU introduced a slightly different approach on several topics, e.g., the introduction of NZEB, RES and cost effectiveness calculations. MSs should require a continuous professional training programme to help qualified experts to remain up-to-date and thus allow them to retain their license, in addition to any voluntary training that MSs now offer.

The topics in which changes in training are necessary are to address new requirements on energy performance, changes in EPC content, new calculation procedures, introduction of NZEB and increased influence of RES and advanced innovative systems, as well as recommendations that may be closer to reality and not lead to false expectations.

Modular training focused on application is also needed. This programme should include specific trainings to cover the needs of experts based on problems identified through quality assurance programmes. Ideally, synergies with training of EPC experts, inspectors of heating and air-conditioning systems, as well as energy auditors for the EED should be identified and implemented at the MS level.

Energy performance requirements using

Cost-optimal levels

OVERVIEW AND OUTCOMES

AUGUST 2015

1. Introduction

The Energy Performance of Buildings Directive, (EPBD, Directive 2010/31/EU) and particularly Article 4.1 recital 14, obliges Member States (MSs) to "assure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels". MSs shall also "take the necessary measures to ensure that minimum energy performance requirements are set for building elements that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are replaced or retrofitted, with a view to achieving cost-optimal levels".

The cost-optimal level is defined in Article 2.14 of the EPBD as "the energy performance level which leads to the lowest cost during the estimated economic lifecycle" from two different perspectives: financial (looking at the investment itself at the building level) and macro economic (looking at the costs and benefits of energy efficiency for society as a whole).

The cost-optimal levels must be calculated following specific guidelines. Article 3 and Annex I of the EPBD define the energy performance calculation methodology. Article 5 and Annex III set out how to undertake comparative analysis between the different options that results in the definition of the cost-optimal levels. Energy performance must be calculated according to a specific methodology, which must also be developed by MSs in line with the requirements set out in Annex I of the EPBD.

MSs must report on the comparison between the minimum energy performance requirements and calculated cost-optimal levels using the comparative methodology framework provided in Articles 5.2, 5.3 and 5.4 and Annex III of the EPBD.

To support MSs in calculating the cost-optimal levels, the EU published regulations for the comparative methodology framework (Commission Delegated Regulation, 244/2012) and accompanying guidelines (2012/C 115/01)[1].

This report deals with questions relating to Articles 3-8 of the EPBD, as well as Annexes I and III, i.e., it is not limited to issues related to cost-optimality, but also touches on general issues related to procedures for calculating a building's energy performance. It describes the main discussions and conclusions reached by the Concerted Action (CA) EPBD on these issues.

2. Objectives

In March 2012, the Commission published the comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements. The comparative methodology framework was established in accordance with Annex III of the EPBD and it differentiates between new and existing buildings and between different categories of buildings. Furthermore, a document guiding MSs on how to perform the cost-optimum calculations and analyses was published in April 2012.

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[1] Both documents are available at the European Commission's web site: http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm

MSs have calculated their cost-optimal levels of minimum energy performance requirements using the comparative methodology framework and relevant parameters, such as climatic conditions and the practical accessibility of energy infrastructure, and compared the results of this calculation to the minimum energy performance requirements in force. If this calculation demonstrated a deviation from the requirements larger than 15%, the MS should have taken action to modify the requirements, or indicated a way to make the requirements come within a 15% deviation within a reasonable period of time.

One of the primary objectives of the CA EPBD's work during 2010-2015 has been to facilitate exchange of experiences between MSs and the EC on how to carry out calculation of MSs' cost-optimal energy performance levels. Additionally, MSs were offered the opportunity to discuss the reports required by the EC and to suggest improvements to the accompanying guidelines. Due to MS calculation of the cost-optimal levels, it was possible to create an overview of the potential impact on MS minimum energy performance requirements.

The CEN has developed a number of standards. Though these standards are not directly implemented in every national energy performance procedure, most countries use CEN-compatible approaches. The package of CEN standards relating to the EPBD are undergoing revision during 2013-2016, and new versions of the Standards are expected by 2016. MSs are following the progress of this work, and there is close collaboration between the CA EPBD and the CEN. In particular, the CA EPBD has provided the CEN with input towards preparation of the revised set of standards. A Liaison Committee was established with the objective of making MSs' needs regarding the usability of the Standards explicit, in order to contribute to the effectiveness of the standards from the MSs' perspective. The Liaison Committee acts as a liaison between the CEN and the EPB Committee (formerly Energy Demand Management Committee -EDMC, representing the MSs) during the development of the revised EPBD-CEN standards, and interacts with the European Commission and the CA EPBD to mutually benefit from the knowledge and experience available. Collaboration between MSs and the CEN is ongoing.

The introduction of Nearly Zero-Energy Buildings (NZEB) will require an increased focus on calculation procedures and on which renewable energy sources (RES) are to be included in future NZEB requirements at a national level. Methodologies for calculating NZEB energy performance and inclusion of RES in the calculations have been investigated and are also discussed in the chapter "Towards 2020: Nearly zero-energy buildings" in this book. The Commission Delegated Regulation (No. 244/2012) states that the calculation of costs for establishing NZEBs should be included as a variant in the MS calculation exercise to identify the cost-optimal levels for new and possibly also for existing buildings.

With the increased energy performance requirements of NZEBs included in future national building regulations, compliance checking of new buildings' performance becomes increasingly important. The significance of quality control in the entire building process (from design, through construction to the final building stages) is a topic that has been discussed, but will require further attention.

3. Analysis of insights

Since the publication of the EPBD Directive 2010/31/EU, MSs have performed their own national calculations of cost-optimal energy performance levels for new and existing buildings. Therefore, the focus of discussions within the CA EPBD has been on exchange of experiences regarding the calculations, the identification of reference buildings and energy saving measures, the interpretation of the rules and guidelines provided by the EC, and the implications on national energy performance requirements.

The following topics are presented in this section:

- energy performance calculation procedures;
- calculating cost-optimal energy performance levels;
- energy performance requirements for new and existing buildings.

Some of these topics were also discussed within a wider context in the CA EPBD and therefore are also addressed from different perspectives in other chapters in part A of this book.

3.1. Energy performance calculation procedures

Energy performance methodologies have mostly been dealt with before the Directive 2010/31/EU, therefore only special topics that have been discussed after 2010 are described in this section. For information about topics previously discussed, information is available online[2].

3.1.1 Handling exceptions and innovative systems

Innovative and not-commonly-known systems and materials, e.g., in preparation for constructing NZEBs, cannot always be handled directly by the national energy performance calculation tools. A survey among MSs showed that there are three fundamentally different ways of handling exceptions and innovative systems in the MS energy performance calculations:

1. The performance of the innovative component or system may be evaluated with a *separate (unofficial, but validated) tool*. The results from this unofficial evaluation would then create *input for the official tool(s)* to give the same effect as calculated by the separate tool used for evaluating the performance of the innovative component/system. An example of this approach is the calculation of preheating of ventilation air in underground ducts using a separate software. The calculated input is then dealt with as increased heat recovery efficiency in the official calculation tool, resulting in the same annual improvement of energy performance as calculated by the separate tool. This method can be more or less formalised through its general acceptance and the implementation of verification requirements. Among the *advantages* are: the method is quick and flexible; comparison between different tools is possible; the user can use specialist tools when appropriate. On the *disadvantages side* are: problems with result verification; results may depend on selected input data based on unreliable (user-dependant) methods; lack of compatibility of results; unclear legal aspect; CEN standards are not available for all innovative technologies.
2. *No single calculation tool* is prescribed, and it is thus possible to find a wide variety (ranging from ordinary, quasi-stationary monthly methods to advanced dynamic simulations) among those accredited tools that are capable of calculating or simulating advanced/innovative technology or material. The *advantages* of this method are: it is flexible as any appropriate tool may be used; it will boost competition in the market. Among the disadvantages are: different tools will give different results thereby giving the possibility to use the tool that gives the most favourable results; it is necessary to create additional quality control for results from various tools. The *disadvantages* are considered so serious that this alternative is not recommended.
3. Advanced or innovative technologies can be used *only after calculation routines have been implemented* in the official calculation tool(s). The manufacturers need to provide the necessary information for evaluating and implementing the requested methodology. The main *advantages* of this method are: it provides a wide market introduction for new technologies; it is legally acceptable; the quality of the information is uniform and coherent. The main *disadvantages* are: implementation is slow and expensive; it is costly for the authorities; it increases the complexity of the tool; it may exclude small, innovative market players. With this approach, it is suggested that groups of manufacturers in a MS jointly pay for testing and development as well as validation, which will produce an acceptable procedure (which may, however, require independent development).

The best solution would be a combination of the different approaches. The method chosen and the way different methods are combined depend to a high degree on the legal framework of each MS. Using a combined approach allows for the optimal solution in any context and offers increased flexibility. An example of a combined methodology would be: when a MS, which is normally using method one or three, in case the calculations need to account for an innovative system, allows the use of alternative calculation tools.

[2] *See www.epbd-ca.eu/outcomes/CA_Annex_4_Procedures.pdf and www.epbd-ca.eu/outcomes/CT_Reports_14-04-2011/CT4_Procedures.pdf*

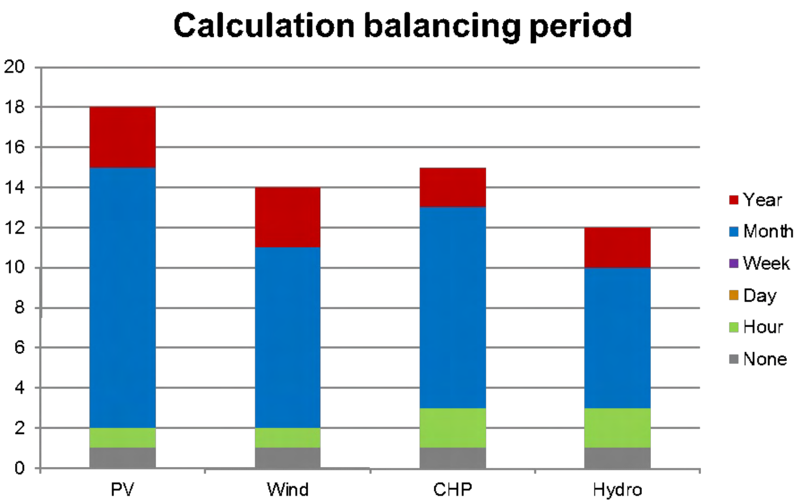
The use of the alternative tool should, however, only be allowed after application and proper validation of the tool and models used.

It will be increasingly important to enable inclusion of innovative systems and materials in energy performance calculations as requirements approach NZEB levels.

3.1.2 Introduction of renewable energy sources in the energy performance calculations

MSs have different approaches on how to handle RES in their energy performance calculations and legislation. Electricity production from photovoltaics (PV) is generally accepted in most MSs, but there are differences in how the electricity is accounted for in the national calculation procedures. A few MSs allow for an annual balancing of the electricity production, while the rest of the MSs balance the electricity production on a monthly basis - primarily due to the overall balancing period of the national calculation tools, which in most cases is monthly (Figure 1). More or less the same differences and approaches apply for RES-based heating and cooling production.

Figure 1: Balancing period for electricity production from RES for selected MSs.



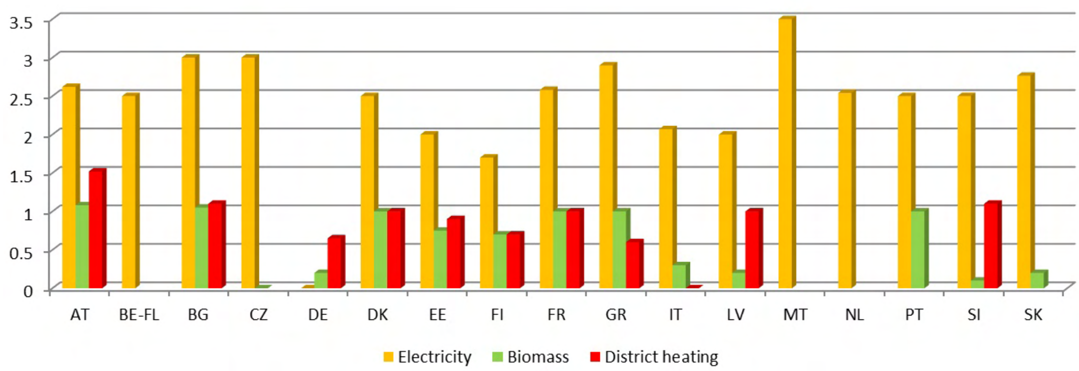
Beyond considering different RES sources when calculating buildings' energy performance, another issue is the primary energy-weighting factor used in the calculation of the RES contribution and the amount of RES energy that can be subtracted from the calculated energy performance. The primary energy factors for different types of RES vary among MSs (Figure 2). The primary energy factor for biomass varies between 0 and 1.08. This diversity reflects different political ways of looking at biomass, beyond pure combustion chemistry. A primary energy factor of 0 reflects 100% clean fuel, while 1.08 may indicate that biomass is a scarce resource and not always possible to replace. In the first case, almost no energy saving measures will be profitable in case of a major renovation. The same variation in calculations is found for other heat sources, e.g., district heating that varies between 0 and 1.52.

From a sample of twenty MSs that provided detailed information on this issue, seventeen MSs allow inclusion of electricity from PV, while twelve allow electricity from local wind-turbines and combined heat and power (CHP) to be included in the calculated energy performance of buildings. Nine of these twenty MSs also allow the inclusion of electricity from hydropower.

Production of heat from RES is, like the production of electricity, also accounted for differently in different MSs. Here the diversity in possible sources of heat production is much more significant than for the production of electricity, and methods of handling these different sources vary significantly.

For instance, passive cooling is taken into account in most MSs' national calculation tools, while active cooling technologies based on RES are in most cases not addressed, or handled indirectly in the national tool for calculating buildings' energy performance.

Figure 2: Primary energy factors for electricity, biomass, and district heating (average for selected MSs).



One way for MSs to increase the share of RES in a building is to offer subsidies to building owners for setting up systems for RES production. From inquiries sent to selected MSs, it seems that the most subsidised RES systems for electricity generation are PV and on-site wind turbines. The most subsidised RES systems for heating are solar thermal- and heat pump-based systems. For RES-based solar cooling, only one MS has a subsidy scheme and other RES-based cooling production methods are only subsidised in a few MSs. In some MSs, the possibility of obtaining subsidy for RES-based systems depends on the circumstances: either a local utility company offers subsidies for their local customers, or subsidies only apply if certain conditions are fulfilled, e.g., replacement of an old oil burner with a ground coupled heat pump.

Since the implementation of NZEBs must become the norm by 2018-2020, there is an ever-increasing need for MSs to clarify their understanding of NZEBs. It is not possible to compare NZEB requirements for MSs that already have an established definition, due to variations in climate and in the way requirements are set up, but there are significant variations in the understanding of NZEB among MSs. This topic needs close monitoring in the future, and further information can be found in the chapter "Towards 2020: Nearly Zero-Energy Buildings" in this book.

It is important for MSs to ensure that unrealistic low primary energy factors do not hinder deployment of NZEB efforts and effective energy saving measures in existing buildings.

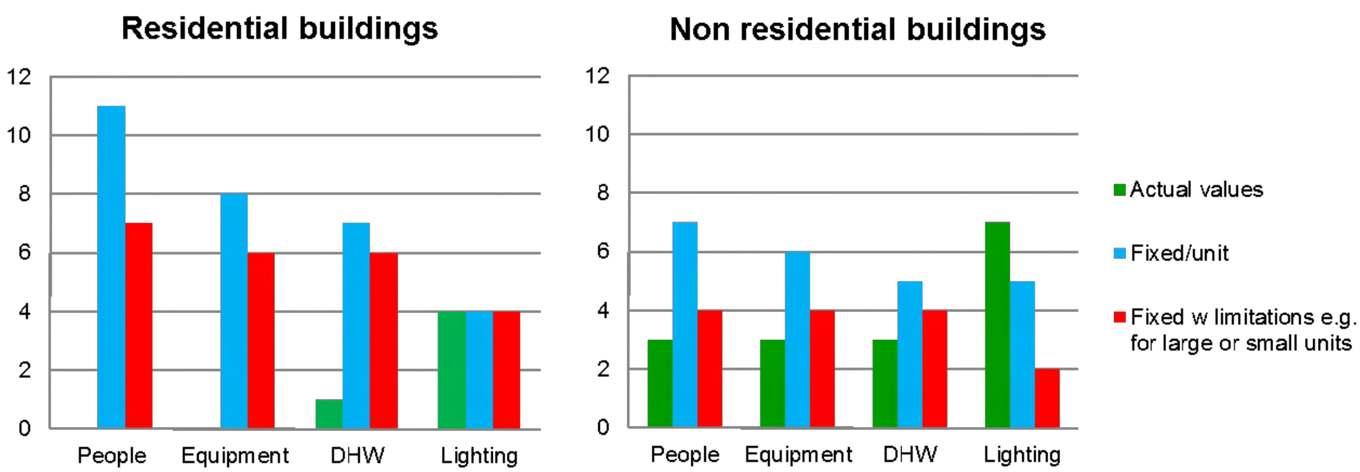
3.1.3 Estimating realistic energy savings in Energy Performance Certificates

Given the fact that most MSs use fixed or other kinds of default values as boundary conditions for input data for energy performance calculations (Figure 3), it is not surprising that calculated energy performance normally differs from measured energy consumption. Consequently, the calculated energy savings due to energy upgrades suggested in the Energy Performance Certificate (EPC) will also deviate from the energy savings actually achieved. On the other hand, the aim of the EPC is not to calculate real energy consumption and hence energy savings but, rather, to compare building energy performance under a standard pattern of use.

Adjusting input boundary conditions to actual values may result in realistic (in comparison with measured energy consumption) calculations of energy demands. This is also the case for the simpler, quasi-stationary calculation tools using monthly average values.

The optimal solution for creating EPCs and calculating realistic energy savings is achieved by carrying out three calculations: one calculation using default values to calculate the label itself and then one with actual input parameters for calculating energy performance both before and after implementing energy saving measures. This suggestion however, is not required in any MS. Additionally, actual values may be difficult to identify, so it is necessary to make adjustments for reality. Even if actual values are available, there are still issues that cause calculated energy savings to differ from the savings

Figure 3: Type of input parameters used in MSs for internal loads in energy performance calculations.



achieved: the 'prebound' effect, i.e., before refurbishment, users of buildings with poor energy efficiency are using less energy than predicted, and the 'rebound' effect, where users of energy-refurbished buildings use more energy[3] than predicted; therefore the amount of energy saved is lower than expected.

There is no doubt that this issue will continue to be a central part of MSs' discussions on achieved energy savings and on how the EPC can be used as a tool to promote and assess energy savings. The EPC as a tool for building benchmarking, independent of user behaviour, is undoubtedly very valuable. This is comparable to car energy labelling, where although no-one expects to be able to obtain the same degree of economy as stated by the manufacturer, it is generally agreed that the relative comparison between two cars is reliable. EPCs should continue to act as a benchmarking tool for buildings that is independent of user behaviour. It may however be supplemented by additional calculations for realistic energy consumption and hence savings valid for the actual building and its use, e.g., use of realistic indoor temperature, ventilation rate, hot water consumption, pattern of use of heating systems in moderate southern EU climates, etc.

3.1.4 Buildings as providers of demand side flexibility

A collaboration between the three Concerted Actions (i.e., the CA on the Renewable Energy Sources Directive, the CA on the Energy Efficienty Directive and the CA on the Energy Performance of Buildings Directive) has been established to investigate the possible promotion within the three Directives of Demand Side Flexibility (DSF), i.e., flexible use of electricity by customers based on price signals.

DSF has the potential to contribute to an affordable, reliable and sustainable electricity system. DSF is considered to have many and significant potential benefits as it increases the flexibility of the electricity system. The existing electricity system already includes a high degree of flexibility provided mostly by stand-by power plants and a few large customers.

The increase of intermittent (renewable) generation will result in a greater need for flexibility. However, DSF is not expected to deliver this flexibility alone: storage, fuel shift technologies, more interconnection between MSs and optimal functioning of the EU internal energy market will all contribute to meeting the need for flexibility.

Buildings conditioned by a heat pump or by direct electric heating, especially NZEBs with large inertia and, thus, with a long time constant, will be able to offer induced or postponed use of electricity especially in periods with fluctuating electricity production from renewable energy. In this way, the building can use extra electricity in periods with abundance and help reducing the peak-demand by postponing demand in periods with shortage. A building's thermal mass and its built-in potential water storage can provide flexibility by shifting the temperature setpoint within the acceptable comfort range (or even more in hours outside use) and thus allow for acceleration or delay of energy demand. In case of overheating or undercooling a building in periods of abundant RES-based electricity, the building's overall energy consumption will increase, while overall CO_2 emissions may well decrease. If DSF is going to be included in MS building energy requirements in the future, there is thus a clear need for new regulation and calculation procedures, both taking into account the value of flexibility for the electricity grid.

There is little doubt that DSF in general will draw increased interest in balancing the growing production of electricity from RES and hence the fluctuating production that is sometimes out of phase with traditional electricity demand. This will call upon buildings to become active players and provide their share of DSF in the future by induced use of green electricity at periods with abundance and deferred use in periods with shortage of green electricity.

It is not always possible to directly address innovative and uncommon systems and materials in the national most energy performance calculation tools, e.g., in preparation for constructing NZEBs. Three fundamentally different ways of handling exceptions and innovative systems were identified.

There is a large diversity among MSs regarding inclusion of RES in national definitions and requirements. In some

[3] *Minna Sunikka-Blanka & Ray Galvina (2012). Introducing the prebound effect: the gap between performance and actual energy consumption. Building Research & Information. Volume 40, Issue 3, 2012.*

cases, RES contributions are calculated with a primary energy factor of 0, making almost no energy saving measures cost effective.

Standard calculations, as carried out in the EPC, are the best tool for benchmarking buildings without influence of the users. Estimates of realistic energy savings require additional calculations, taking into account user behaviour.

3.2 Calculating cost-optimal energy performance levels

The EPBD requires MSs to report on the comparison between their legal minimum energy performance requirements and calculated cost-optimal levels using the comparative methodology framework. The Comparative Methodology Framework is accompanied by Guidelines from the Commission to enable the MSs to:

> Establish at least nine reference buildings – one for new buildings and two for existing buildings subject to major renovation, for single-family, multi-family, and office buildings respectively. In addition to office buildings, MSs must establish reference buildings for other non-residential building types for which energy performance requirements exist, e.g., educational buildings, hospitals, hotels and restaurants, sports facilities, wholesale and retail trade services buildings, and other types of energy-consuming buildings. Several building types can be represented by the same reference building type, e.g., hotels and prisons, or offices and universities, if appropriate.
> Define packages of energy efficiency measures to be applied to these reference buildings.
> Assess the primary and final energy needs of the reference buildings and the impact of the applied improvement measures.
> Calculate the life cycle cost of the building after energy efficiency measures are implemented, by applying the principles outlined in the comparative methodology framework.

The Guidelines give reasonable recommendations on how to carry out calculations of the cost-optimal levels and provide an overview of the input parameters and results. However, some MSs have decided not to use the tables suggested in the Guidelines, but rather adapt the data to the format used in their own national calculation tool in order to make reporting more targeted to their needs.

The use of only one reference building per building type does not cover the wide differences in the real building stock. According to experience from test runs, 3-4 reference buildings for each building type would be necessary in order to get a representative picture of the building stock diversity. When analysing the existing building stock, it is possible to identify a large number of different building types due to differences in construction and use. Based on this, some MSs have defined up to 184 (in the case of The Netherlands) different reference buildings to describe their building stock, while other MSs simply used the minimum number (nine) as described in the Guidelines.

For any reference building, a number of variations on packages of energy saving measures must be calculated in order to identify the cost-optimal level. There is a large diversity in the number of calculations carried out in different MSs. The Flemish region of Belgium, for example, used random variations of energy saving measures and calculated more than 100,000 combinations for each reference building. Other MSs have carefully selected, among logical packages, the variation of energy saving measures to calculate, and have thus limited the number of calculations significantly.

The methodology for calculating cost-optimal levels seems to work well, as it delivers interesting results and the effort needed to make the calculations is manageable. Calculation of numerous variants of energy-saving measures or packages of measures is necessary in order to obtain accurate cost-optimum values. A minimum of ten variants per reference building must be calculated in order to identify the cost-optimal level, but somewhere between twenty and fourty variants seems to be the ideal number in order to more clearly identify the cost-optimal level. Even so, many of the calculated cost curves are quite flat (i.e., they show little difference in energy performance compared to investment levels) and, in many instances, no individual, clear optimal point could be identified. This means that *many MSs find* *a cost-optimal range of measures by combining the building envelope and the technical systems rather than an individual optimal point*. The cost-optimal level is often defined at the lower end of the range to ensure the lowest possible energy consumption within the optimal range of costs (Figure 4).

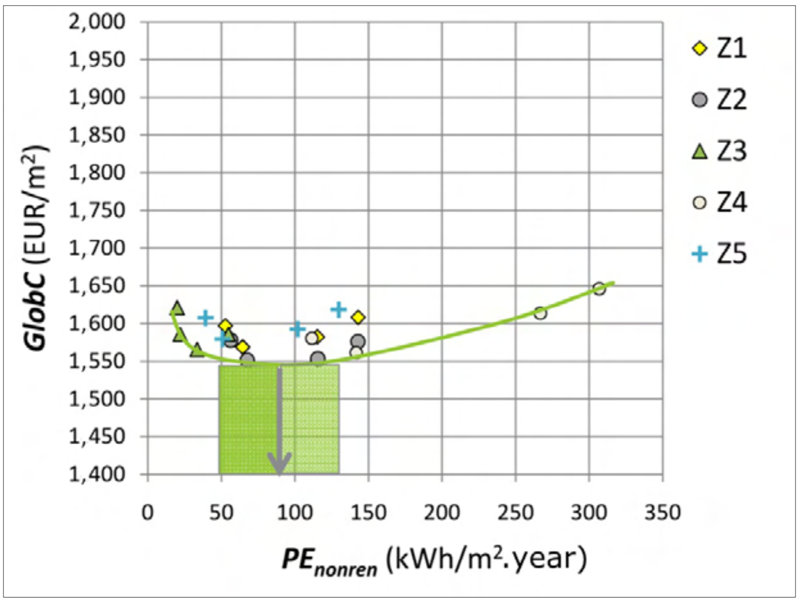
Most MSs (27) have submitted[4] their calculation of their cost-optimal levels. Lessons learned from the cost-optimal calculations vary significantly among MSs. Exchange of experiences and information during CA EPBD discussions (see box on the right) have been of great value for the development of the current Guidelines, and potential further advice provided by the Commission.

Implications of cost-optimality calculations on national energy performance requirements

Examples from selected MS calculations of the cost-optimal levels for new and existing buildings are given next in order to illustrate the huge variety among MSs in setting requirements that are within the acceptable range of 15% from the calculated cost-optimal level.

In *Slovakia*, the 2013 minimum energy performance requirement for blocks of flats was 126 kWh/m².year. Due to the results of the calculation of the cost-optimal levels, these requirements will be tightened to 63 kWh/m².year in 2016. The NZEB requirement, which will be the minimum requirement by 2019 (for public buildings) and by 2021 (for all buildings) is estimated to be 32 kWh/m².year (see Figure 5).

Figure 4: Example graph showing the cost-optimal range of different packages of energy saving measures.



Lessons learned relating mainly to the calculation process

- *The input from experts with experience in this kind of calculation (e.g., development of scenarios for reference buildings) is essential to support legislative changes, and in particular to address real complexities rather than just presenting academic exercises for simple example buildings. This would result in more widely applicable Guidelines and better results.*
- *Minimum energy performance requirements are usually set at the national level and do not take into account the possibilities for RES at the regional, local, district or site level. Therefore, the cost-optimal level is often a compromise, using only those technologies that can be used in all localities. As a result, some real cost-optimal packages with RES may be missed. More flexible minimum requirements with a focus on local conditions should be recommended to trigger the use of RES depending on the specific local conditions, e.g., a local source for small-scale hydropower.*
- *Cost-optimal levels derived from non-renewable primary energy might not always be cost-optimal for individual users because they are based on analyses of reference buildings rather than a specific building, as required by the EPBD. Decisions on energy saving measures for the building owner might need technical-economic analyses that are adjusted to the actual building.*

Wish list for additional advice

- *Provide further guidance on choosing the type and characteristics of reference buildings.*
- *Provide further clarification of economic scenarios.*
- *Improve description of how to establish typologies for new residential buildings.*
- *Define standard forms for reporting on energy management systems.*
- *Define common variants of packages for energy efficiency.*
- *Extend the calculation period to 60 years to reflect the typical economic life of buildings. In particular, the 30-year period does not fully account for the benefit of installing longer-lasting fabric improvements.*

[4] http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

In *the Flemish region of Belgium*, the cost-optimal level for residential and non-residential buildings was calculated in the spring of 2013. In Flanders, the primary energy use (kWh/m².year) is not an indicator used for checking compliance with Flemish building regulations. Instead, the so-called E-level (primary energy consumption divided by a reference value) is used. The results (Table 1) indicate that the cost-optimal level for residential buildings with PV is E50, which should be compared with the 2014 requirement of E60. For offices and schools, the cost-optimal level without PV is E57, which is close to what is already defined in the 2014 Flemish building regulations. Since the E57 level is close to the 2014 requirement, further steps are planned in order to gradually reach NZEB levels by 2021 (and E55 by 2016).

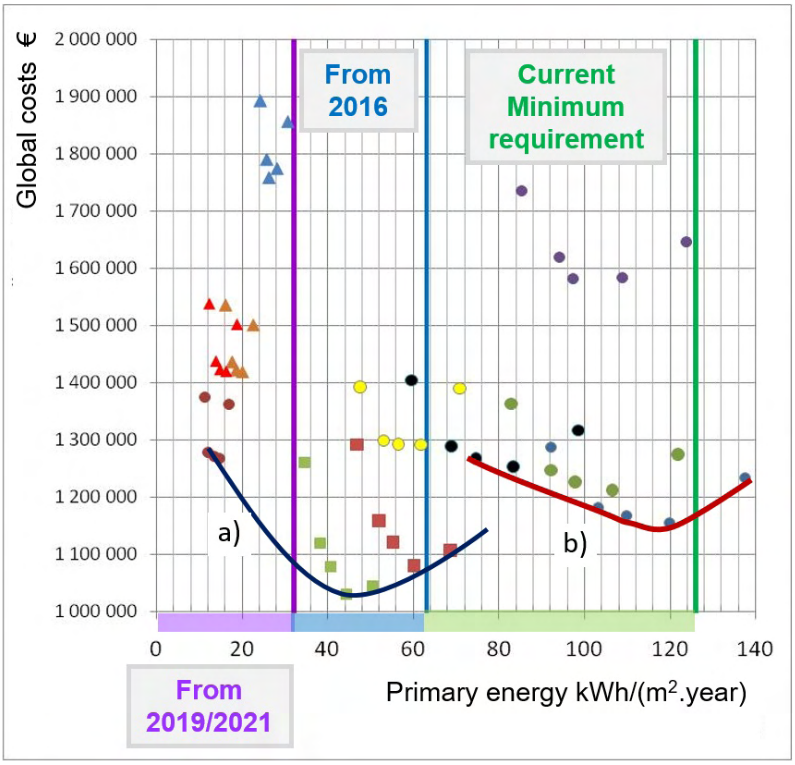
In the expected 2021 Flemish building regulations, the E-level requirements will be E30 for residential buildings, and E40 for offices and schools. These more demanding levels represent the expected future cost-effective levels.

In order to find the cost-optimal point, different packages of energy-saving measures were chosen, reflecting the interaction between various measures. Generation of random combinations of measures is believed to help identify a more accurate optimum. These randomly generated combinations also included improbable and clearly non-optimal packages. Although those were excluded from the calculations, the number of packages calculated per reference building was still more than 100,000.

- 1a. District heating-gas
- 1b. District heating-biomass
- 2. Condensing gas boiler
- 3. Condensing gas boiler+heat recovery
- 4. Condensing gas boiler+solar thermal collectors
- 5. Biomass boiler
- 6. Biomass boiler+heat recovery
- 7. Air water heat pump
- 8. Groundwater heat pump
- 9. Biomass boiler+solar thermal collectors
- 1c. District heating-CHP

Table 2 summarises the *Danish* cost-optimal levels in comparison with the energy requirements for new buildings in the 2010 Danish building regulations (BR10). Analyses are based on a financial perspective (i.e., effects on the whole building stock). The gap between the BR10 energy regulations and the cost-optimal levels is shown as a percentage of the cost-optimal level of requirements in kWh/m².year primary energy, inclusive of renewables.
A negative gap indicates that the requirements in the Danish BR10 are tighter than the cost-optimal level.
The BR10 includes the 2010-2015 minimum energy performance requirements in Denmark. Two voluntary classes, LEB2015 (Low Energy class 2015)

Figure 5: Calculation of costs and primary energy use in block of flats with indication of the current requirements level, the requirement level from 2016 and the 2020 level (NZEB) for different heating sources (example from Slovakia). Conversion factors for primary energy used in the calculations are biomass: 0.2; natural gas: 1.36; CHP district heating: 0.7. The blue curve (a) represents heat pumps and biomass solutions while the red curve (b) represents heat sources that are feasible for all locations.



Building type	Heat supply	Cost optimum kWh/m².year	Deviation between cost-optimal and BR10 requirements (%)		
			2010-2015 Minimum requirements	LEB2015 Voluntary class	B2020 Voluntary class
Single-family house	District heating Heat pump	68.7 51.1	-15.7% -2.8%	-44.9% -49.8%	-57.0% -58.0%
Multi-family house	District heating	53.6	-9.2%	-36.1%	-44.7%
Office building	District heating	51.7	31.2%	-16.0%	-37.3%
Weighted average	DK mix.		2.8%	-34.4%	-48.8%

Table 1: Comparison of energy performance levels for new and existing buildings in Flanders, Belgium.

and B2020 (Building class 2020) are both already defined in the BR10 as prospects for minimum requirements for 2015 and 2020 respectively. Only the relevant heat supply sources in relation to Danish heat plans are included in the calculations.

In relation to the new housing examples, the present minimum energy requirements in the BR10 all show gaps that are negative, with a deviation from the cost-optimal point of up to 16%. With the planned tightening of the requirements for new houses in 2015 and again in 2020, the energy requirements can be expected to be tighter than the cost-optimal point in the current price structure. However, it must be expected that the costs for the necessary improvements and for new technologies will decrease, and hence future requirements and cost-optimal points will eventually converge.

In relation to new office buildings, there is a gap of 31% between cost-optimality and the 2010 requirement. In relation to the 2015 and 2020 requirements, there are negative gaps to the point of cost-optimality based on 2014 prices.

If the gaps for all new buildings are weighted on an average, based on a mix of building types and heat supply for new buildings, in Denmark, there is a gap of 3% on average for new buildings, in the current regulations (BR10). The planned tightening of the energy performance requirements in 2015 and 2020, using today's prices, is 34% and 49% more strict than the cost-optimal levels.

Many MSs have noted that one or more building types had more lax minimum energy performance requirements than the calculated cost-optimal levels (resulting in more than 15% difference between the two). In many cases, the identified gap has already been addressed by changing the national legislations, or will soon result in new, tighter national minimum energy performance requirements. A survey showed that nine countries saw a tightening of 11% to 25% on the energy performance requirement between 2011 and 2014.

In most cases, the curve defining the calculated cost-optimal level is almost horizontal over a range of equally cost-optimal combinations of energy saving measures around the cost-optimal level. This means that there is little additional investment required to obtain additional energy savings if the building is within the cost-optimal range. Many MSs have thus decided to define their cost-optimal level at the lower end of the range to ensure the lowest possible energy consumption within the optimal cost range.

Most MSs have experienced that one or more building types have more lax energy performance requirements than the calculated cost-optimal levels (with more than 15% difference between the two).

3.3 Energy performance requirements for new and existing buildings

MSs deal with setting energy performance requirements for new and existing buildings in different ways.

Especially for existing buildings subject to major renovations, the diversity is immense. Some MSs set requirements only for those individual building components that are being renovated or replaced, while other MSs set requirements for the whole building.

Setting requirements for new buildings also differs among MSs, not only in terms of energy performance levels, but also in terms of other properties in the building envelope. For example, there are substantial differences in the units of measure used by MSs (kWh/m^2,

Table 2: Cost optimal requirements for new buildings in the Danish Building Regulations 2010. For the different building types and heat supply, the table shows the cost optimum in kWh/m^2.year primary energy and the percentual gap between the cost-optimal level and the 2010-2015 requirements

	Existing buildings		New buildings	
	Previous levels	Optimal level	Previous levels	Optimal level
Single-family	no E-level, only U-values	(E90)	E70 (2012), E60 (2014)	E50
Multi-family	no E-level, only U-values	(E90)	E70 (2012), E60 (2014)	E50
Office buildings	no E-level, only U-values	(E72 (office), E49 (school))	E70 (2012), E60 (2014)	E57

comparison with reference building, kg CO_2/m^2). There are also differences among the properties of the building envelope. For example, infiltration is handled very differently by MSs (e.g., compulsory tests versus quality certification programmes). On the other hand, most MSs tend to set limits on U-values. There are also very different ways of checking compliance. For example, Sweden set requirements that are verified through comparison with the measured energy consumption two years after taking the building into use. Designers thus need to establish a margin that can absorb the variations caused by user behaviour and different climates.

Compliance checking and setting requirements for new and existing buildings has been one of the focus areas during 2010-2015. Additionally, setting requirements for technical building systems has also been discussed.

3.3.1 Energy performance requirements for renovation of existing buildings

The two main methods for setting requirements for existing buildings subject to major renovation both have advantages and disadvantages (Table 3).

The main advantages of *component requirements* are that they are easy to explain, confirm and enforce, and therefore they offer the possibility for increased user acceptance. On the other hand, this method is difficult to regulate (especially indoor works are difficult or impossible to check) and does not lead to improvements of adjacent areas or components. Moreover, it is not easy to decide which measure to implement first without a holistic approach.

Applying *whole-building requirements* makes it easy to set ambitious energy

Table 3: Pros and cons for the different approaches for setting energy performance requirements to existing buildings subject to (major) renovation.

Building component requirements	
Pros	Cons
• Sets minimum standard for replacement of individual windows/doors/ walls/ boilers/etc. • Requirements direct architects and engineers towards cost-effective solutions • Simple to assess • Stimulates the market and improves supply of energy-saving components • Partially market driven • Easy to explain, and therefore possibility of increased user acceptance • Easy to confirm and enforce in cases where a construction permit is required • Effective for achieving energy and CO_2 savings • Easy to control components' performance	• Difficult or impossible to check when a construction permit is not required (e.g., indoor works) • Does not improve adjacent areas • Requirements might not 'add up' to a low energy building • New materials and solutions can be excluded • Lack of flexibility creates a need for exceptions • Interaction between components is easily missed • Decision what to do first is not so easy without a holistic approach • Improvement of a single component might have negative effects on other parts
Whole-building requirements	
Pros	Cons
• It may set ambitious energy requirements for major renovations, change of use and extensions • There is a possibility of avoiding costly energy measures that only have a small effect on the energy demand of the building • It is possible to achieve the cost-optimal level • Easy and direct connection to the energy performance indicator(s), i.e., overall energy evaluation	• The requirements are often considered difficult to understand by the industry • There are no requirements ensuring the use of energy efficient components (for normal maintenance, minor refurbishments, etc.) • Additional costs due to requirements for the whole building may be a hinderance for implementing energy-saving measures at all
Whole-building and component requirements	
Pros	Cons
• Strengthening of requirements is easier when an alternative is available • In the course of the refurbishment of one building element, a holistic approach might tackle additional measures • It is possible to achieve the cost-optimal level • Easy and direct connection to the energy performance indicator(s)	• Often, the refurbishment of a small building is a matter between owner and craftsmen and no architect is involved to implement a holistic approach • Lack of flexibility • There may be an imbalance between efficient (component) and cost-optimal solutions (whole building) • Architectural limitations • More difficult to administer several requirements

requirements for major renovations, change of use and extensions, and to avoid costly energy measures, which may only have a small effect on the energy demand of the building. However, there are no requirements ensuring the use of energy-efficient components for normal maintenance or minor refurbishments, and there is a risk that additional costs due to requirements for the whole building may be a hinderance for implementing energy-saving measures at all. Moreover, in many cases, especially in the case of refurbishment of small buildings, the owner and craftsmen are the only players involved and there is no architect nor engineer to encourage (or design and calculate) a holistic approach.

A combination of *whole-building* and *component requirements* makes it easier to tighten the requirements, as there are possible alternative solutions that can meet the overall requirement. However, this approach also implies the negative points for each of the individual paths.

Only two MSs/regions have only whole-building requirements in force, while seven MSs/regions rely solely on component requirements. The other MSs/regions require a combination of component and whole-building requirements (Figure 6).

Some MSs, even some of those MSs with combined requirements, have suggested that setting requirements for building components that are being replaced or renovated is sufficient to ensure an optimal energy performance of the renovated building. In an earlier study[5], it has even been suggested that *"compliance with whole-building energy performance requirements may hinder major renovations if the procedure for meeting the regulations is too complicated or too costly"*. It seems that a combination of whole building and component requirements is the optimal solution to ensure a holistic approach for energy savings in the building stock in general.

3.3.2 Requirements for technical building systems in new and existing buildings

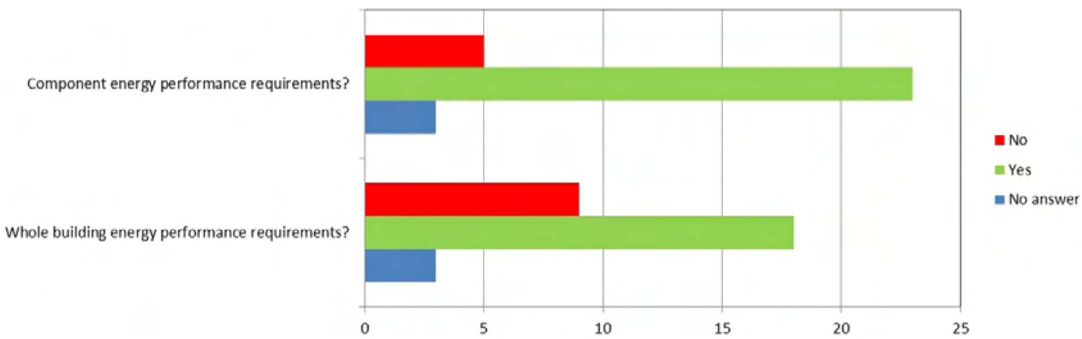
The EPBD uses the term technical building system (TBS) in the recitals and Articles 1, 2, 8 and 11. Article 8 calls for minimum standards for energy performance, installation, dimensioning, adjustment and control. These standards are obligatory in existing buildings, and they refer to system performance rather than product performance or whole building performance.

Most MSs have TBS performance regulations of some kind in place and about two-thirds report having the same requirements for TBS for new and existing buildings. The EPBD does not require that MSs set regulations for TBS in new buildings, though most MSs apply TBS regulations to new, as well as existing buildings. In most cases, there are no requirements for carrying out a whole building energy performance calculation to prove compliance, as minimum TBS requirements are considered sufficient.

When TBSs are being installed in new buildings, regulations might require design calculations to be carried out so that system energy performance can be evaluated. However, in existing buildings, the original design information for TBSs will not usually be available, nor will building data (in the form of dimensions, heat loss, etc.). So, in the context of system replacement in existing buildings, it may be too difficult and time-consuming to carry out a rigorous system design and performance evaluation. TBS requirements are thus often limited to performance requirements for each individual component.

More detailed information about TBS regulations is found in the chapter on "Inspections" in this book.

Figure 6: Number of MSs that set requirements for existing buildings subject to major renovation as whole-building or component requirements.



[5] *Thomsen et al (2009). Thresholds related to renovation of buildings - EPBD definitions and rules. SBi 2009:02. Danish Building Research Institute, Aalborg University.*

3.3.3 Checking and enforcing compliance for new buildings

MSs have different approaches to demonstrating compliance with energy performance requirements, and some have adapted their regulations to implement Article 27 of the EPBD on penalties.

With the progressive increase of the energy performance requirements included in national regulations, the issue of checking compliance of energy performance of new buildings becomes increasingly important. An effective compliance scheme becomes a crucial element of regulation, especially in the context of NZEB.

As previously indicated, the requirements set by MSs affect different parameters of the building (e.g., U-values, infiltration, system efficiency, overall performance, etc.). MSs may choose to check different elements at different stages.

Compliance with energy performance requirements is checked at different stages of the building process in different MSs. Some MSs even check compliance several times during the building process (Figure 7).

In addition to the energy performance requirements for new buildings, most countries also set other requirements. Figure 8 shows some of these requirements.

Compliance check and quality control regarding the airtightness, thermal bridges, summer comfort and availability of daylight in new buildings require increased attention, as buildings are moving towards NZEB, since these topics account for an increasing share of buildings' total energy consumption.

A special compliance check philosophy is in place in Sweden, based on an operational rating system applied to new houses or apartments after two years of operation. It is not necessary to measure single parameters as long as the measured value of energy consumption complies with the building code.

A combination of whole building and component requirements seems to be the optimal solution for ensuring implementation of the most effective energy saving measures in existing buildings - not only when undertaking major renovations, but also when renovating minor parts of the building.

Figure 7:
Most countries check compliance with the requirements for new buildings on more than one occasion.

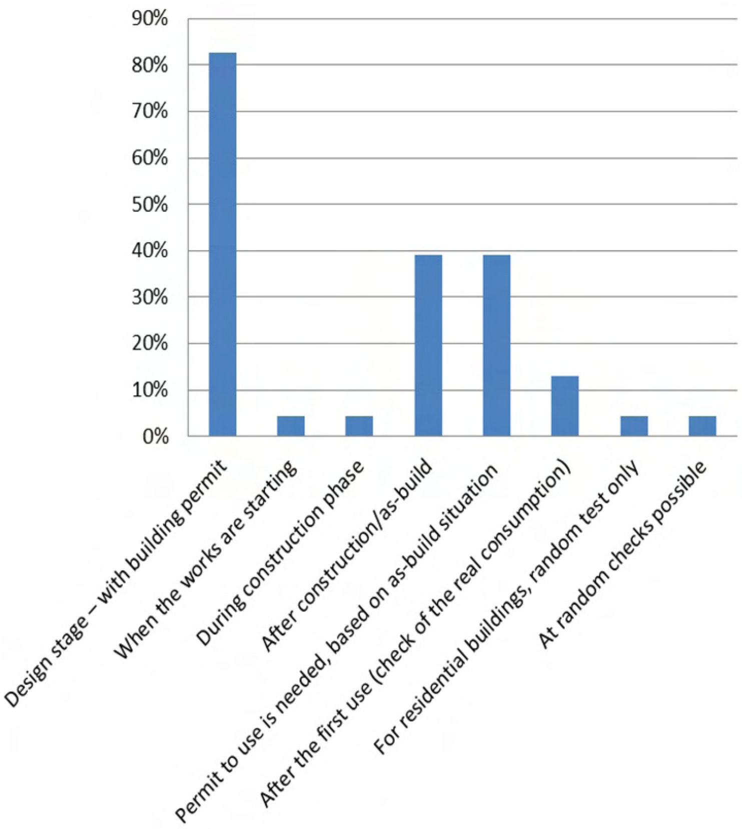
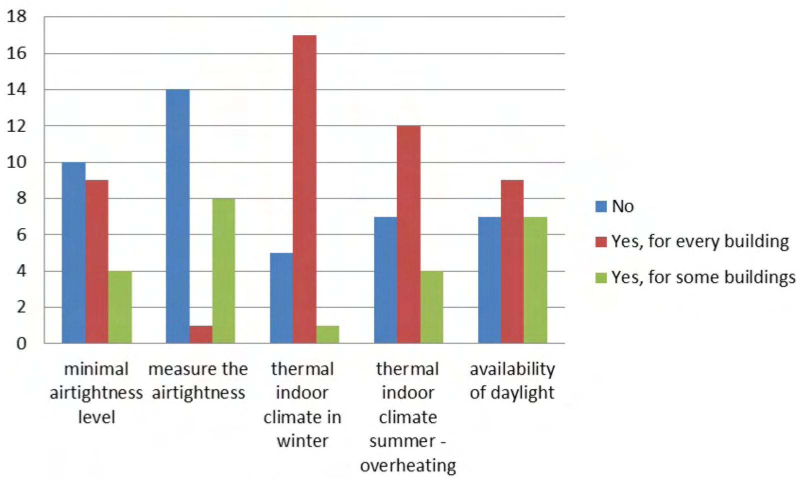


Figure 8: MSs that set requirements in addition to energy performance requirements for new buildings.



Many MSs have chosen to prescribe the same TBS component requirements for new, as well as for existing buildings when replacing TBSs.

With the progressive increase of energy performance requirements included in national regulations, the issue of checking new buildings' compliance with requirements becomes more and more important. An effective compliance scheme becomes a crucial element of regulation, especially in the context of NZEB.

4. Main outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Implications of cost-optimal levels on energy performance requirements	Most MSs had one or more building types with looser energy performance requirements than the calculated cost-optimal levels.	Most MSs planned to tighten their energy performance requirements when necessary.	Energy and component costs will evolve and tighter energy performance levels will presumably become cost-optimal.
Reference buildings and energy saving measures for cost-optimal calculations	There is a large variation among MSs' approaches to calculating cost-optimal levels, ranging from a few combinations of measures per reference building up to 100,000.	Based on these reference buildings, and a sufficient number of variations, sensitivity studies are able to produce cost-optimal levels.	For existing buildings, there is a need to develop a comprehensive and relevant set of reference cases.
Legal framework and Guidelines on calculating cost-optimal levels	Experiences from the first round of calculations highlighted strengths and weaknesses of the Guidelines and suggested areas for improvement.	In many cases, the calculated cost-optimal level varies little over a large range of equally cost-optimal combinations. MSs are encouraged to select their minimum requirements at the lower end (lower energy needs) of the cost-optimal range.	The Guidelines should be continuously updated to reflect lessons learned and best practices from MSs.
Compliance checks for additional performance requirements for new buildings	Most countries have additional requirements for energy performance levels for new buildings, e.g., airtightness, summer comfort, daylight.	Compliance can be checked at different levels, e.g., airtightness can be ensured by careful design and construction, or direct measurements in the completed building.	With the increased energy performance requirements in NZEBs, compliance checking of the performance of new buildings becomes increasingly important.
Setting energy performance requirements for existing buildings	There are pros and cons for setting mandatory energy performance requirements for existing building renovations with either whole-building or component requirements.	A combination of component and whole-building requirements may prove to be the best solution to implement the most energy saving measures.	Requirements should ensure maximum energy savings, while reducing investment costs and not hindering refurbishments due to too rigid, too costly or too complicated requirements.
Requirements for technical building systems (TBS)	Many MSs have chosen to prescribe the same component requirements in new and existing buildings when replacing TBS.	Equivalent component requirements for TBS in new and existing buildings makes it easy for the industry to deliver TBS.	MSs still need to make significant improvements for implementing the requirements for TBS.
Handling exceptions and innovative systems in energy performance calculation procedures	Most MSs' building codes do not handle innovative systems and materials well.	Three fundamentally different ways of handling exceptions and innovative systems were identified, i.e., separate (unofficial) tools; any tool allowed; after implementation in official tool.	It will be increasingly important to enable inclusion of innovative systems and materials in energy performance calculations as requirements approach NZEB levels.
RES in NZEB	There is a large diversity among MSs regarding inclusion of RES and types of RES in the national requirements and NZEB definitions.	Taking different RES sources into account when calculating energy performance strongly depends on the primary energy factors used.	It is important for MSs to ensure that unrealistic low primary energy factors do not hinder deployment of NZEBs and effective energy saving measures in existing buildings.
Calculation of realistic energy savings for building renovation	Standard calculations, as carried out in the EPC, are the best tool for benchmarking buildings without influence of the users.	Estimates of realistic energy savings require additional calculations, taking into account user behaviour.	Cost-effective renovation towards NZEB requires improved methods for estimating accurate energy savings.

5. Lessons learned and recommendations

Energy performance calculation procedures

Innovative and not-commonly-known systems and materials cannot always be handled directly by the national energy performance calculation tools. It is recommended that MSs ensure smooth inclusion of innovative systems in energy performance calculation methodologies in order to promote the design of NZEBs. Development of new energy efficient products is often ahead of the capabilities of energy performance calculaton tools, and there is a need for flexibility to include them in the calculations.

MSs implement different approaches as to how to handle renewable energy sources (RES) in their energy performance calculations and legislation. In some cases contributions from RES, e.g., biomass, are calculated using a primary energy factor of 0, making almost no energy saving measures cost-effective. It is important for MSs to ensure that primary energy factors do not hinder implementation of NZEBs. According to the EPBD, it is required that the RES be located "nearby" the building if it is to be taken into account in the building's energy performance. Also, there are significant differences among MSs on how far "nearby" is, ranging from "at the building and the building site" to "within the borders of the MS".

Most MSs use standard inputs for energy performance calculations and thus these results are generally not in line with the measured energy consumption. Calculated energy savings presented in the EPC are therefore often different from the energy savings actually experienced. However, standard calculations, as carried out for the EPC, are the best tool for benchmarking buildings without influence of the users, while a supplementary calculation can provide realistic energy savings. Cost-effective renovation towards NZEB requires improved methods for estimating realistic energy savings. Several MSs have issued different guidelines for calculating realistic energy use and savings, as summarised in a report from CIBSE[6].

Calculating cost-optimal energy performance levels

There is an increased focus on setting out adequate and cost-optimal energy requirements in the national building regulations. Additionally, the cost-optimal calculation exercise resulted in recommendations for an update of the Guidelines to the Regulations for cost-optimal calculations, e.g., more guidance on choosing the type and characteristics of reference buildings, more clarification on economic scenarios and improved Guidelines of how to establish building typologies.

In most cases, the curve defining the calculated cost-optimal level is almost horizontal over a range of equally cost-optimal combinations of energy saving measures around the cost-optimal level. It is recommended that MSs set their requirements at the lower end of the cost-optimal range.

Many MSs have experienced that one or more building types have looser energy performance requirements than the calculated cost-optimal levels. Many MSs are working on closing, or have already closed, this gap by implementing tighter national minimum energy performance requirements for new and existing buildings.

Energy performance requirements for new and existing buildings

With the increased energy performance requirements for NZEB included in future national building regulations, compliance checking of the performance of new buildings becomes increasingly important. Compliance with requirements is not limited to energy performance requirements, but in several MSs also includes other aspects like airtightness, daylight levels, summer comfort, etc. There are different methodologies for compliance checks used in MSs depending on the assessment method and the requirement(s) to be checked.

There are two fundamentally different approaches to setting requirements for existing buildings subject to major renovation, namely whole building requirements or component requirements. Neither of the two methods is ideal and it is recommended that a combination of the two is implemented. The main advantages

[6] *Cheshire D. & Menezes A.C. (2013). Evaluating operational energy performance of buildings at the design stage. CIBSE TM54:2013.*

of a combined approach are: it is easy to strengthen requirements when an alternative is available; the approach is helpful during the setup of funding schemes; it is possible to achieve the cost optimum for each component; and there is an easy and direct connection to the energy performance indicator(s). It is recommended that requirements should ensure maximum energy savings without implementing requirements that are too rigid, too costly or too complicated. Works that do not require a building permit or which are performed inside the building are especially difficult to monitor.

Setting standards for technical building systems (TBS) is obligatory in existing buildings, and it refers to system performance rather than product performance or whole building performance. Even though it is not obligatory to set standards for TBS in new buildings, it is recommended to prescribe the same component requirements in new and existing buildings. This will make it easier for the industry to deliver highly efficient components as only one set of rules apply, and consequently prices will decrease as the market increases.

Towards 2020

Nearly Zero-Energy Buildings

OVERVIEW AND OUTCOMES

AUGUST 2015

1. Introduction

With the adoption of the Energy Performance of Buildings Directive (Directive 2010/31/EU - EPBD) in 2010, both the building industry and Member States (MSs) faced new challenges. One of the most prominent among them is the progress towards new Nearly Zero-Energy Buildings (NZEB) by 2021 (or by 2019 in the case of public buildings), while in parallel supporting the transformation of existing buildings into NZEBs. Thus, since 2010, the Concerted Action EPBD (CA EPBD) has been discussing the issues related to moving 'Towards 2020 - Nearly Zero-Energy Buildings' promoting dialogue and the exchange of best practices among MSs and thereby contributing to a more effective implementation of the EPBD in the MSs.

The work focused on the transposition of the Directive 2010/31/EU into national law, namely on the national detailed application in practice of the framework definition of NZEB, and on the national plans for increasing the number of NZEBs.

This report summarises the main outcomes of the discussions on this topic from March 2011 to March 2015. The successful contribution on MSs progress towards 2020 is based on the active participation of the national delegates (representing national authorities in charge of implementing the EPBD), including information gained from questionnaires, national studies, poster presentations, and study tours.

2. Objectives

Article 9 of the EPBD requires that *"Member States shall ensure that (a) by 31 December 2020 all new buildings are nearly zero-energy buildings; and (b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings"*. MSs shall furthermore *"draw up national plans for increasing the number of nearly zero-energy buildings"* and *"following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings"*.

A NZEB is defined in Article 2(2) of the Directive 2010/31/EU as *"a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby"*.

The specific CA EPBD activities on the topic 'Towards 2020 – Nearly Zero-Energy Buildings' support the MSs through the exchange of experiences regarding already existing high performance buildings, ranging from low energy buildings to passive houses, zero-energy and zero-emission buildings, and even to buildings with an energy surplus.

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Figure 1: Two NZEBs visited by CA EPBD: on the left, a single-family demonstration house in Berlin (Germany); on the right, a renovated multi-family house in Graz (Austria).

The discussion topics included the different national applications of the NZEB definition, the most common building and service system solutions, calculation methods, supporting documents (e.g., guidelines), awareness-raising activities for the general public, subsidies and other available incentives and support policies, etc.

A particularly important objective has been the integration of Renewable Energy Sources (RES) into the NZEB national implementation. This is part of the EPBD requirements, as the nearly zero or very low amount of energy consumed in NZEBs should be covered to a very significant extent by energy from renewable sources, but it also links to the RES requirements from Directive 2009/28/EC (Renewable Energy Sources Directive - RESD). In accordance with the RESD (Article 14(4)), by 31 December 2014 MSs must, in their building regulations and codes, or by other means with equivalent effect, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation.

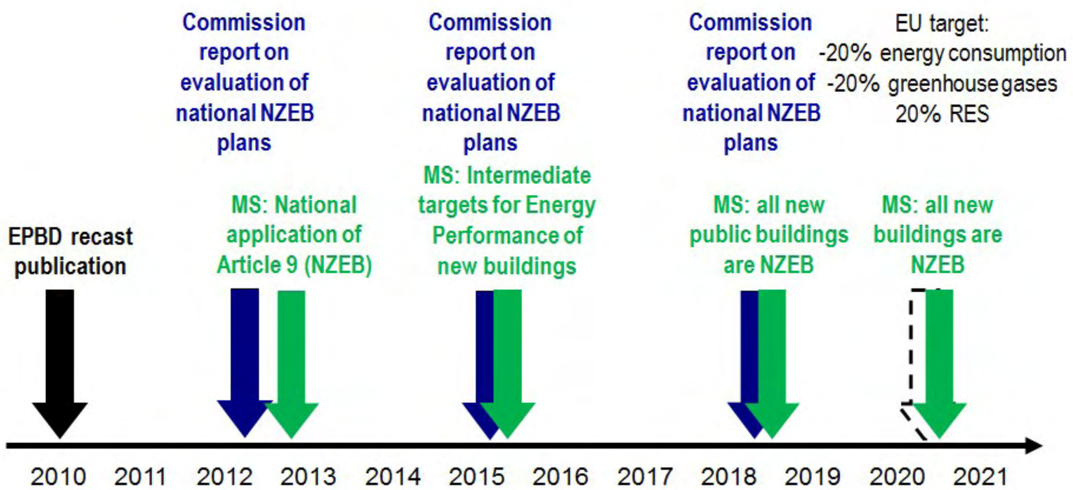
One of the main objectives of this period (for all MSs) has been to ensure that the national application of the EPBD NZEB definition is feasible at both technical and financial levels. For this reason, four study tours have been organised to better evaluate the particularities of NZEB in different environments and applications. These study tours have included visits to already existing buildings (new and renovated) that are close to the performance expected from an NZEB.

There is a very close link between the NZEB discussion and the CA EPBD activities on 'Energy performance requirements using cost-optimal levels', because the cost-optimal minimum energy performance requirements will have to meet the NZEB level by the end of 2018 for public buildings, and by the end of 2020 for all other new buildings. Additionally, both topics involve work on calculation procedures. This has fostered the exchange of views, challenges and ideas between technical and economic experts from the MSs.

Finally, discussions have also focused on the national plans for increasing the number of NZEBs.

The timeline for actions by the MSs and the EC related to NZEBs (Article 9 of the EPBD) is presented in Figure 2.

Figure 2: Timeline of NZEB-related actions according to the EPBD.



3. Analysis of insights

3.1 Mapping of national applications of the NZEB definition

3.1.1 National applications of the definitions in place by April 2015

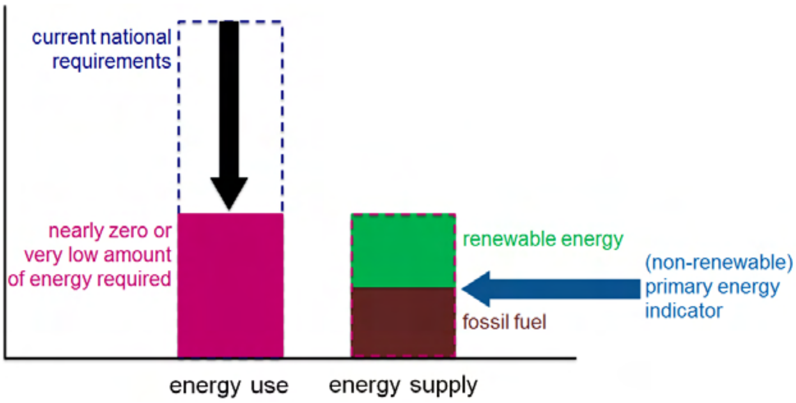
Continuous work and discussions have taken place from 2011 to 2015, gathering and comparing the status of national applications of the NZEB definition in the MSs. Table 1, which is taken from a special CA EPBD report[1], presents an overview of the available information regarding the detailed national definitions in April 2015, based on the national plans for increasing the number of NZEBs and the work within the CA EPBD. Figure 3 presents the main elements of the NZEB definition of the Directive 2010/31/EU Article 2(2).

According to Table 1, which was reviewed by the national representatives of the participating countries, about 40% of the MSs do not yet have a detailed definition of the NZEB in place. Some of them state this clearly in their national plan for increasing the number of NZEBs. About 60% of the MSs have laid out their detailed NZEB definition in a legal document, but a few of them emphasise the draft status of the definition, or that the definition might be updated later on. The relevant legal documents are either building regulations, energy decrees and official guidelines, or the national NZEB plans.

The very high energy performance is expressed in at least nine MSs by requiring that the building must fall into one of the top energy classes of the energy performance certificate. Other countries give specific information about the ratio of the tightening of the energy requirements compared to the 2014 level (or the 2012 level in some cases). These tightening ratios are between 10-25% and 50-60%. Denmark states a tightening of even 75% but relates it to an earlier energy performance requirement (2006).

The vast majority of EU countries (twenty three MSs and one of the three Belgian regions) use a primary energy indicator in kWh/m².year, in line with Annex I of the EPBD, either in their detailed NZEB definition, or in their current energy performance requirements for new buildings. Two additional MSs and the other two Belgian regions use either E-levels (a figure for primary energy use

Figure 3:
Graphical interpretation of the NZEB definition according to Articles 2 and 9 of the EPBD.



divided by a reference primary energy use), or include primary energy as a calculation result, but not as the indicator.

In most MSs, the limits for the nearly zero or very low amount of energy required are placed on more than just primary energy. The additional parameters include U-values of building envelope components, mean U-values of the building envelope, net and final energy for heating, cooling and possibly other energy uses and CO_2 emissions.

While about one third of the countries have only indirect requirements for the recommended 'very significant extent of renewable energy', those with direct requirements set them mostly as an energy share of the primary energy use. The required renewable energy share varies from > 0% to > 50%. A few other countries set specific minimum renewable energy contributions in kWh/m².year. Applying 'indirect' requirements means that, due to the low maximum value of primary energy use allowed for NZEBs, the use of energy generated from RES is implicit, although a specific minimum required amount is not included in the national definition.

By April 2015, about 60% of the MSs have laid out their detailed NZEB definition in a legal document and the vast majority of MSs use a primary energy indicator in kWh/m².year. While many MSs require a renewable energy share of the primary energy or a minimum renewable energy contribution in kWh/m².year, others use indirect requirements, such as a low non-renewable primary energy use that can only be met if renewable energy is part of the building concept.

[1] *Overview of national applications of the Nearly Zero-Energy Building (NZEB) definition, Detailed report, April 2015, available at www.epbd-ca.eu/wp-content/uploads/2016/01/Overview_of_NZEB_definitions.pdf*

Table 1: Overview of the available information regarding the detailed national NZEB definitions (April 2015)

Country		Main points of the NZEB definition				
		Detailed definition	**Very high energy performance**	**Nearly zero or very low amount of energy required Limits placed on:**	**Very significant extent of renewable energy**	**Primary energy indicator in kWh/m².year**
Austria		EPBD text implemented in OIB 6 of 03/2015. Detailed definition included in national plan of 03/2014	Maximum final energy use reduced by ≥ 50% compared to energy performance requirements of 2012	Heat demand, total energy efficiency factor, final energy, primary energy, CO_2 emissions	Direct: Minimum share of the final energy dependent on the implemented RES technology. Examples: • 50% of the final heating energy covered by biomass • 10% of the final DHW energy	Yes
Belgium	Brussels Capital	Included in *Arrêté du Gouvernement de la Région de Bruxelles-Capitale* of 21 December 2007, modification of 26 March 2013	Passive house	Heat demand, primary energy	Indirect *	Yes
Belgium	Flemish Region	Included in Regulation of the Flemish Government of 29 November 2013 regarding the energy performance of buildings	E-level (=primary energy use/reference energy use) ≤ E30 (for residential buildings); ≤ E40 (for offices/schools)	Component U-values, mean U-value of building envelope, primary energy as E-level	Direct: minimum share and alternative of single measure with quantitative requirements (e.g., 0.02 m²/floor area solar thermal (for single-family houses) or 10 kWh/m².year (for houses, apartments, schools, offices))	E-level (=primary energy use/reference energy use); not in kWh/m².year
Belgium	Walloon Region	Interpretation of EPBD text in national plan, study contracted, definition will evolve	Building envelope close to passive house and required E-level (=primary energy use/reference energy use)	Component U-values, primary energy	Under discussion: direct (> 50% of residual consumption of heat + cold + electricity)	Included for residential buildings in current minimum energy performance requirements. E-level used for all buildings
Bulgaria		Draft definition in national plan (BPIE study)	Class A	Primary energy	Direct: minimum share of 20% to 50% depending on building type	Yes
Croatia		Definition for single-family house in national plan. Definition for various building categories in Technical Regulation on Energy Economy and Heat Retention in Buildings (OG 130/14)	E.g., single-family house: 40.9 kWh/m².year primary energy (continental)/ 33.4 kWh/m².year (coastal)	Primary energy	Direct: minimum share of 30% of renewable energy from annual primary energy	Yes
Cyprus		Included in decree ΚΔΠ 366/2014 (issued on 1 August 2014)	Energy class A	Component U-values, heat demand (for residential buildings), installed lighting power (for office buildings), primary energy	Direct: at least 25% of primary energy	Yes
Czech Republic		Included in Regulation No. 78/2013 Coll.	Reference technologies, 30% lower mean U-value, 10-25% lower primary energy compared to current requirements	Mean U-value of building envelope, delivered energy, primary energy	Indirect *	Yes

Country	Main points of the NZEB definition				
	Detailed definition	**Very high energy performance**	**Nearly zero or very low amount of energy required Limits placed on:**	**Very significant extent of renewable energy**	**Primary energy indicator in kWh/m².year**
Denmark	Included in BR10, currently voluntary, to be adjusted	Building class 2020 (75% reduced to 2006)	20 kWh/m².year (for dwellings) / 25 kWh/m².year (for other buildings) primary energy	Indirect *, examples of solar panel sizes necessary to cover deficiencies in combination with district heating/heat pump in national plan	Yes
Estonia	Included in regulation VV No 68:2012 "*Energiatõhususe miinimumnõuded*"	Building class A	Primary energy: 50 kWh/m².year (for single-family houses) / 270 kWh/m².year (for hospitals)	Indirect *	Yes
Finland	The detailed definition will be finalised in the course of 2015 and the aim is to present the legislative proposal to the parliament in autumn 2016	-	-	-	-
France	Included in RT 2012	1/3 of prior requirements	50 kWh/m².year primary energy	Direct: 5-12 kWh/m².year for single- and multi-family houses, more in RT 2020	Yes
Germany	EPBD text implemented in energy saving act, detailed definition is being developed	Probably along KfW efficiency houses	Probably mean U-value of the building envelope and primary energy	Direct requirements included in current minimum energy performance requirements	Requirements included in current minimum energy performance
Greece	EPBD text implemented in Law 4122/2013 of 19 February 2013	-	-	Direct requirements included in current minimum energy performance requirements	Requirements included in current minimum energy performance
Hungary	Draft definition included in Decree about Determination of Energy Efficiency of Buildings of 7/2006 (V.24), detailed definition is being developed	More efficient than cost-optimal level	Specific heat loss coefficient of the building envelope, primary energy	Direct requirements included in current minimum energy performance requirements	Yes
Ireland	Draft definition included in the national NZEB plan	(Primary) energy performance coefficient = 0.302, carbon performance coefficient = 0.302 for typical dwelling: 45 kWh/m².year, for other buildings: 50-60% improve-ment comared to current requirements; rating A3 or higher	(Primary) energy/carbon performance coefficient	Direct requirements included in current minimum energy performance requirements (RES contribution of 10 kWh/m².year (thermal) or 4 kWh/m².year (electrical)); planned to be introduced for non-residential buildings in 2015	Yes (together with carbon dioxide performance indicator in kg CO_2/m².year)

Country	Main points of the NZEB definition				
	Detailed definition	**Very high energy performance**	**Nearly zero or very low amount of energy required; Limits placed on:**	**Very significant extent of renewable energy**	**Primary energy indicator in kWh/m^2.year**
Italy	EPBD text in Decree Law no. 63/90 of 2013, new energy decree includes detailed definition near completion	Primary energy significantly lower than current requirements (e.g., 60% tightening for a small multi-family building near Milano)	Primary energy for heating, primary energy for cooling, total primary energy	Direct: planned for NZEB is 50% of primary energy (direct requirements included in current minimum energy performance requirements)	Yes
Latvia	Included in Cabinet Regulation No. 383/2013	Building class A	Energy demand for heating ≤ 30 kWh/m^2.year; primary energy demand ≤ 95 kWh/m^2.year	Direct: at least partial use of RES (> 0%)	Yes
Lithuania	Included in Construction Technical Regulation STR 2.01.09:2012	Building class A++	Specific heat loss of the building envelope, efficiency of systems, primary energy	Direct: largest part of energy consumed (> 50%)	Yes
Luxembourg	Interpretation of EPBD text included in national plan and in national legislation (RGD 2014), detailed definition not yet fixed	Probably at least building class A-A	Net heating demand, primary energy	Indirect *	Yes
Malta	Proposed definition included in national plan, consultation process ongoing	Very high energy perfor-mance	Primary energy ≤ 40 kWh/m^2.year (for houses or apartments), ≤ 60 kWh/m^2.year (for other buildings)	Indirect *	Yes
Netherlands	National plan: aim to set requirement close to energy performance coefficient = 0 by 2018/2020, at least 2 feasibility studies	Close to energy performance coefficient = 0 (zero-energy building)	Mean thermal resistance of closed building envelope components, U-value of windows, (primary) energy performance coefficient	Indirect *	No. Energy performance coefficient is not in kWh/m^2.year); primary energy in MJ/m^2.year calculated as interim result
Norway	No detailed definition available	-	-	Direct requirements included in current minimum energy performance requirements	-
Poland	Translation of the EPBD text in national plan. Detailed definition included in Regulation of the Minister of Infrastructure on the technical conditions to be met by buildings and their location (Journal of Laws No 75, pos. 690), amendment in 2013	No details available	Maximum U-values for the building envelope components, maximum final energy performances indexes for heating, ventilation, hot water, cooling and lighting, maximum primary energy	Indirect *	Yes
Portugal	Translation of the EPBD text in Decree law 118/2013, Article 16. Detailed definition not yet available	-	-	-	Minimum energy performance requirements included in current legislation

Country	Main points of the NZEB definition				
	Detailed definition	**Very high energy performance**	**Nearly zero or very low amount of energy required Limits placed on:**	**Very significant extent of renewable energy**	**Primary energy indicator in kWh/m².year**
Romania	Included in updated national plan of July 2014	Reference technologies with best available technology packages, 13-58% lower primary energy than current requirements	Primary energy, CO_2 emissions	Direct: at least 10% of primary energy	Yes
Slovak Republic	Translation of EPBD text in Act No 555/2012, requirements in MDVRR SR 364/2012 Coll.	Class A0, primary energy 50% lower than current requirements	U-values of building envelope components, final energy use for heating, hot water, cooling and lighting, primary energy,	Direct: at least 50% reduction of primary energy	Yes
Slovenia	Translation of EPBD text in Energy Act of March 2014 (*Energetski zakon, Uradni list RS, št. 17/14*). National plan includes a detailed NZEB definition (approved by the Government on 22 April 2015)	Nearly 50% reduction of heating energy demand, at least 25% reduction of primary energy compared to current requirements. Requirements for public buildings 10% more strict than for other non-residential buildings	Mean U-value of building envelope and U-values of its components; heating energy demand $Q_{h,nd}$ < 25 kWh/m².year; primary energy [kWh/m².year]: 75 (single-family house), 80 (multi-family house), 55 (non-residential)	Direct: 50% RES as share of total delivered energy	Yes
Spain	Translation of EPBD text in RD 235/2013 (pending final approval). Detailed NZEB definition not yet available	-	Probably U-values of building envelope components, heating and cooling energy demand, primary energy (non-renewable and total)	Probably indirect. (Minimum energy performance requirements and direct requirements for certain buildings included in current legislation)	Probably yes. (Minimum energy performance requirements included in current legislation)
Sweden	No detailed definition is available yet. National plan states that there is currently no economic basis for further tightening. Next control planned for 2015	-	-	-	No. (There are stricter requirements for electrically heated buildings, though)
United Kingdom	National plan: no NZEB definition but target of zero carbon for new buildings through incremental changes to Building Regulations	Zero carbon new buildings in England from 2016 (homes)/2019 (non-domestic), other jurisdictions have similar ambitions. Highest EPC rating	Final energy demand, CO_2 emissions	Indirect	CO_2 emission as main indicator; primary energy indicator included in calculation method outputs in most jurisdictions

* Indirect: No specific renewable energy requirement but the low maximum values of primary and/or final energy use cannot usually be met without using renewable energy sources

3.1.2 Number of requirements for NZEB

Work in the CA EPBD and the EC's two progress reports on NZEB[2] have shown that the specific NZEB definitions in the countries vary considerably in the number of requirements used. The following CA EPBD analysis from October 2013 takes into account a sample of fifteen MSs. Not all of them had already officially fixed NZEB definitions, thus the plans of MSs that were still then working on this topic are also included. On the other hand, not all countries with legally fixed NZEB definitions, as pointed out in 3.1.1, have been part of this study.

While two countries set, or planned to set, only one specific NZEB requirement, namely primary energy, the other countries use, or planned to use, up to six additional requirements. Those additional requirements included CO_2 emissions, final energy, mean U-values, maximum transmission losses, efficiency factors of the whole building service system or part of it, etc.

General energy performance requirements for buildings, but also those specifically for NZEBs, are linked to historical background in most countries. Requirements enacted by early energy legislation are retained and tightened, but rarely abandoned completely. Thus, there are:

> countries that use many different requirements for new buildings in general, and tighten most of these requirements or define additional ones specifically for NZEBs, e.g., Denmark and Germany;
> countries that use many different requirements for new buildings in general and use few specific requirements for NZEBs, e.g., Belgium-Flemish Region, Cyprus, Estonia, The UK England & Wales, and the Czech Republic;
> countries that use few requirements for new buildings in general and many specific ones for NZEBs, e.g., Latvia.

In the sample of fifteen countries, 80% have set primary energy requirements, 53% have set requirements for using renewable energy, and 33% have set final energy use requirements as specific NZEB requirements.

Additionally, many countries limit transmission losses for NZEBs (40%) and/or demand certain building services efficiencies (40%). Ventilation loss requirements are used specifically for NZEBs in 20% of the sample countries. Heating energy limits for NZEBs are set in 27% of the countries. Only one country includes both final energy use limits and heating energy use limits in its NZEB definition. There are two countries in the sample with CO_2 emission requirements, of which one sets no primary energy requirement. It is interesting to note that two countries have set specific NZEB indoor comfort requirements.

The main arguments in support of either few or many NZEB requirements were as in Table 2.

MSs have adopted a wide range of detailed definitions of NZEB. While some countries set or plan to set only one requirement, which is typically primary energy, CO_2 emissions or delivered energy, other countries use or plan to use many additional requirements. Those additional requirements include mean U-values, maximum transmission losses, minimum efficiency factors of the whole building service system or parts of it, etc.

Table 2: Main arguments in support of either few or many NZEB requirements.

Few NZEB requirements	Many NZEB requirements
> easier to explain what a NZEB is > easier to prove what a NZEB is > easier to check what a NZEB is > easier to reach a cost-optimal solution (due to a higher flexibility in the approach)	> easier to adequately accommodate different building types > draws attention to important design phases through detailed, transparent design rules > draws attention to the construction phase (together with additional checks) > accelerates innovations for various products

[2] *available at ec.europa.eu/energy/en/topics/energy-efficiency/buildings/nearly-zero-energy-buildings*

3.2. Convergence between the concepts of NZEB and cost-optimal energy performance requirements

Based on EPBD Article 5 'Calculation of cost-optimal levels of minimum energy performance requirements' and Article 9 'Nearly Zero-Energy Buildings', the beginning of the years 2019 (for new public buildings) and 2021 (for all new buildings) will be the convergence point between the cost-optimal calculations and the definition of NZEB: by 2019/2021, NZEB shall have a cost-optimal combination of building envelope and building service systems.

As a result, the cost-optimal calculations for 2012 have to be reviewed for 2019/2021[3], since there are certain factors like prices, technological developments and primary energy factors that will change between now and 2019/2021. Ten MSs reported in March 2013 that they have performed studies that take into account estimated changes in the following parameters:

> primary energy conversion factors: eight MSs;
> energy prices: nine MSs;
> investment costs: five MSs;
> technology and efficiency developments and innovations: three MSs.

Three countries have studied all four factors listed above. Other factors that were examined (but only one factor per MS) were CO_2 reduction costs and discount factors.

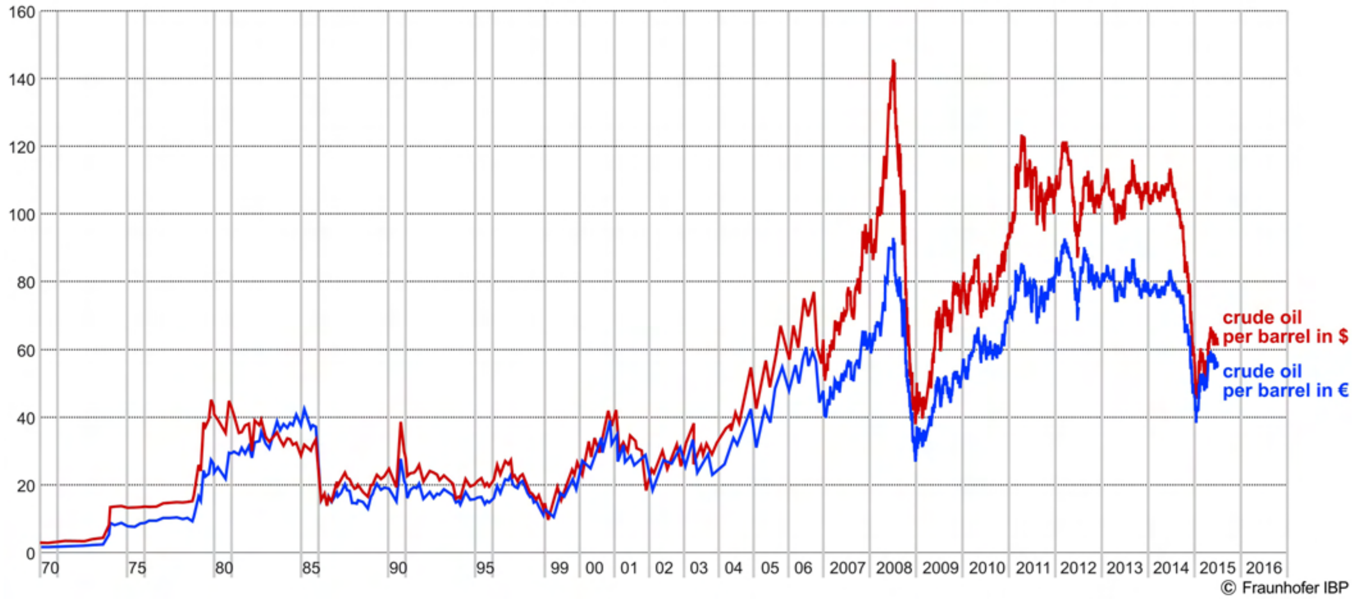
The primary energy conversion factors, or more precisely the non-renewable primary energy factors for the national electricity mix and for district heating energy will decrease because higher rates of RES will be integrated into their generation systems in the near future. Applied estimations included e.g., in Denmark electricity primary conversion factors of 2.5 in 2012 and 1.8 in 2020, and district heating conversion factors of 1 in 2012 and 0.6 in 2020. Hungary used values of 1.12 for the 2012 primary energy conversion factor for district heating based on combined heat and power (CHP), and 0.65 for 2020.

The estimated increases of the energy prices that were used in the calculations were between 2-3% per year and 5-6% between 2012 and 2020 in total.

The development of loan interest rates and of financial incentives might be additional factors that can be also analysed in the cost-optimal calculations. However none of the ten countries have claimed to have studied these evolving factors so far.

MSs reported that, using the present costs, technologies, and primary energy conversion factors, the currently available national applications of the NZEB definition are not fully in compliance with the cost-optimal requirement, because there is no certainty about the evolving influence factors for the calculations for the year 2019/2021, see Figure 4. Only one country (Denmark) reported that it has used the study on evolving factors to adjust its national application of the NZEB definition. Other countries might follow.

Figure 4: Strong fluctuation of the crude oil price complicates the prediction of 2019/2021 NZEB boundaries.



[3] *This is coherent with the EPBD Article 4(1) timeline for cost-optimal reports, whereby the first report was due by June 2012 and the following five years later (June 2017). Due to the actual date of adoption of the Delegated Regulation on the cost-optimal methodology, a formal extension was granted to MSs for submitting the first reports by March 2013, which in practice brings the five-year review to be done before March 2018.*

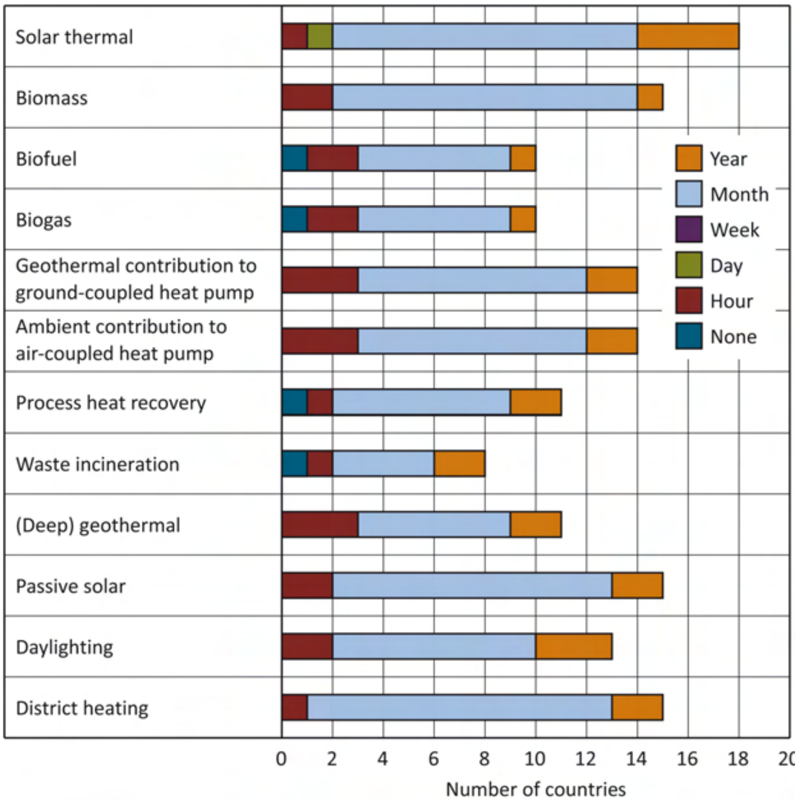
Therefore, the topic is certainly worth revisiting in the future when developments in existing and new technologies, as well as the cost of these technologies, may change the picture, and hence initiate new calculation results and new discussions. Updated cost-optimal calculations using expected evolving influence factors can give indications of the changes necessary for the detailed national application of the NZEB definitions in the coming years. In 2020 they can be used to fix the final requirements for NZEBs.

Ten MSs performed a cost-optimal study for 2019/2021 (e.g., for NZEBs), taking into account evolving parameters such as primary energy conversion factors, estimated energy prices, investment costs, and technology efficiency developments and innovations. The update of cost-optimal calculations with expected values of evolving influence factors in the coming years might allow for iterations of the national NZEB definitions.

3.3. MS approaches to introduce renewable energy sources (RES) in NZEB

The CA EPBD has continously discussed national boundary conditions for the use of RES in buildings in general, but also specifically for NZEBs. The analysis described in this section of the report was produced in May 2014 based on input from twenty MSs.

Figure 5: Balancing period for heat production from various RES sources in MSs national calculation tools.



MSs allow for almost all forms of RES to be taken into account, but there are differences in how electricity is accounted for in the national calculation procedures (for more details see the chapter on Energy Performance Requirements Using Cost-Optimal Levels, in this book), as well as in the primary energy factors which MSs use. For example, two MSs (Estonia and Malta) allow for an annual balancing of electricity production, but most of the other MSs balance electricity production on a monthly basis - primarily due to the overall balancing period of the national calculation tools, which in most cases is monthly. More or less the same differences and approach apply for heating and cooling production using RES. The thermal RES strategies used in most MSs are solar thermal, 'green' district heating (both are used in eighteen MSs) and biomass (in seventeen MSs). The applied balancing periods for thermal RES are presented in Figure 5.

The EPBD recommends that the nearly zero or very low amount of energy consumed in NZEBs is to be covered *"to a very significant extent by energy from renewable resources, including energy from renewable sources produced on-site or nearby"*. In the national definition of 'nearby', there are significant differences among MSs, ranging from at the building itself (e.g., The UK and France for photovoltaic (PV) panels) and the building site (e.g., Austria, Slovenia, Slovakia), to within the borders of the MS (e.g., Malta). Belgium-Flemish Region defines 'nearby' as on-site, except for district heating and participation. The Netherlands and Bulgaria have defined it as RES installed at a maximum distance of 10 and 15 km respectively. In Denmark, RES is considered 'nearby' as long as the building owner has an economic interest (e.g., investment) in the RES system and the RES system is located in the same municipality or a neighbouring municipality of the building site. Lithuania has not defined 'nearby', but accepts all RES regardless of where the energy source and power generation equipment are located. More than half the MSs have not yet outlined a definition of 'nearby'.

Taking into account different RES must be discussed further in the future in order to verify the boundary between the building and the surrounding utility grids, and to avoid double counting of RES production on the MS level.

MSs have different approaches on how to handle RES in their energy performance calculations and legislation. Moreover, the primary energy factors used for renewable energy sources and technologies differ considerably among MSs. Energy from RES can include both those located on-site or nearby the building. 'Nearby' has so far been defined only by some countries and rather differently, ranging from 'on the building itself' to 'within the country'.

3.4. NZEB in energy performance certificates (EPC)

The CA EPBD collected Energy Performance Certificate (EPC) layouts that have been adapted to include NZEBs. The examples from the MSs show that there are widely different methods for including NZEB in the EPC. Often no adaptation is needed, or only small adjustments or additional energy performance classes; a scale may be suitable for including NZEBs and even the 'plus energy' building level (a building that produces more energy than it consumes over an annual period). Many MSs chose not to show the NZEB level explicitly on the EPC front page. The approaches can be distinguished as follows (the list of countries is indicative and meant only to illustrate the various approaches):

> no change at all: use of existing layout, no adaption, a NZEB is class A (or A+ or similar): the Czech Republic, Italy, Hungary;
> no change in the layout but addition of guidelines for NZEBs: France;
> addition of one or several classes in order to present NZEBs: Croatia, Denmark, Lithuania, Luxembourg, Portugal, Slovakia, The Netherlands;
> small changes in the layout regarding indicators or design: Austria, Estonia;
> new layout, change from scale to classes, NZEB is class A or A+: Germany (for residential buildings), Latvia;
> addition of a NZEB indicator to the existing scale (e.g., an arrow similar to the current minimum energy performance requirements): Germany (for non-residential buildings), Malta.

The survey showed that in most cases adaptations to present the NZEB-level on the EPC are rather insignificant. However, not all countries foresee integrating an NZEB indicator on the EPC at this stage. They want to make EPCs as user-friendly as possible, and point out that an additional indicator will render the EPC less understandable for the building owners, tenants and other building users. If the possible advantages of an indication of the NZEB-level, e.g., better communication of the 2019/2021 minimum requirements, are to be exploited in all MSs, the requirement to include this indicator may need to be added to the next version of the EPBD.

3.5 Practical experiences with NZEB

3.5.1 Selected examples of NZEB in the countries

The CA EPBD identified examples of existing buildings that have an energy performance level in the expected range of NZEB (or approaching NZEB level) in the different EU MSs. In total thirty-two practical examples of NZEB-like buildings from twenty different MSs have been collected and published in a specific CA EPBD report[4].

Though the selected buildings cover a wide range of climates, building types and sizes, the cross analysis gives a good overview of what kind of buildings are expected to be NZEB in the different countries and EU regions. For example the average U-values in the buildings are 0.29 W/m².K (walls; range: 0.065–1.97 W/m².K), 1.16 W/m².K (windows; range: 0.70–4.5 W/m².K), 0.14 W/m².K (roof; range: 0.06–0.55 W/m².K) and 0.29 W/m².K (ground/cellar ceiling; range: 0.68 – 2.19 W/m².K). The realised U-values can be as low as 0.065 W/m².K for walls and roofs and 0.70 W/m².K for windows, and demonstrate the highest level of energy efficient building technologies currently available. On the other hand there are a few examples presented with more conventional U-values of up to 1.97 W/m².K for walls, and even 4.5 W/m².K for windows, in one of the Southern European countries. The higher U-values are partly acceptable due to the warmer climatic conditions, but also show that some of the technical developments for energy efficient building components are not yet available and/or used in all EU MSs. In addition, the more conventional U-values and building components result in lower costs.

[4] *Erhorn, H. and Erhorn-Kluttig, H.: Selected Examples of Nearly Zero-Energy Buildings. Report of the Concerted Action EPBD. 2015, available at www.epbd-ca.eu/wp-content/uploads/2011/05/CT5_Report_Selected_examples_of_NZEBs-final.pdf*

The buildings are often heated by heat pumps, followed by gas boilers and connections to a district heating net. Hot water is mostly generated in combination with the heating system. Where cooling systems are used, these often involve thermally activated building components[5] in the cooling strategy.

About three quarters of the buildings use a mechanical ventilation system with heat recovery. Only three of the buildings in the report rely on natural ventilation (window opening) for fresh air.

In terms of RES, PV panels are the most common option, with nearly 70% of the NZEB examples using them. Solar thermal panels are part of the energy concept in more than half of the buildings. Other renewable energy used in the buildings is geothermal (from ground source heat pumps), biomass and district heating with high shares of renewable energy. The average percentage of the total final energy use that comes from RES is 70% for the thirty-two buildings, but can be as high as 216% in one of the so-called 'plus energy' houses included in the collection.

The improvement compared to the current national requirements is between 21% and 202%, with an average of 74%. A (net) zero energy building has an improvement ratio of 100%. An improvement ratio of more than 100% is possible if the building is a 'plus energy' building. The average of the additional costs compared to the current national requirements is 208 €/m² or 11% of the total costs. However there are also buildings with zero additional costs and buildings with up to 473 €/m² or 25% of the total construction and technology costs. It must be noted though that some of these buildings are special demonstration projects or prototypes, and they may not really be representative of the future typical costs of NZEBs when these technologies become standard.

Nearly all MSs have started to gather experience from practical examples of NZEB-like buildings. The case studies show a wide range of building envelope qualities and types of building service systems and included RES. The most dominant technologies are: increased insulation and high performance windows, as well as mechanical ventilation systems with heat recovery, heat pumps and PV applications. There are differences between climatic conditions, though, and some of the solutions are less frequently adopted in Southern European MSs.

The average of the additional costs is 11% of the total cost, or 208 €/m². However one NZEB case study resulted in no additional costs.

3.5.2 NZEB apartment buildings

NZEB apartment buildings (new buildings and renovations) have been the focus of a detailed comparison between eight available documented examples in six MSs (Austria, Croatia, Denmark, Finland, Germany and Spain) with the following main results:

> The average U-values of the building envelope components are 0.20 W/m².K (external walls), 0.12 W/m².K (roofs), and 0.33 W/m²K (cellar ceilings/ground slabs). Windows are mostly triple-glazed and result in an average U-value of 1.0 W/m².K.

> The building service systems are often connected to the district heating unit, sometimes with solar support. Other systems include heat pumps, gas boilers and combined heat and power units. Domestic hot water (DHW) is mostly generated centrally by the generator(s) of the heating system. Only one case study includes a cooling system, and uses a reversible heat pump for generation and a floor heating system as distribution system.

> The most frequently applied RES systems are on-building solar thermal and PV systems. In all cases with district heating systems, the district heating generation also includes RES: biogas and geothermal via a heat pump are each applied in one system.

> During the construction phase, a few projects had difficulties with workforce quality regarding new technologies and airtightness. Other projects had no such difficulties.

> While two projects reported an energy consumption that meets or even undercuts the predicted energy use, a few projects will need another monitoring year to take care of systems and automation that did not work according to plan.

> Most of the projects reported that the costs were affordable or financially attractive to the tenants. Additional

[5] *Thermally activated buildings components are ceilings, floors or walls that include pipes or ducts with water or air for either heating or cooling, thus activating the building mass of the component and reducing the heating or cooling load.*

costs compared to conventional buildings were as low as 0 €/m² for the Croatian and one Finnish example, 20 €/m² for the Danish example, 27 €/m² for the Spanish example and 25 €/m² for the second Finnish example.
> Under 'experiences with the project', several projects specifically reported user satisfaction and improved quality of life.

A detailed analysis of renovated apartment blocks in Austria focused on the technologies used for renovating multi-family houses into NZEBs or even 'plus energy' houses. One innovative technology that was identified is a prefabricated facade system that also contains the installations and several renewable energy measures. The CA EPBD also studied financing methods for such deep renovation projects in Austria. Besides identifying an interesting financing method that uses the money of private investors (with acceptable paybacks) for the renovation of certain buildings in combination with governmental and local subsidies, discussion also focused on whether the support of some pilot projects with high subsidies could help meet the targeted high renovation rate in general.

Apartment buildings are an interesting building type when it comes to the implementation of NZEBs, as they are rather similar in all EU MSs and represent a significant portion of the building stock. The CA EPBD has analysed several examples of NZEB-like apartment buildings and found comparable building concepts in many countries, as well as interesting financing approaches. Most of the projects reported that the costs were affordable or financially attractive to the tenants. Several projects specifically reported user satisfaction and improved quality of life.

3.5.3 Single-family houses used as pilot projects

In the EU, single-family houses are the most common building type, and thus attract the most MS interest. Thus the CA EPBD collected various MS experiences with high-performance single-family houses.

British experts reported that there is often a difference between the predicted (calculated) energy performance and the measured results of the buildings. It should be noted though, that this is relative. While the absolute amount of deviation in energy use is often smaller in high performance buildings, the deviation percentage increases with the reduction of energy needs. The following reasons for these differences have been determined, based on experience with high performance buildings:

> deviations between design and as built;
> significantly lower seasonal efficiency of boilers and heat pumps than predicted and expected;
> problems with mechanical ventilation systems, including draughts, noise, faults and poor performance;
> poor workmanship on the installation of solar thermal systems;
> different user behaviour in reality than assumed in the calculations;
> use of control systems that are too complicated for the users.

Some countries, e.g., Austria and Germany, have good practical experience with high performance houses. In those countries, fewer failures at the construction site are found, and houses with a higher energy efficiency than that required by national regulations have a dominant share in the market of new residential buildings.

Finally, the experience in The UK shows that it is difficult to introduce NZEBs in countries in which the average time which people stay in a purchased home is about seven years before a new home is bought and the old one is sold. This makes investment in energy efficient technologies rather difficult, as they rarely pay back within that short timespan.

There is often a significant difference between the predicted (calculated) energy performance of buildings and the measured results. There are countries with good practical experience with high performance houses, where this type of house already has a dominant share in the market of new residential buildings. In these countries, the differences between the predicted and the actual performance are smaller.

3.5.4 Public buildings as leading examples

In Article 9, the EPBD sets earlier implementation dates for NZEB for new buildings occupied and owned by public authorities. Public buildings shall be used as leading examples for the process of moving towards NZEB. There is already a variety of high performance public buildings in several countries, some of which are presented in the catalogue of selected examples of NZEBs produced by the CA EPBD (see footnote 3). Germany, the focus of a CA EPBD study tour on this issue, uses prominent buildings like the 'Reichstag' (the Federal Parliament building), several ministry buildings, and community buildings e.g., schools and kindergartens, as lighthouses for the general development in the building sector. School buildings can be used as a special means of communication with pupils and their families, and can thus reach many different groups of the society. This approach is also applied in several other countries, such as Ireland, The UK, Denmark, Italy and Norway. The national approaches are supported by several EU projects, e.g., the EU FP7 School of the Future[6] and the IEE ZEMedS[7].

In Germany and Latvia, there are specific research and funding programmes for new and retrofitted community-owned buildings at NZEB level. There are several communities in different countries (e.g., Denmark, Germany and Belgium-Flemish Region) that have implemented their own energy decree, with energy performance requirements that are further tightened in comparison to national minimum requirements. The requirements apply to community buildings and buildings built on community land. The German Federal Government has committed to build its own new buildings at NZEB level already since 2012. An interesting measure is the installation of an energy commissioner responsible for the energy efficiency of all federal buildings of Germany.

The use of public buildings as leading examples is already in place in several MSs. Various instruments, e.g., financial support for communities, specific research programmes, tighter energy performance requirements, etc., are in use.

3.5.5 NZEBs in Southern Member States

A key challenge for NZEB in Southern MSs is to ensure the environmental comfort without the use of significant energy for cooling. The technologies most frequently used to reduce the cooling energy demand in the MSs are solar control features (e.g., mobile or fixed shading devices and structures, including verandas), night ventilation, ground-coupled heat exchanger for pre-cooling of ventilation air, and ventilation systems with summer mode (bypass of heat exchanger). Reversible heat pumps are a common solution where mechanical cooling is needed.

According to practical experience, the following conclusions can be drawn:

> The use of shading and night ventilation are the most important passive cooling strategies.
> Thermal mass can only be used effectively in climates with significant differences between day and night outdoor air temperatures.

Additional experience in warm climate countries shows that ground-coupled heat exchangers for ventilation (earth cooling tubes) work well in France, Portugal and Greece and that insulation is effective in warm climates, as it can reduce energy needs for both heating and cooling.

The experience with high performance buildings in France led to NZEB requirements combining energy performance and comfort by limiting the primary energy use, the new bioclimatic indicator (relating heating, cooling and artificial lighting demand) and the indoor temperature accounting for the intensity of discomfort.

In countries with a warm climate, a combination of NZEB requirements for energy performance with specific comfort criteria might be advisable. The essential issue is to create indoor conditions that allow occupants to feel comfortable without air-conditioning during warm periods, or to reduce the cooling load where cooling is still necessary.

3.6. National plans to increase the number of NZEB

Article 9, paragraph 1 of the EPBD indicates that *"Member States shall draw up national plans for increasing the number of nearly zero-energy buildings"*. The article also includes further information on what must be included in the national plans, namely: the detailed application in practice of the NZEB definition (including a numerical indicator of primary energy use expressed in kWh/m^2.year), intermediate targets (by 2015) and information on policies and financial measures to increase the number of NZEB.

[6] *EU FP7 demonstration project School of the Future (260102), available at www.school-of-the-future.eu*
[7] *IEE project ZEMeds (IEE/12/711), available at www.zemeds.eu*

In order to support MSs in this work, a possible structure for the national plans was developed. In general, there seem to be two ways to structure the national NZEB plans: either with the focus on the content topics, as defined in the EPBD Article 9, i.e., a report topic by topic, or by concentrating on the building type (new/existing/public/residential/non-residential).

The drafts of the national NZEB plans have been discussed during this CA EPBD period. Three key aspects of the national plans have been specifically analysed by the CA EPBD:

> intermediate targets for improving the energy performance for new buildings by 2015;
> policies and financial or other measures adopted for the promotion of NZEBs;
> national requirements and measures concerning the use of energy from RES in new and existing buildings.

The intermediate targets indentified were not all planned for 2015, as stipulated in the EPBD. Instead, MSs are developing these targets over the whole period between 2013 and 2019/21. Several countries plan to set more than one intermediate target between 2013 and 2019/21. However there are twelve countries that foresee a tightening of the energy performance requirements within the year 2015, as shown in Figure 6. The targets can be grouped into the following headers (see Figure 7): envelope quality, building service system efficiency, passive house standard, net energy demand, final energy demand, primary energy demand, CO_2 emissions, renewable energy sources, earlier implementation of NZEBs and lower building energy performance classes.

The policies and financial or other measures for the promotion of NZEBs, including measures for using RES, demonstrate a wide variety. They include:

> policies and requirements, e.g., requirements for integrating RES, renovation roadmaps, including in the context of Article 4 of the Directive 2012/27/EU (Energy Efficiency Directive - EED), green deals, etc.;
> using the public sector as a frontrunner, e.g., retrofit programmes for local authority-owned buildings, model contracts for Energy Service Companies (ESCOs), financial subsidies for RES measures in public buildings, etc. For example, Ireland's National Energy Efficiency Action Plan (NEEAP) and the Energy End Use Efficiency and Energy Service Plan include specified aims for energy efficiency improvement (in GWh of savings) by 2015 and 2020. In both plans, the public autorities play an exemplary role. They are only allowed to buy or lease buildings rated at least A3 from 2015 onwards, purchase energy efficient equipment and vehicles (Triple E register), display EPCs in buildings over 500 m^2, and apply green tenders;
> financial incentives, e.g., loans with reduced or 0% rates, tax credits, third party financing, revolving funds, the use of EU Structural and Investment Funds, etc.;
> demonstration programmes and buildings, e.g., exemplary NZEBs, educational excursions, exhibitions of energy saving technologies, etc. For example, Germany runs several demonstration programmes for new buildings up to the level of plus energy houses and energy efficient renovation of existing buildings;

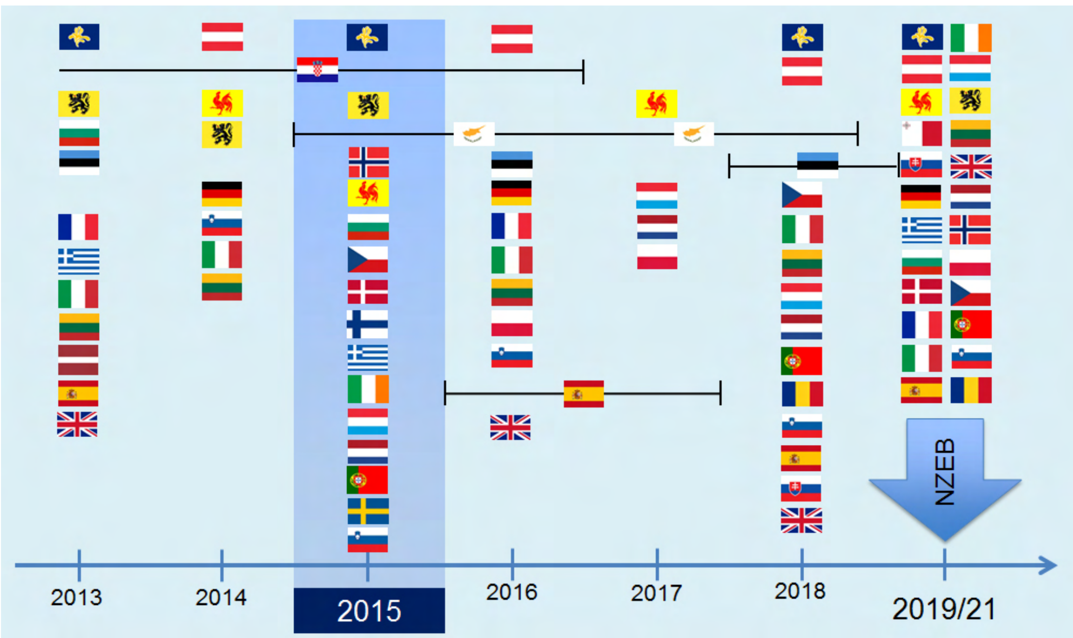


Figure 6: Timing of planned intermediate targets for energy performance requirements in the different MSs as stated in the national plans for NZEBs, and the deadline for NZEBs in 2019/2021. The black lines show foreseen time spans in which a tightening of energy performance requirements is planned in a country.

Figure 7: Type of planned intermediate targets for improving the energy performance of new buildings in the different MSs as contained in the national plans for NZEBs (not an exhaustive list).

- research work, e.g., virtual and real energy research centres, data studies, building material research, etc.;
- communication with and education of various target groups, e.g., central databases with information for the public, information and training of builders, communication campaigns, energy agencies, etc. For example, an interesting approach from Belgium (Flemish region) is to position the NZEB as a brand with practical guide on how to build a NZEB, lists of NZEB frontrunners (architects, energy experts, construction companies, installation companies, manufacturers and banks), demonstration buildings, TV programs and cheaper loans.

By presenting specific interesting national examples as best practices, inspiration has been shared with all countries participating in CA EPBD from 2010-2015.

MSs have planned intermediate targets towards NZEBs, not only for 2015 but also over the whole period from 2013 to 2019/2021.

The CA EPBD activities supported the MSs in developing their national plans towards NZEBs by giving inspiration through the presentation of interesting examples for financial incentives and demonstration programmes, as well as communication and education, etc.

4. Main outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
National applications of the NZEB definition	By the end of April 2015 about 60% of MS have laid out their detailed NZEB definition in a legal document.	'Very high energy performance' is introduced in different ways, including X% less than current requirements, top building classes, or zero carbon buildings. Not all definitions contain direct requirements for renewable energy contributions.	Several MSs are still working on the detailed application in practice of the NZEB definition. Existing applications will have to be reviewed and may be adapted prior to the target dates of 2019/2021.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Convergence between the concepts of NZEB and cost-optimal energy performance requirements	There are uncertainties in predicting factors like energy prices, component costs and technical innovations.	Ten countries performed cost-optimal studies for 2019/2021, taking into account estimates of evolving factors.	Cost-optimal calculations towards NZEB must be repeated closer to 2019/2021 to account for technological developments and better cost estimates.
Introduction of RES in NZEB	MSs take various different approaches to accounting for renewable energy contributions.	Primary energy (weighting) factors and available definitions of 'nearby' vary among MS.	There is a need for further national and CEN work to converge on how to account for renewable energy and how to express passive contributions.
NZEB in EPC	Examples of EPC layouts that include NZEB show widely different approaches in MSs.	NZEB can be expressed with no or small adjustments (e.g., a certain top energy performance class) or by introducing a new indicator (e.g., an additional arrow on an energy performance scale).	To increase the visibility of NZEBs, the specific presentation of this energy performance level on EPCs in all MSs will be helpful.
Examples of practical experiences with NZEB	Nearly all MSs have started to gather experience by constructing examples of NZEB-like buildings. The case studies show a wide range of building envelope quality, types of building service systems and RES.	Most dominant technologies are insulation, high performance windows, mechanical ventilation with heat recovery, heat pumps and PV applications. The average additional cost of the prototypes was 11% of the total costs (ca. 200 €/m²).	Further experience with innovative technologies and control strategies is needed, as are studies on user acceptance and influence and indoor comfort. Reduction in additional costs must be sought.
Practical experiences with NZEB: apartment buildings	The CA EPBD has analysed several examples of NZEB-like apartment buildings and found comparable building concepts in many countries, as well as interesting financing approaches.	Apartment buildings are an interesting building type for the implementation of NZEBs. They are rather similar in all EU MSs and represent a large proportion of the building stock.	With more national NZEB definitions and example buildings available, the comparison between examples will lead to more representative average costs and experiences.
Practical experiences with NZEB: single-family houses	In some MSs, there is a significant difference between the predicted and the measured energy performance.	In MSs with a dominant share of high performance buildings in the market of new residential buildings, fewer failures are reported.	The workforce needs to be trained for installing certain more advanced technologies (BUILD UP Skills).
Practical experiences with NZEB: public buildings as leading examples	Several countries use public buildings as lighthouses for the general development of high performance buildings.	A list of instruments to support the use of public buildings as leading examples towards NZEBs was compiled.	Financial support programmes for community buildings are important in the future (e.g., for NZEB retrofit).
Practical experiences with NZEB: Southern Member States	Successful technologies for reducing cooling energy use include good solar shading, night ventilation, ground heat exchangers, and reversible heat pumps.	A combination of NZEB requirements for energy performance and comfort criteria might be advisable.	More examples and further information on successful technologies and their costs are needed.
National plans to increase the number of NZEBs	MSs have planned intermediate targets towards NZEBs not only for 2015, but also for the years between 2013 and 2019/2021. Several countries plan to realise more than one tightening of requirements during this period.	There are several good examples for financial incentives, demonstration programmes, as well as communication and education measures.	The first national NZEB plans were sent in September 2012. The plans will have to be updated every three years and new versions should be prepared based on the best practices that were identified.

5. Lessons learned and recommendations

With many details in the national applications of the Nearly Zero-Energy Buildings (NZEB) definition still under development in a significant number of Member States (MSs), the exchange of information in the Concerted Action EPBD (CA EPBD) has proven to be very helpful for those responsible for the implementation of the EPBD in MSs.

A major challenge is the convergence point between the NZEB definition and the cost-optimal energy performance requirements. Several major parameters cannot be easily predicted over the next five years. These parameters include future performance of new technologies and existing technologies that will be further improved in the coming years, cost developments of technologies, future primary energy factors (mainly for electricity, as well as for district heating and cooling), due to changes in the infrastructure, cost developments of energy carriers, labour and planning, as well as boundaries like changing climate and lifestyle. Therefore, NZEB levels will perhaps need to be based on the updated cost-optimal calculations due by March 2018, at the latest.

The national applications of the NZEB definition need to show a clear direction, although the exact values might still have to be adjusted by the MSs at a later stage, when costs and the other influencing factors become predictable with a higher degree of certainty. However, a clear indication of the tightening range (e.g., 30-50% better energy performance compared to the current requirements) is necessary for the building industry, investors and planners to stimulate timely technological innovations and developments.

NZEB pilot and demonstration projects have been realised in the MSs, along with promotion and subsidy programmes to support their early market implementation. Despite the current financial crisis in Europe, these kinds of projects and programmes should be continued and extended to all European countries and to more types of buildings (many MSs only have experience with one or just a few building types). Experience in some MSs shows that state investment in financial incentive programmes is a win-win situation, because of the payback from the increased number of jobs and tax revenues.

Rehabilitating the existing building stock into more energy efficient buildings remains one of the main difficulties to be overcome, even more so when the targets are as high as they are with the NZEB. MSs must improve their national plans for the gradual tranformation of existing buildings into NZEBs and their long-term strategies for mobilising investment in the renovation of the national building stock, and quicken the pace of implementation. Initial experiences show that it may be difficult to reach the same level of NZEB minimum energy requirements for new and renovated buildings with equivalent timelines, because the cost-efficiency is different. The requirements regarding primary energy use and renewable energy contribution will also have to take into account the resulting costs. A life cycle assessment approach should be considered for the future. This is in accordance with the EPBD NZEB requirements for existing buildings, which refer to the need for continuous policy and financial support, without target dates (contrary to the NZEB provisions on new buildings).

A major focus should be on motivating building owners to renovate buildings to the NZEB level. Therefore, successful examples without subsidies are needed, while unsuccessful examples or negative press articles are significant barriers that have to be overcome. Roadmaps for renovation in several steps might also be helpful.

As stimulation instruments, tax reductions have been suggested together with special programmes for buildings under multi-ownership, pilot projects and a database of successful examples.

Compliance and Control

OVERVIEW AND OUTCOMES

AUGUST 2015

1. Introduction

The Energy Performance of Buildings Directive (EPBD) emphasises compliance and control as vital elements for its successful implementation. This report contains information, statistics, outcomes and conclusions from the dialogue on national approaches to compliance and control during the period 2011-2015.

The discussions within the Concerted Action EPBD (CA EPBD) focused mostly on compliance with the energy performance requirements and control of the Energy Performance Certificates (EPCs). As Member States (MSs) implemented the EPBD, experience of enforcing energy performance requirements and of EPC quality control has grown significantly, but it seems that there are still quite a few substantial challenges preventing the EPBD from being fully implemented and thus acheiving its goals.

Compliance and control issues for inspections have also been addressed. Fourteen countries opted to replace heating system inspections with alternative measures, while seven countries did the same for AC systems, therefore, issues of compliance and control of inspections and inspectors do not apply in those cases. The other countries have, by the end of 2014, already implemented a working approach to monitor and ensure the quality of inspections of heating and cooling systems (sixteen MSs implemented an inspection approach for controlling heating systems and twenty-one for cooling systems). However, not all of them have yet established an active control system for inspectors and/or for inspections and reports.

This report attempts to obtain the relevant information from every MS in the EU. However, as this was not possible for every aspect, the total number of countries covered in some statistics may be less than twenty-eight (or twenty-nine including Norway).

2. Objectives

Directive 2010/31/EU introduced two new obligations for the MSs, in order to improve the quality and effectiveness of its implementation:

> MSs shall lay down the rules on penalties for infringement of the national provisions adopted pursuant to the Directive (Article 27).

> MSs shall implement an independent control system for EPCs and for inspection reports (Article 18). The requirements for the control system are specified in Annex II of the EPBD.

2.1 Enforcing compliance with requirements and rules

The delivery of regulatory outcomes is not only based on how regulations are designed. Experience with the EPBD in recent years showed that regulation without enforcement leads to lack of compliance, while the effective use of sanctions increases compliance with the regulations.

The Organisation for Economic Co-operation and Development (OECD) underlines in its report entitled

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'Regulatory Enforcement and Inspections'[1] that ensuring effective compliance with rules and regulations is an important factor in creating a well-functioning society and trust in the government, and is necessary to effectively achieve a government's goals. The major challenge is to apply enforcement strategies that deliver the best possible outcomes by achieving the highest levels of compliance, while keeping regulatory costs and administrative burdens as low as possible.

The CA EPBD focussed on enforcement strategies, actions to improve the compliance rate and sanctions to penalise infringements.

2.2 Independent control system

In order to maximise the potential benefits of the EPBD and to achieve credibility in the market, not only compliance checks but also quality control of the issued certificates are both essential. The CA work focussed on:

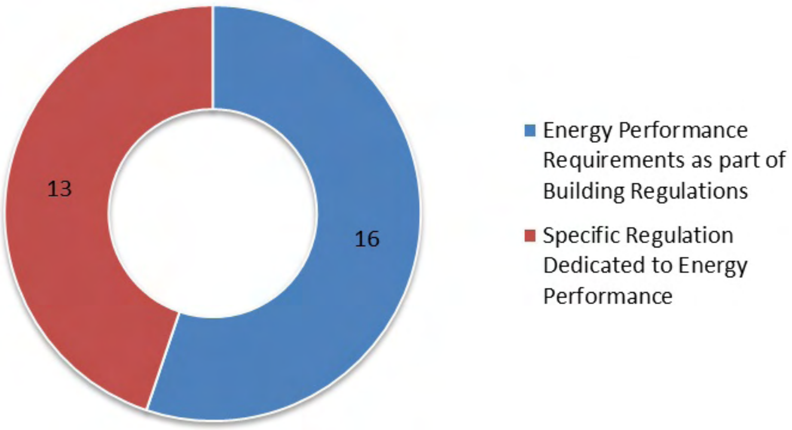
> how to set up and run an independent control system;
> the necessary sample size, both for random and targeted controls;
> quality monitoring and analysis of the control results.

3. Analysis of insights

3.1 Checking compliance with the energy performance requirements for new and renovated buildings

The energy performance requirements for new and renovated buildings are one of the key elements of the EPBD (Articles 4, 6 and 7 of Directive 2010/31/EU).

Figure 1: Types of legislation for energy performance requirements in new and renovated buildings.



Moreover, MSs should tighten requirements in the coming years to reach Nearly Zero-Energy Buildings (NZEB) by 2021 (Article 9).

Many MSs focused compliance checks on energy performance requirements before the introduction of Directive 2010/31/EU, although the establishment of sanctions was only formally required by Article 27. Since January 2013 at the latest, MSs must apply penalties to infringements of their regulations implementing the EPBD.

3.1.1 Two different approaches

In general, two different approaches to energy performance requirements exist in the legal frameworks (Figure 1):

1. The approach through building regulations. Building regulations contain requirements in different areas like fire safety, structural safety, acoustics, waste disposal, building accessibility, electrical safety, ventilation and energy performance. With this approach, energy performance is just another requirement included in the general building regulations. The UK, Ireland or The Netherlands are typical examples of this approach.
2. The approach, adopted e.g., in Belgium and in Portugal, of a dedicated regulation for buildings' energy performance requirements.

This difference in legal frameworks can influence the rules on proof of compliance, the framework for sanctions for infringements and the duties of the controlling authority. If the energy performance regulation is part of the building regulation (as in the first approach), the sanctions are in most cases the same for all kinds of infringement. If the legislation is separate, the control system and sanctions can differ from those for other infringements related to new or renovated buildings.

Experience shows that it is often more challenging to enforce energy performance requirements if they are part of a global building regulation or if one authority is in charge of controlling all building requirements. As resources and budget for enforcement are limited, some MSs have to make a difficult choice between different requirements to enforce.

[1] *OECD (2014), Regulatory Enforcement and Inspections, OECD Best Practice Principles for Regulatory Policy, OECD Publishing http://dx.doi.org/10.1787/9789264208117-en*

3.1.2 Responsibility for compliance

The holder of the building permit is, in general, the person responsible for compliance with energy performance requirements. However, special provisions to protect private builders and buyers of new buildings may exist, as is the case in Belgium: the legislation appoints the developer and/or the professional advisors (e.g., designer, architect, energy expert) as (co)responsible for the building's compliance with energy performance requirements. The relevant energy expert (e.g., architect or engineer) is in charge of calculating the energy performance, and is responsible for the accuracy of this calculation.

3.1.3 When to check compliance

There has been significant evolution in the way MSs check compliance with building regulations. Where calculations in the design stage were, in the past, the most important proof of compliance with energy requirements, the majority of MSs now undertake a double check:

1. During the design stage, the fulfilment of the requirements is checked for the first time. This usually takes place when obtaining the building permit. This check is essential to ensure that the construction specifications take into account all measures necessary to reach a certain level of energy performance.
2. When the construction phase is finished, a second calculation and proof of compliance is undertaken. This second check is crucial to ensure that the building, as it has been built, complies with the requirements. In three MSs, the regulations include provisions to check the building's real energy consumption after it comes into use.

In 2014, twenty-one MSs (up from ten MSs in 2010) asked for proof of compliance at a certain point after construction was complete. The other countries check compliance at different phases or even only through random checks (see Figure 2).

3.1.4 Instruments used to check and demonstrate compliance

The calculation methodology for new and refurbished buildings is described in national and/or regional legislation, or by means of a national standard. Seventeen countries have public software. In four countries, the public software must be used exclusively, while the remaining countries have a mixed system with public software for some building types and commercial software for other building types. Twelve MSs have a free market with only commercial software. In most cases, commercial software is required to pass a validation test before it is recognised by the MS.

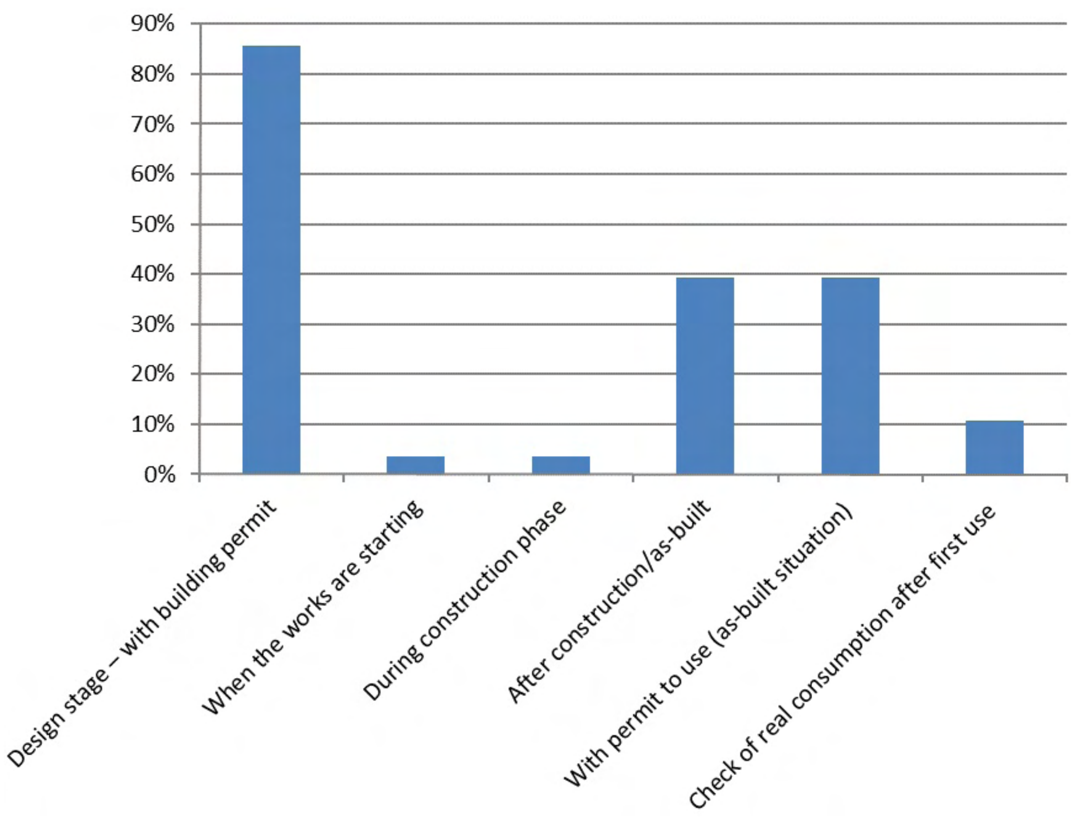


Figure 2: When is compliance with energy performance requirements checked for new buildings? (2014)

The first step to check compliance should be built into the software, which can give quick feedback to experts and builders and generate documents containing the relevant information. In some MSs, e.g., in Belgium, where fines are used as a sanction, the software immediately calculates the fine for a non-compliant building project (Figure 3). Knowing the amount of the fine is useful feedback for the expert and builder, and it can also be key to a smooth infringement process.

For the as-built proof of compliance, MSs use the Energy Performance Certificate (EPC) or other specific forms (Figure 4).

A central database or registry of EPCs for new or renovated buildings is available in twenty-four countries. In the five remaining countries, this kind of tool is either under development or planned for the future. A central database makes it possible to build an efficient compliance checking process and system. In certain countries, the database is restricted so that buildings that do not comply with energy performance requirements are unable to send in their results. This is a delicate decision, as it could trigger fraud: when the building does not meet the requirements, the expert could submit a deliberately false calculation that complies with the requirements, simply to obtain the EPC.

Although not specifically mentioned in the EPBD, an independent control on the energy performance calculations for new and renovated buildings is necessary in order to verify that the expert has made a correct calculation of the 'as-built' situation. As this control is very similar to the independent control on EPCs for existing buildings, it is addressed in 3.2.

Checking compliance with energy performance requirements is crucial to achieve energy efficiency in buildings in practice.

Checking compliance in the planning phase is necessary to ensure all provisions are taken into account before construction begins.

Checking compliance with the requirements after the construction phase is necessary because a large number of building projects change between the planning phase and the actual construction.

The first step is a check for compliance using the software. The EPC of a new building should contain an indication of its compliance with energy performance requirements.

The inclusion of information about new and refurbished buildings' compliance in a central database enables the operation of a smart enforcement scheme and monitoring of the compliance rate. The existence of such databases is now widespread.

3.2. How do MSs make the EPC reliable through independent controls

The EPBD requires the introduction of an independent control system for the EPC and for inspection reports on heating and AC systems (Article 18). When 'EPC' is mentioned in this chapter, this also refers to the control of the 'energy performance calculations' for both new and renovated buildings, which is very similar to or in some cases the same as the control on the EPC.

Figure 3: Example of a warning in the software in Belgium, which appears if required levels are not met, and with calculation of the administrative fine.

Scheidingsconstructies eisen (U/R)

Eisen zijn niet gerespecteerd

Boete

De totale oppervlakte die onderworpen is aan de 2% regel : **383,79m²**.

Voor ten hoogste 2% van de oppervlakte die hierboven vermeld wordt, moet niet voldaan worden aan de eisen, dit is **7,68m²**.

Indicatieve boete na het toepassen van de 2% regel : **696,54 EUR**.

Indicatieve boete: **696,54 EUR**

Figure 4: Example of part of the EPC of a new building where compliance with energy performance requirements for new buildings is displayed (Belgium - Flemish Region).

energieprestatie- en binnenklimaateisen

JA	NEEN	
☐	☐	Het E-peil voldoet.
☐	☐	Het K-peil van het volume, waarvan de wooneenheid deel uitmaakt, voldoet.
☐	☐	Alle constructiedelen voldoen aan de maximale U-waarden of de minimale R-waarden. De volgende constructiedelen voldoen NIET aan de maximale U-waarden of de minimale R-waarden: ☐ vloeren ☐ muren ☐ vensters ☐ dak ☐ andere constructiedelen en constructiedelen van gemeenschappelijke ruimten
☐	☐	Er is voldaan aan de ventilatievereisten.
☐	☐	Het risico op oververhitting is beperkt.
☐	☐	De netto-energiebehoefte van de verwarming voldoet.
☐	☐	Er is voldaan aan de minimum hoeveelheid hernieuwbare energie.

Independent control systems on EPCs were already introduced for implementation of Directive 2002/91/EC in twelve MSs before 2010, when it became a requirement with the adoption of Directive 2010/31/EU. In eleven MSs, EPC quality control systems appeared more recently (from 2010-2013). By 2014, twenty-seven countries (out of twenty-nine) had an operational independent control system for EPCs (Figure 5).

The control systems situation for inspections, however, is different. Among the sixteen MSs where heating systems inspection is undertaken, only seven have established a control system. Among the twenty-one MSs that have opted for AC inspections, six MSs organised a control system and two others have it ready but have not yet begun implementation. The other MSs are still in the preparatory phase and do not yet have control systems in operation.

3.2.1 The responsible authority

MSs can delegate implementation of the control system to third parties according to Article 18 of the EPBD. Seven countries have appointed a third party to run the EPC control system. These third parties are often the same as the accredited bodies responsible for expert certification. In the other twenty-two countries, the central or regional government, or a governmental agency, runs the EPC control system. Some MSs, including Denmark and The UK, ask that the certified companies run an internal quality assurance system, in parallel to that of the government.

Of the six MSs that have an operational control system for AC inspections, two MSs entrusted this task to a third party and four have a public control system in place. For system owners who do not comply with the obligation to undertake regular maintenance in countries where it is compulsory, there is a fine (e.g., Italy). The chimney sweepers (in countries where they are responsibile for heating inspections) oblige the occupant to submit the boiler for inspection. None of the MSs engaged in heating inspections opted for third party quality control.

3.2.2 The control sample

The EPBD states that a statistically significant percentage of all EPCs or inspection reports issued annually must be controlled through a random sample.

Figure 5: The year when MSs began to apply the independent control system.

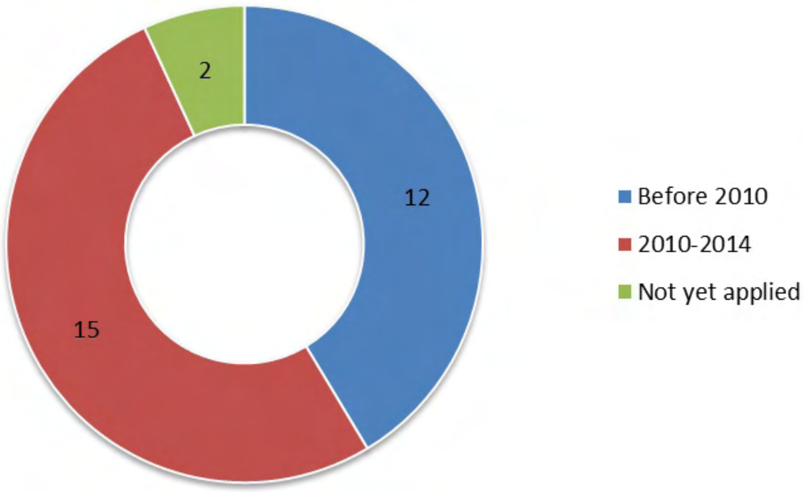


Table 1: Random sample size necessary to ensure statistical confidence (Source DG Energy).

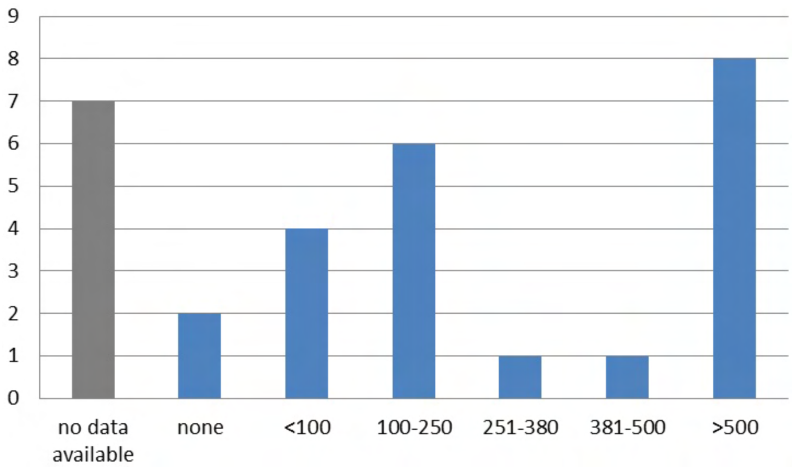
Population size	Sample size	Significant percentage
100	80	80.000%
200	132	66.000%
500	217	43.400%
1,000	278	27.800%
2,000	322	16.100%
5,000	357	7.140%
10,000	370	3.700%
20,000	377	1.885%
50,000	381	0.762%
100,000	383	0.383%
200,000	383	0.192%
500,000	384	0.077%
1,000,000	384	0.038%

This random sample is used to provide an understanding of the overall quality of the EPCs or inspections. In statistics, both the confidence interval and the confidence level are needed in order to define a statistically significant percentage. In the context of the Energy Performance of Buildings Committee, the EU Commission services estimated that a confidence interval of 5% with a confidence level of 95% would be suitable for this type of independent control. This means that the result has a 95% probability that the sample gives a compliance rate at ±5% of the actual population compliance rate (which is unknown). The control of a sample of randomly selected EPCs shown in the table (Table 1) ensures that the control results for the sample can be trusted as an accurate estimate of overall EPC quality.

Many MSs note that the cost of and workload for the independent control system is a significant factor that leads to a possible random sample that is not large enough. In practice, one MS did not control a random sample and one MS did not control at all. In 2014, at least eleven MSs used a random sample that was too small, especially when the sample is split up into subsamples (e.g., new/existing buildings or residential/non-residential buildings (Figure 6).

Subsampling can be necessary to establish compliance rates when the method (calculation procedures, inspection protocol) differs, as between residential and non-residential buildings. Also a different sample for new and renovated versus existing buildings seems necessary, as there are risks of fraud. For existing buildings, there is a risk of fraud in order to obtain a better EPC and thus influence the sale price or the speed of the buying/selling process. For new or renovated buildings, there is a risk of fraud when buildings do not comply with the requirements. In that case, the owner can put pressure on the expert to make false calculations to avoid the penalties for not fulfilling the requirements.

Figure 6: Size of the random samples in MSs.



Eighteen MSs use a type of targeted control in addition to the random sample, based on several criteria (Figure 7). The targeted control enables MSs to have the most significant impact on experts who deliver poor quality EPCs with the available resources (cost-efficiency). MSs use it to check the correct application of the EPC and the energy performance requirements and also in some cases to check compliance with different requirements. A random control is useful in order to evaluate the quality of the whole body of EPCs, while a targeted control is better suited to detect bad EPCs and experts who produce problematic EPCs.

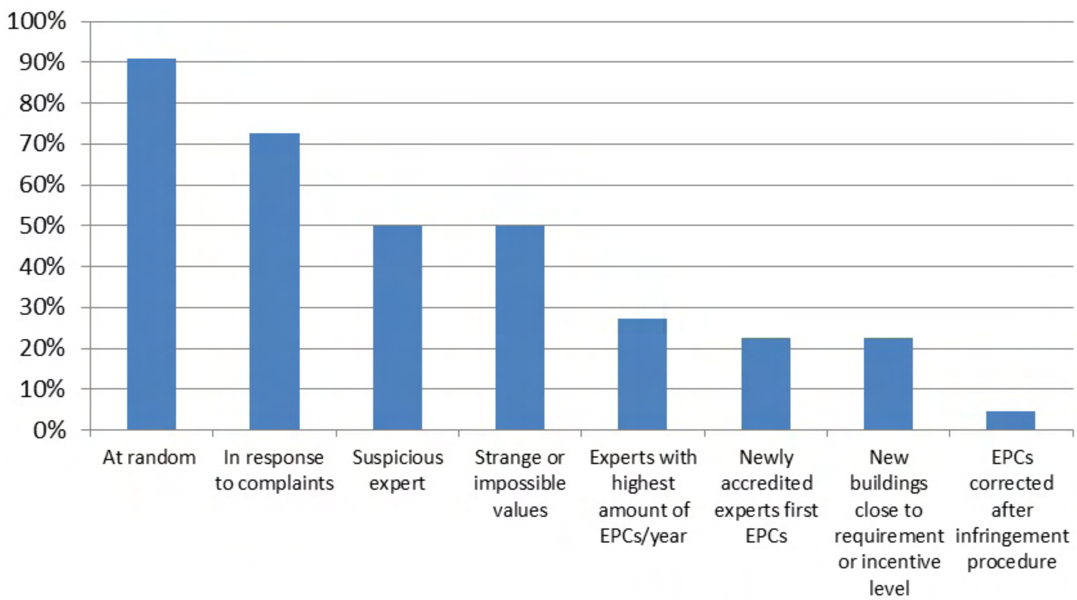
Some MSs believe that each certificate should be randomly subject to controls irrespective of the expert, while other MSs prefer that the expert rather than the certificate be subject to control.

3.2.3. Smart options for quality control

Even if an effective independent control system can be organised with or without a central EPC database, the MSs using such databases recognise them as an essential element of their EPC scheme and an important factor for high compliance rates. Statistics regarding the availability of central EPC databases in the MSs are mentioned under 3.1. These databases are used to issue certificates, to perform control checks, to crosscheck specific certificates, and for datamining and statistical purposes.

Recent developments in MSs show that interconnected databases can be a powerful tool for the control process. One such application enables an investigation

Figure 7: Reasons to perform a targeted check.



of whether a building with renewable energy installations (information from the EPC database) has effectively applied for green certificates (information coming from a second database) and vice versa.

The energy performance calculation and often also the inspection methodology are implemented through software. Experience shows that if there are no validation rules in the software, experts make a number of avoidable mistakes that can have a huge influence on the EPC rating. Integrating validation rules into the software is an excellent and easy step to avoid most inaccurate or incomplete input data. In 2013, nine MSs had implemented a scheme to validate input data. The control system can identify the validation rules, e.g., frequent errors made by experts. A good set of validations in the software or the database can replace the validity check according to option A of Annex II of the EPBD (see 3.2.4). Implementing validation rules in the software is an easy and very cost-efficient measure to improve the quality of every EPC or inspection report. Typically, out-of-range values (e.g., surfaces, volumes), or specific parameters below or above a threshold or expected value (e.g., efficiency, performances of installations) are used as validation rules (Figure 8). Linking different parts of the calculation procedure also allows the identification of impossible or improbable values (e.g., energy use for fans is necessary for mechanical ventilation).

3.2.4 The different means of controlling quality

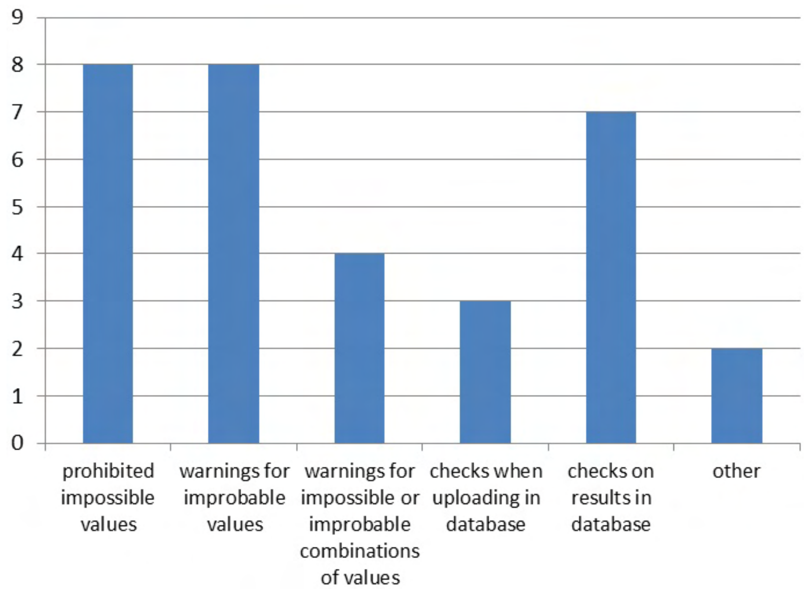
Annex II of the EPBD indicates different means of control and defines different options as presented in Table 2. Only four MSs control only according to Option A of Annex II (validity checks of input data used to issue the EPC and of the results stated in the certificate). Most MSs (nineteen) indicate that they combine options A, B and C. Only two MSs indicate that they use option C alone (the most complete option). However, in practice, thirteen MSs have not implemented any kind of control yet, in spite of having defined the control mechanisms in legal documents.

In addition to desk audits, on-site controls are also used. On-site controls are in general used less frequently than desk controls, as they are more time consuming and it is often difficult to get access to the building or building site. Only fifteen MSs reported undertaking on-site controls. Of eight MSs that published figures on the kind of control they use, four MSs do on-site controls in less than 2% of all control cases, one MS in around 8%, and two MSs in 17%. Only one MS reports on-site control as the most common type among the various control types they use. The other MSs only do desk control.

In some MSs, authorities visit the building at the same time as the expert. This avoids the problem of access to the building, but takes away some of the control possibilities. If the control officer and the expert visit the building at the same time, the expert is warned and will thus not commit a fraud that he might otherwise in cases where there was no control officer present.

A review of the reports made in the office can reveal inaccurate or false data at a lower cost, although on-site control is the

Figure 8: Types of validation rules implemented in EPC software or in the central database.



EPBD-recast Control Option	Input data	Calculation results	Recommendations	On site visit
A	Validity check	Validity Check	-	-
B	Check	Verification	Verification	-
C	Full check	Full verification	Full verification	-
C*	Full check	Full Verification	Full verification	Check correspondance
E(quivalent)	...	...	...	...

Table 2: Control options as defined in Annex II of Directive 2010/31/EU.

most thorough, and often the only way to identify bad, false or incongruous figures or cases of fraud. In both cases, the level of detail of the control can vary significantly - from a limited investigation of very specific elements to full control of all elements. Specifications of the evidence for input data is made in most MSs and is linked to verification possibilities and methods.

Surveys of the relevance of controlling different areas revealed that the control system should evaluate not only the input data, the heating or AC system information, the accuracy and the relevance of the recommendations, but also the completeness of the report and the independent nature of the recommendations.

MSs apply both random controls to assess the compliance rate, as required by the EPBD, and targeted controls to enforce the quality and compliance of the EPCs and inspections.

Several interpretations of the statistically significant percentage of EPCs to control, as described in the EPBD, exist in Europe. The control samples in MSs are generally below the target guidelines defined by DG Energy.

Smart options for control, through linking different databases and validation rules, were developed by several MSs. The majority of controls are desk-based and do not include a site visit, although this is often the only way to detect fraud.

Figure 9: Year when the requirement for the inclusion of the EPC in advertisements came into force in MSs.

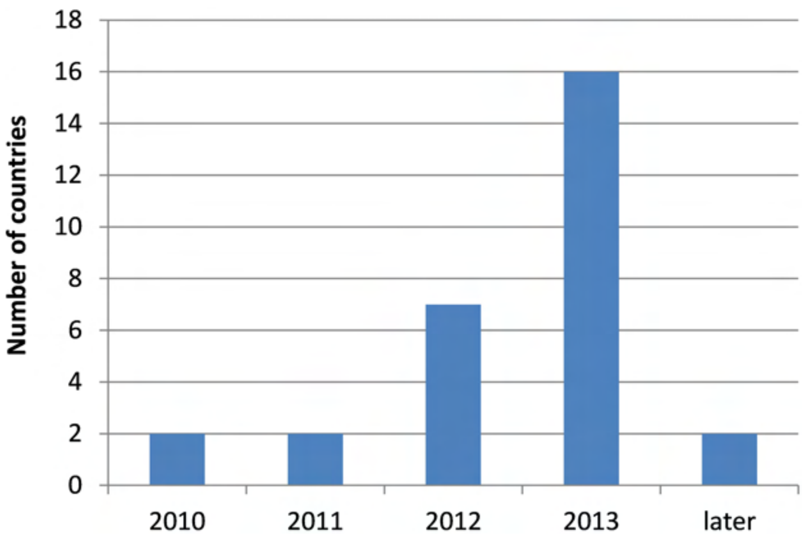
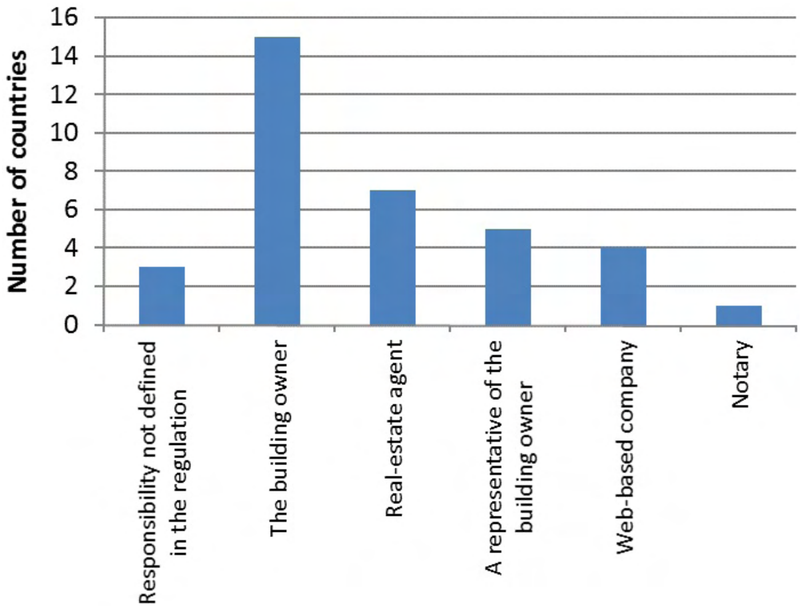


Figure 10: Actors responsible for compliance with the advertisement requirement.



3.3 Checking the requirement of including the energy rating in the advertisings

The EPC is used to provide insights into a building's energy performance for potential buyers or tenants. In order to play this role, the EPC has to be available at an early stage. The EPBD mandates the publication of the EPC in advertisements in commercial media (Article 12 §4). In the majority of MSs, this requirement came into force in 2012 - 2013 (see Figure 9).

3.3.1 Responsibility for placing the information in the advertisement

Several actors can be considered responsible for compliance with the advertisement requirement. The building owner is mentioned as one possibility in most MSs (fifteen MSs, see Figure 10). Other actors, such as real-estate agents, representatives of the building owner, web-based companies or notaries are also mentioned in the regulations as responsible for compliance with this requirement. Three MSs did not define who is responsible for compliance and thus, in these cases, enforcing this requirement is nearly impossible.

3.3.2 Controls

In 2013, responsibility for controlling compliance with the advertisement requirement was not clearly defined in five Member States, where it is practically impossible to enforce compliance. In the MSs where controls are undertaken, random checks (in eight MSs), as well as targeted controls in response to complaints (in ten MSs), are the most common methodologies.

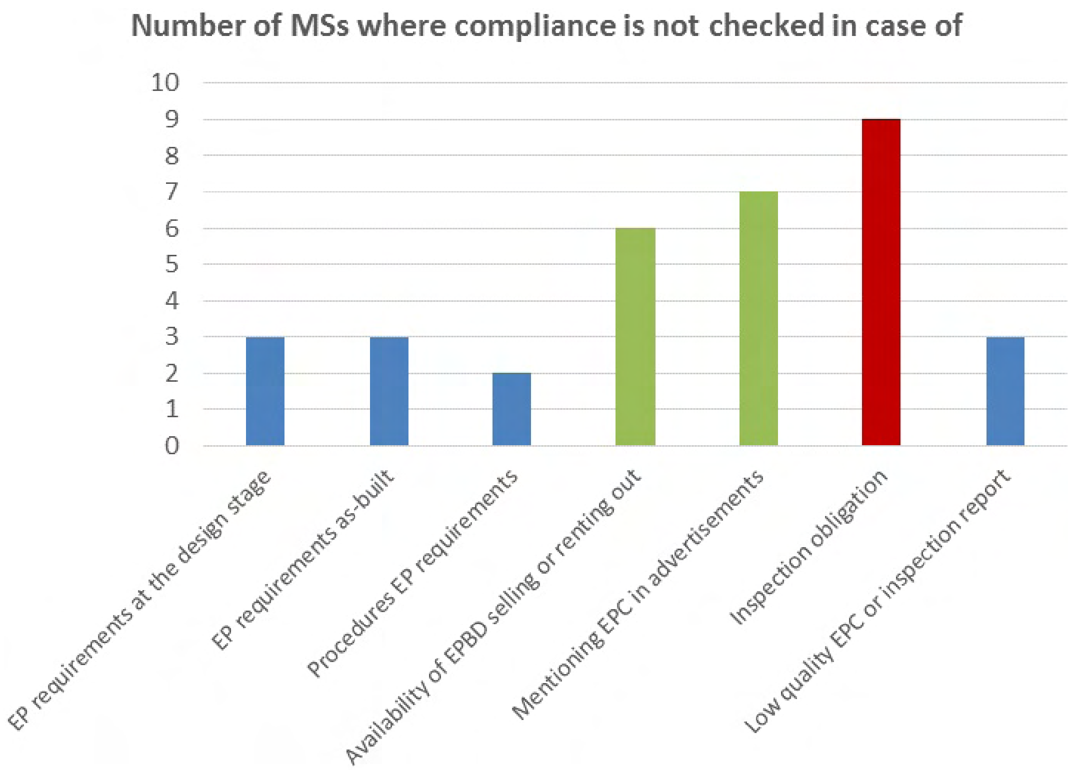


Figure 11: Number of MSs where compliance with the different obligations under the EPBD was not checked in 2013 (twenty-four MSs, March 2013).

The compliance rate for this requirement was known in only one MS, where communication with and control of real estate agents has led to an improvement in the compliance rate from 47% in the first year to 95% three years later.

Although the obligation to include the energy rating in advertisements exists in most MSs, there is very little enforcement. In a few MSs, the regulation does not even define who is responsible for enforcement, nor does it include penalties for non-compliance.

Even if overall there is a general compliance with this obligation in many MSs, in 2014 figures on the effective compliance rate were available in only one MS.

3.4 Sanctions

The imposition of sanctions is an essential part of an enforcement system. There is no point in checking compliance if infringements are not sanctioned. Penalties should be used in cases of non-compliance with the regulation, e.g., in reaction to severe neglect by the builder or developer (compliance checking), the owner (failure to issue an EPC, absence of the energy label in advertisements and failure to display the EPC in public buildings frequently visited by the public), or to false reporting of actual energy performance or other severe instances of non compliance by the expert (independent control).

Most MSs have accounted for sanctions in their legislation, but it must be noted that some MSs do not have explicitly defined sanctions. Reference to sanctions in the legislation does not necessarily mean that compliance with requirements of availability and display of the EPC is monitored and that sanctions are laid down in practice. An enquiry in 2013 revealed that a number of MSs do not check compliance with one or more of the EPBD requirements (Figure 11). Several examples of sanctions in the case of non-compliance with several EPBD requirements are discussed in the rest of this section.

3.4.1. Non-compliance with energy performance requirements

For new and renovated buildings, it is necessary to lay down sanctions in practice to discourage non-compliant builders from deriving a commercial advantage, relative to compliant builders, by avoiding the investment needed to ensure compliance.

The difference in legislation approaches (building regulation or separate legislation) influences the framework for sanctions on infringements (see 3.1.1).

Penalties for non-compliance are generally imposed on the builder or the developer. When a building does not meet the energy performance requirements in the design stage, the usual sanction is that the building permit is not granted.

Figure 12: Sanctions in case of non-compliance with energy performance requirements in the design stage (from a sample of twenty-four MSs, March 2013).

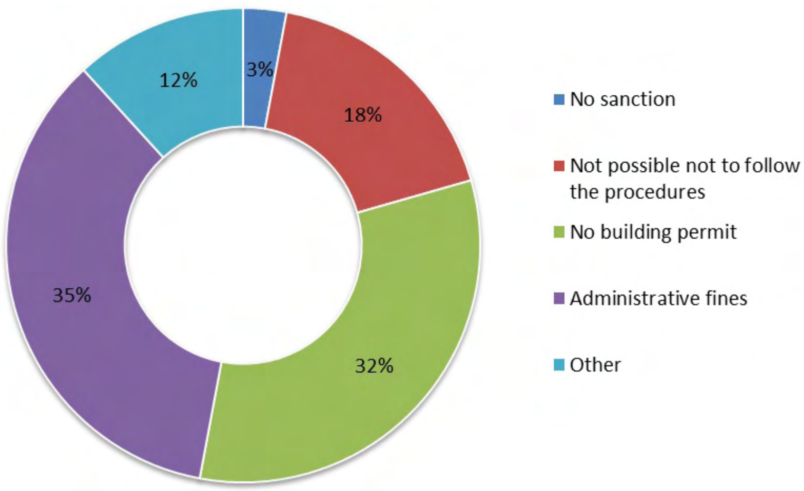
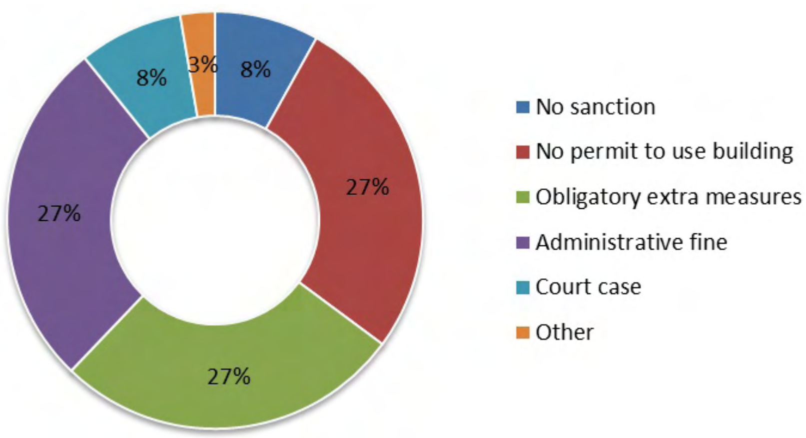


Figure 13: Sanctions in case of non-compliance with energy performance requirements in the 'as-built' stage (from a sample of twenty-four MSs, March 2013).



The design must be adapted until the building complies (Figure 12).

When the building does not meet the energy performance requirements as-built, one or more of the following types of sanctions are commonly laid out in MSs regulations (Figure 13):

> the use of the building is prohibited (with the implicit obligation to take extra measures until the building complies);
> the obligation to take extra measures until the building complies, within a certain period;
> administrative fines;
> court cases.

The experiences of some MSs showed that the type of sanction has a significant impact on the effectiveness of enforcement and on the compliance rate. In the design phase, necessary adaptation of the project is quite effective. During construction, the obligation to implement extra measures can also be an appropriate sanction. In the as-built phase, the obligation to take extra measures is sometimes not an appropriate sanction. Some requirements (e.g., ventilation, airtightness of slab insulation), cannot always be corrected through mandating extra measures. In that case, other types of sanctions, e.g., administrative fines, are more appropriate.

Sanctions during the design stage are quite effective, as in 75% of the MSs non-conformity in the design stage leads to rejection of the building permit. Sanctions during the as-built stage are less commonly laid down in pratice. A number of MSs have arrived at a system where proof of compliance is required for all buildings during the as-built stage (see 3.1.3).

Some MSs, like Belgium, have extensive successful experience with imposing administrative fines. Some MSs effectively sanction non-compliance by not granting the permit to use the building. Other MSs only control compliance in the as-built stage, based on a random sample of all or only one requirement. Random sampling seems inappropriate as a means to detect and sanction non-compliance because the likelihood of inspection can be very low. The low probability of being checked can lead to a sense that fulfilment of the requirements is not important at all and the result will be similar to the situation in MSs where there is no control at all in the as-built phase, or where every citizen is assumed to act according to the rules, without enforcement.

3.4.2 Sanctions in case of non compliance with other EPBD requirements

The most frequent sanctions in cases where the EPC is not provided at the point of sale or rent are administrative fines (in ten MSs). In one country, the building cannot be sold or rented (without an EPC). It must be noted that seven MSs did not define sanctions in their regulation. However, in practice, only two MSs actually apply sanctions in cases of non-compliance.

When the EPC is not included in advertisements, the most common sanction is a fine (in ten MSs). Eight MSs did not explicitly define the type of sanction in their regulations. In practice, by 2014, sanctions for non-compliance had been applied in only two MSs.

The most common sanctions for the absence of an inspection report are fines (in twelve MSs). In some MSs, a court case is possible, in theory, if the inspector reports false irregularities in the system, in view of getting money from repeated inspections. In several MSs, no sanction is laid out in the legislation.

The most frequently used sanctions for low-quality EPCs are administrative fines (in eleven MSs), temporary (in fifteen MSs) or definitive (in seventeen MSs) withdrawal of the accreditation of the expert responsible for the EPC data, or the obligation to produce a correct EPC at no cost to the owner.

The most common sanction for poor quality inspections is the removal of an inspector's accreditation, in the event of malpractice.

The quality control of inspections requires sanctions when reports do not comply with the necessary level of accuracy in reporting results and recommendations. In extreme (and rare) cases, an inspector who violated the requirement of independence or the correctness of behaviour with the client was sanctioned through the cancellation of his/her authorisation to make inspections. The inspection then must be repeated by another inspector.

The imposition of sanctions is an essential part of the enforcement system. For specific types of non-compliance, some MSs did not define the sanction in their regulation. According to the type of non-compliance, the sanction can be imposed on either the building owner or on the experts.

Sanctions for experts are applied in most MSs as a result of non-conformity detected by the independent control system. Compliance during the design stage is effectively ensured by linking it with the building permit.

Sanctions for other EPBD-related infrigements are either non-existent or negligible in almost every MS. Much improvement is needed, and this is one of the important topics for the future.

Non-compliance with requirements when a building is assessed 'as-built' should be sanctioned in every case.

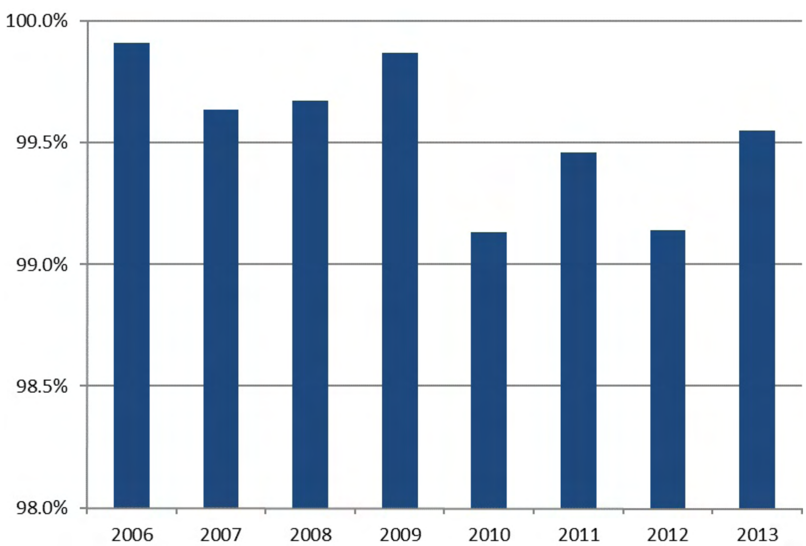
Much improvement is also needed in the monitoring and sanctioning of non-compliance with EPC issue and display and the issuing of the inspection reports.

3.5 Monitoring the quality of the EPC and compliance rates

Monitoring the compliance rate is essential in order to evaluate the efficiency of the regulation. The compliance rate of the different EPBD obligations should thus be a key performance indicator for every ministry, agency or organisation in charge of EPBD implementation.

The examination of compliance and control from 2007-2010 revealed that only a few MSs had a clear understanding of compliance rates or the quality of EPCs or inspections, or even tried to obtain such information. From 2010-2014, this scenario has not improved much: only half of the twenty-four MSs that reported on this issue indicate that they have figures on the compliance rate of new buildings ('as-built') with energy performance requirements. In some MSs, e.g., France, the 'as-built' compliance rate concerns compliance with all building requirements (i.e., also fire safety requirements), or is derived only from a limited control sample. Other MSs, e.g., Greece and Cyprus, monitor the compliance rate, but do not publish this information. Some MSs, e.g., Denmark and Latvia, plan to obtain information on the compliance rate by adding analysis tools to their database or linking/building new databases. Most MSs have no plans to get a picture on compliance rates.

Figure 14: The compliance rate of new buildings with the energy performance requirement 'E-level' during the 'as-built' phase in the Flemish region of Belgium.



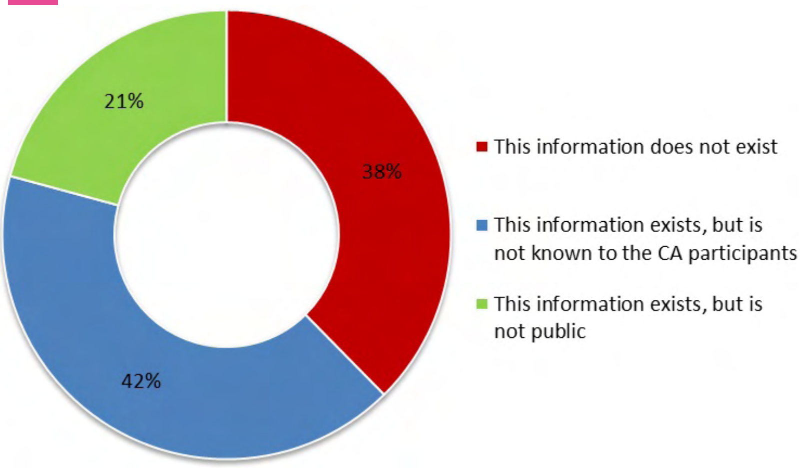


Figure 15: Number of MSs that have information on the percentage of good quality EPCs as result of the independent control of a random sample.

The few MSs that report compliance rates indicate figures around 80%, with one MS indicating compliance for new residential buildings between 94% and 98%, and from 75% to 85% for new, non-residential buildings. Figure 14 shows an example of new buildings' rate of compliance with energy requirements during the 'as-built' phase in the Flemish region of Belgium. The Flemish region lays down administrative fines for infringements of the energy performance requirements. This leads to very high rates of compliance with energy performance requirements 'as-built.' The compliance rate with all requirements (including ventilation rates) has been around 97% since 2010.

A defined percentage of good quality EPCs is one of the essential outcomes of the independent control system. Knowing this percentage is essential in order to monitor the quality of the EPC scheme and to efficiently manage the independent control system. Actions to improve the overall quality of the EPC scheme or to apply sanctions in a more effective way will result in a higher percentage of good quality EPCs. Many MSs still do not have an understanding of EPC quality (based on a random sample) (Figure 15). As MSs use different criteria to define EPC quality, it is difficult to compare the overall quality of the EPC scheme among MSs, but some MSs indicate that 60% to 80% of the controlled EPCs are of good quality.

Significant progress is needed in most MSs. Monitoring the compliance rates with all EPBD requirements and the percentage of good quality certificates or inspection reports should be required for all MSs. This information is vital to analyse the efficiency and efficacy of the schemes and of their enforcement, and to improve the system, if MSs seriously intend to implement a credible, effective system rather than just putting some requirements into law in order to satisfy the EPBD but without making real efforts to make it work and produce the intended benefits.

In 2014, only half of the MSs monitor the rate of compliance with the requirements for new and refurbished buildings, with some monitoring a very limited sample or monitoring compliance with all building requirements (not just energy performance). Even fewer have an accurate view of EPC quality derived from a random sample.

As the compliance rate and a clear picture of the quality of EPCs and inspections are essential information to evaluate the efficacy of the regulation, this remains a challenge in many MSs.

4. Main outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Timing of compliance checks	MSs can check compliance with building regulations at the design stage and/or at the end of the construction phase ('as-built').	The final check at the end of the construction phase is crucial to ensure actual compliance with requirements. A number of MSs made progress in this direction.	Compliance checks at the end of building works ('as-built') make the regulations more efficient and should be encouraged for all MSs.
Objectives of the independent control system	The control system is used to assess and ensure the quality of the EPCs, of the inspection reports and of energy performance calculations.	Two types of control are needed to achieve these goals: randomly selected controls (required by the EPBD) and targeted controls (not mentioned in the EPBD). Many MSs have yet to recognise the benefits of the combination of both types.	Many MSs still need to further develop the implementation of randomly selected controls.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
The size of randomly-selected control samples	The EPBD allows for interpretation of "a statistically significant percentage of randomly selected controls". Guidelines have been provided by DG Energy.	The minimum sample size will substantially increase if MSs want to obtain information on sub-samples (e.g., regional differences, new versus existing buildings, etc.).	The size of random samples is too small in most MSs, and most MSs need to make substantial improvements.
EPC quality	In 2014, quite a few MSs still do not have an idea of the percentage of 'good' quality certificates.	Knowing the percentage of 'good' quality EPCs is necessary to evaluate the EPC scheme and to develop action to improve it.	All MSs should have a clear definition of a 'good' quality EPC. They should know the overall quality of EPCs, based on a random sample.
Inspection controls	Very few MSs have adopted systems to control the quality of inspection reports.	Quality control performed by public authorities could increase citizen confidence in the relevance of MS-imposed inspections.	Wider collaboration among MSs is necessary to identify cheap and effective forms of quality control.
Sanctions	Effective, proportionate and dissuasive sanctions and their practical application could still be further developed in several MSs.	The application of sanctions is essential for enforcement, and checking compliance is pointless if infringements are not sanctioned. Effective sanctioning leads to better compliance.	Very few MSs have applied sanctions in EPBD-related issues. Strong action is needed, otherwise compliance and quality cannot be ensured.
Monitoring the rate of compliance with minimum building requirements	In 2014, only half of the MSs monitor the rate of compliance with regulation requirements, some based on a very limited sample.	Monitoring the compliance rate is essential for understanding the efficacy of regulations and for improvement.	MSs should be required to monitor compliance rates and to publish the results.

5. Lessons learned and recommendations

Directive 2010/31/EU drew attention in many MSs to compliance and to independent quality and compliance control systems through its specific requirements for independent control systems and the implementation of related rules on penalties applicable to infringement of the national provisions adopted pursuant to the Directive. Many MSs introduced legislation for compliance and control systems, or adapted existing legislation in recent years. Many MSs experienced similar challenges and used lessons learned to improve or implement solutions. Further exchange of successes is desirable to improve the performance of the EPC scheme and the control system, and to curb fraud.

Athough effective compliance is essential to achieve an improvement in energy performance of the European building stock, compliance and control systems were often overshadowed by efforts by governments and stakeholders to reduce regulatory impact, including sanctions, and to remove 'unnecessary burdens', resulting in far from ideal and less effective regulations. Moreover, regulators in many MSs are increasingly under pressure to do 'more with less' which leads too often to very poor compliance checking or to very limited or light control systems with very limited resources. There is certainly much room for improvement to check compliance with the EPBD requirements in most MSs, as well as with issuing sanctions.

For checking requirements in new buildings, compliance checks in the 'as-built' phase of all buildings should be the standard. Experience with effective sanctioning shows that very high compliance rates in all new and refurbished buildings can be attained while keeping the burden on citizens and the government at a reasonable level.

Almost every MS developed an independent control system for EPCs. As the control system is a measure to ensure quality and is described in the EPBD in more detail, the political will and the resources to implement it are usually greater than those for compliance checking. There are some examples of innovative approaches and best practices in control systems, e.g., validation rules and the use of databases. Validation rules in the software or when uploading the EPC to the database could even substitute type A checks as defined in Annex II of the EPBD. These best practices are worth further exploration and wider application.

Clear guidance on the random sample size and the necessary subsamples, as well as recognition of the additional benefits from targeted controls would help MSs to allocate sufficient budgetary resources to exploit a qualitative independent control system.

For the issuing of the EPC or inspection reports and for the display of the EPC, a compliance check of a broad random sample is necessary while the compliance rate is low, as in most MSs at the end of 2014.

Unbiased monitoring of compliance rates is vital to determine the impact of the regulations on the energy performance of new and refurbished buildings, for inclusion of the energy rating in advertisements, for the availability of the EPC at the moment of sale or rental, for the correct display of the EPC in public buildings, and for the availability of inspection reports. Monitoring and publishing the rates of compliance with all EPBD requirements and the percentage of good quality certificates or inspection reports should be required for all MSs. This information is vital to analyse the efficiency and efficacy of the schemes and of their enforcement, and to improve the system, if MSs seriously intend to implement a credible, effective system rather than just putting some requirements into law in order to satisfy the EPBD but without making real efforts to make it work and produce the intended benefits.

Most MSs still perform too weakly on all, or at least a few of these points. This must be a priority action area in the future.

Effectiveness of Support Initiatives

OVERVIEW AND OUTCOMES

AUGUST 2015

1. Introduction

Finance, information and coordination are vital elements for the implementation of the EPBD Directive 2010/31/EU and within the roadmaps to NZEB, for both new and renovation construction, in order to deliver on policy targets.

This report summarises the main findings of the Concerted Action (CA) on the Energy Performance of Buildings Directive (EPBD) around the topic 'Effectiveness of Support Initiatives' for the implementation of the EPBD Directive 2010/31/EU up to the end of 2014, including conclusions and indications about future directions. It excludes shared detailed topics relating to certification, training and Nearly Zero-Energy Buildings (NZEB), which are addressed in other chapters in part A of this book.

The activities aimed at identifying, developing and assessing approaches and options relevant to EPBD implementation by Member State (MS) authorities. The focus of the work has been towards ensuring the impact of the directive as an effective instrument of change in the building construction and property marketplace.

Arising from our work on these topics, two sets of key issues have consistently emerged.

Firstly, there remains a need to address a lack of awareness and understanding of the scale and nature of financial and related instruments available to mobilise the market. Related to this, national authorities and energy experts working on technical building codes and other issues often do not possess in-depth knowledge and understanding of the language and processes of the financial services community. Similarly, the finance and banking sector is usually unfamiliar with the challenges of many energy efficiency measures. Addressing this gap has been - and remains - an essential issue in order to enable national authorities and energy experts to engage more effectively with the finance and banking sector.

The report by the Energy Efficiency Financial Institution Group (EEFIG), which was published on 26 February 2015, contains recommendations on a range of actions that could help overcome the current challenges to obtaining long-term financing for energy efficiency. This work could lay the basis for further work with the financial challenges related to building renovation across Europe.

Secondly, there remains a need and opportunity for improved coordination systems and synergies among the various national institutions responsible for implementing energy efficiency policy, and notably two other EU Directives, the Energy Efficiency Directive (Directive 2012/27/EU - EED) and the Renewable Energy Directive (Directive 2009/28/EC - RESD). MS need to develop long term plans to drive the deployment of energy efficiency measures and renewable energy sources, and these directives include many requirements relating to buildings. A key issue in this period has therefore been to help to develop these long-term strategies in a more structured and cohesive manner.

2. Objectives

In tackling the strategic EPBD goal of transforming the EU building stock, MSs face many barriers – technological, skills related, economic, informational, financial, legal or regulatory, organisational and marketing related. Within this arena, the focus of

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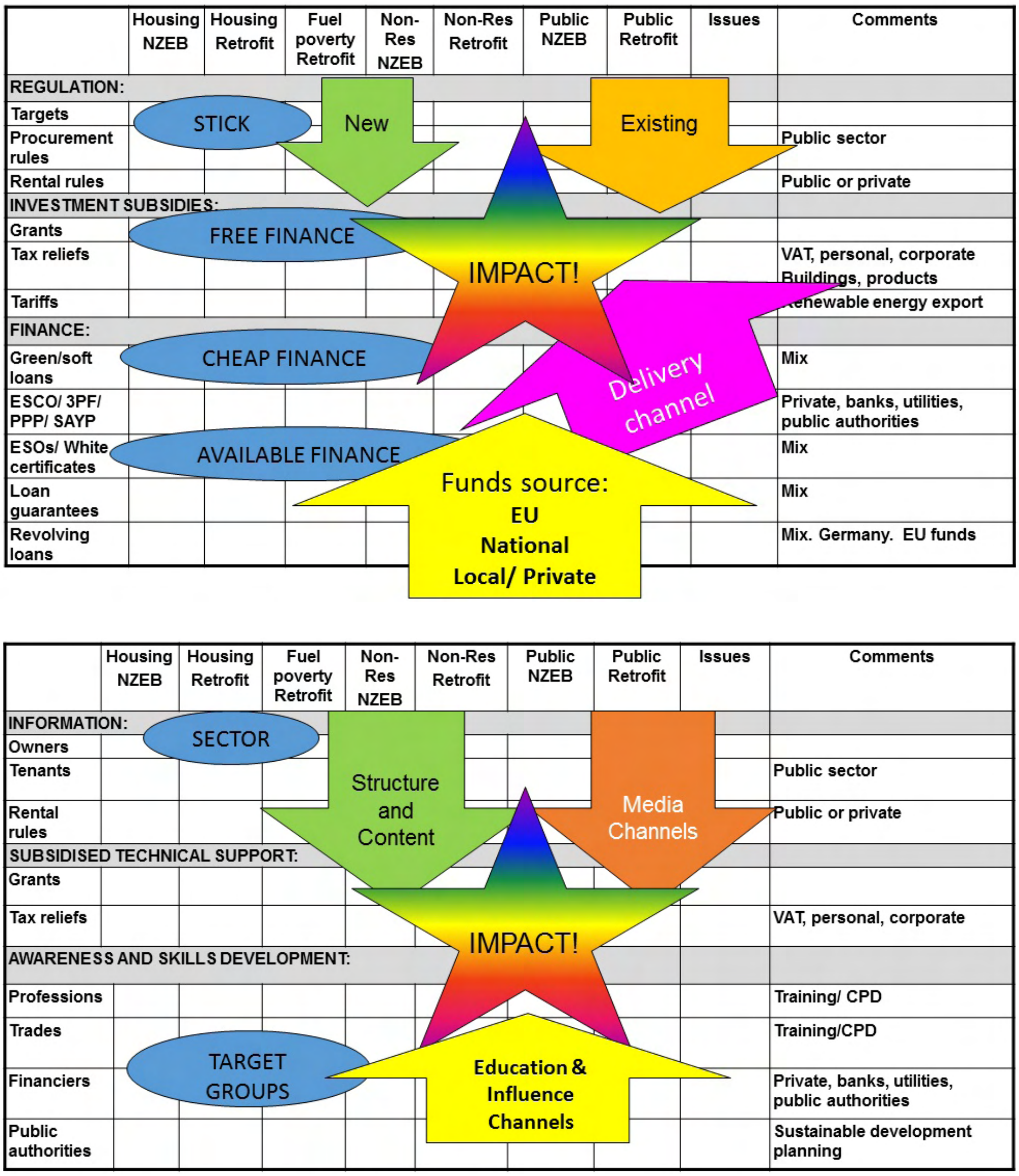
'Effectiveness of Support Initiatives' has been on tackling the financial and informational barriers to energy efficiency action by building owners, investors and users. Its specific role was to assist the implementation of Articles 10 and 20 of the EPBD (Directive 2010/31/EU), including highlighting opportunities and synergies with the EED and the RESD.

Article 10 is concerned with financial incentives and market barriers, and includes a periodic reporting requirement by MSs to the EC. It also sets complementary obligations on the EC to assist MSs in setting up financial support programmes and to analyse the effectiveness of the national supports listed in National Energy Efficiency Action Plans (NEEAPs)[1].

Article 20 relates to the provision of information to owners and tenants of buildings on the different methods and practices for improving energy performance. MSs shall ensure that guidance and training are made available to those responsible for implementing the EPBD, and the EC is invited to improve its information services.

The aims of CA EPBD dialogue on these two articles have been to identify and explore the array of financial and informational instruments available, to assess their effectiveness, and thus help to inform national authorities and the EC in considering policy action options within their jurisdictions. It has also sought to raise awareness on areas of potential synergy in transposition and implementation between the EPBD, the EED and the RESD.

Figure 1: Frameworks of financial and informational initiatives.



[1] *A number of EC reports on financial supports, particularly for building energy renovations, can be viewed on:* *ec.europa.eu/energy/en/topics/energy-efficiency/buildings/financing-renovations*

3. Analysis of insights

The outcomes of the CA EPBD discussions are now summarised from the following selection of topics addressed over the period 2011 - 2014:

1. Overview and mapping of barriers and available support initiatives.
2. Developing strategies for mobilising upscaled investment in deep energy efficiency renovation.
3. Accessing, mobilising and leveraging complementary EU, national/regional and private sector finance.
4. Communicating and working with financial institutions.
5. Experiences with Energy Service COmpanies (ESCOs).
6. Experiences with Energy Efficiency Obligation initiatives.
7. Monitoring and evaluation of policies, programmes, schemes and projects.
8. Exploiting interactions and synergies with the EED and the RESD.

3.1 Overview and mapping of barriers and available support initiatives

A strategic overview of both financial and informational support initiatives, as summarised in Figure 1, allowed the identification of priority areas that MSs need to address.

Support initiatives can be categorised in several ways:

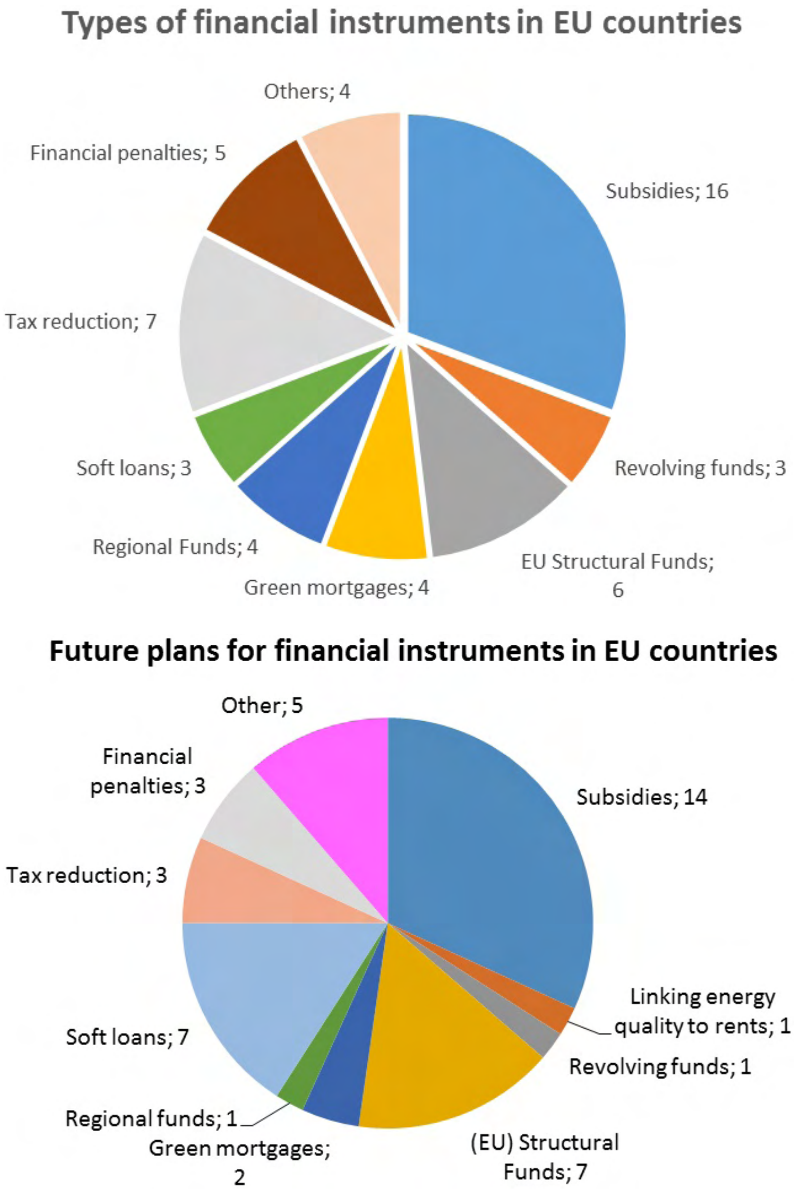
> by policy instrument: regulatory (rules, legislation and penalties), financial (incentives/disincentives), and promotional/informational/developmental (EPC, public information campaigns, media success stories, engaging key influencers, training and other capacity building in the supply chain, etc.);
> by target sector: by age of the building (newbuild versus renovation), by building type (single house, apartment building, commercial, public), by ownership (owner occupied, social housing, private rented), by economic condition of the owner and/or occupant (level of income, access to capital);

and in the important case of financial instruments:

> by grade of financial instrument: 'free finance' (grants, subsidies, tax breaks), 'cheap finance' (favourable loan levels, interest rates), accessible finance (banks, Energy Service Companies (ESCOs) and other Public Private Partnerships (PPPs), third parties), accompanying confidence building measures (guarantees, official securities);
> by source of the financial instrument: EU, national, regional, local authorities, suppliers of energy services or products, private financial institutions.

These numerous circumstances and potential policy tools highlight a strong need - and opportunity - for combined actions across multiple actors. A survey of twenty two MSs indicates that each MS has typically more than one type of incentivising financial instrument. As shown in Figure 2, subsidies/grants, EU funding and soft loans are the most common current (and likely future) types of financial instruments, followed by tax reliefs, guarantees, etc. Germany, Estonia and Lithuania provide incentives for renovating apartment buildings related to

Figure 2: Present applications and future plans for financial instruments among MSs.



certified energy performance. Grants and soft loans are the leading financial instruments for residential and commercial buildings, whereas for public buildings ESCOs/third party finance initiatives are leading, closely followed by grants/subsidies, as shown in Figure 3. However, there is a recognised need to migrate from capital grant based supports to more sustainable market based alternatives, highlighted further in 3.3 below.

It has been estimated that the annual investment in the energy renovation of the building stock will need to grow from 12 B€ (~30 € per capita) to 60 B€ (~150 € per capita) in order to meet the EU target of a 20% energy efficiency improvement by 2020, including the associated EED requirement regarding energy renovation of buildings. Such a market transformation and upscaling of activity requires an unprecedented mobilisation of policy and market actors, in order to tackle the various barriers to decision and action in a co-ordinated way. Comparable challenges apply to the delivery of NZEB standards for new buildings. Figure 4 summarises these barriers, for each of which there are corresponding ingredients for success, including the key role of policy co-ordination and interventions to stimulate and sustain market confidence and commitment. The resources outlined in 3.2 and 3.3 highlight many case examples of how such barriers have been tackled by MSs.

To achieve NZEB and deep renovation uptake on a large scale, two particular requirements have been identified as vital: firstly, insight and understanding of the attitudes and motives of building owners and investors, and secondly, the

Figure 3: MSs views on the most important financial instruments according to building type.

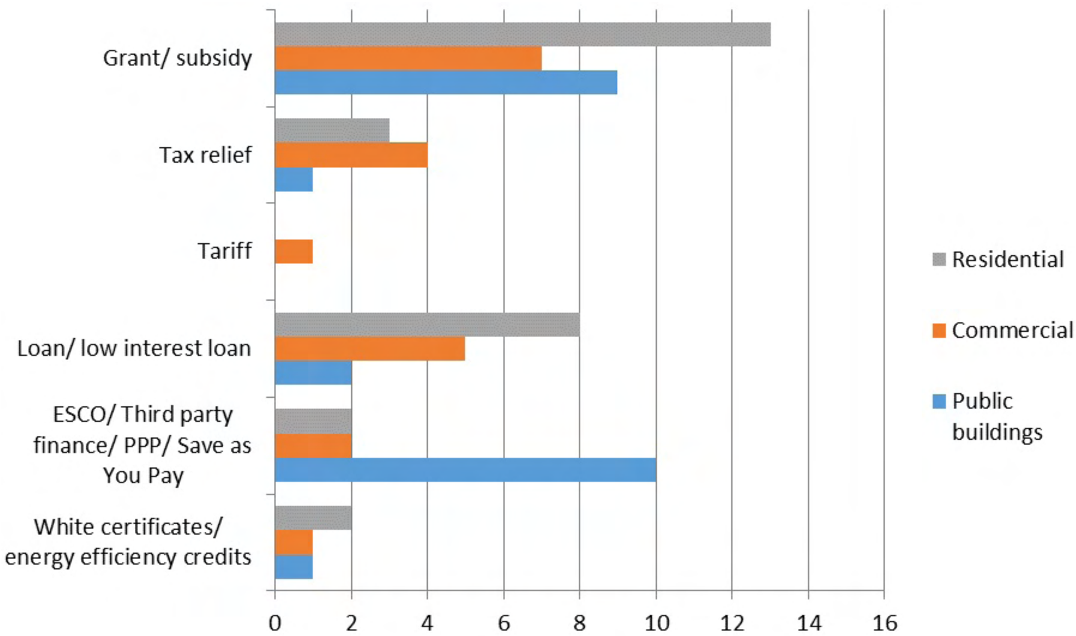
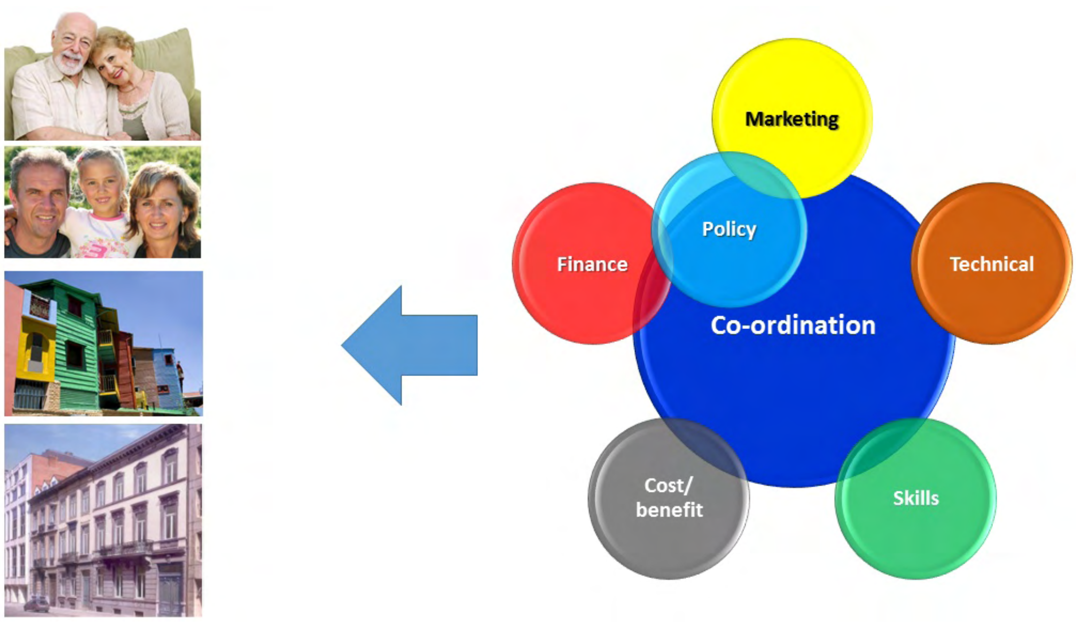


Figure 4: Mobilising and transforming the market: Barriers vs ingredients for success.



availability of suitable finance. Regarding the motives and decision-making processes of these parties, energy efficiency is not often the main argument and there are different perspectives from different stakeholders. Thus, there is a need for information to be configured in a versatile way for different decision makers. For building owners, it may be an overall upgrading of building quality and asset value, improved productivity or comfort, while for governments it may be employment content or health benefits, as well as climate policy advancement. A useful illustration of the multiple benefits of energy efficiency is given in Figure 5.

Among the particular ingredients proposed for stimulating the market (in terms of suitable finance) are:

> one-stop-shops – providing practical information, advice and guidance to assist decision makers (building owners or investors) in relation to procurement, installation and service;
> packaging of measures – clear and attractive energy efficiency product offerings, and highlighting the benefits – including energy efficiency as a key quality and value factor;
> financing options – favourable loans/ green mortgages, ESCOs/ PPPs, Energy Performance Contracting, guarantees, tax reliefs.

The complex arena of support measures is a formidable challenge. A key success factor is the role of policy authorities in providing the focus, coherence and specific interventions to stimulate and sustain market confidence and commitment.

Typically, each MS has more than one type of financial instrument to stimulate energy efficiency in buildings. While MSs still see an important role for grants and subsidies, there is a need to migrate from capital grant based supports to more sustainable market based alternatives.

3.2 Developing strategies for mobilising upscaled investment in deep energy efficiency renovation

Article 4 of the EED obliges each MS to establish a long-term strategy or roadmap for mobilising investment in the energy efficient renovation of the national stock of residential and commercial buildings, both public and private. Responding to this policy priority, which calls for a major upscaling in the volume and depth of renovation, the three Concerted Actions for the EPBD, EED and RESD joined forces and produced a document pack[2] to provide practical assistance to MS authorities.

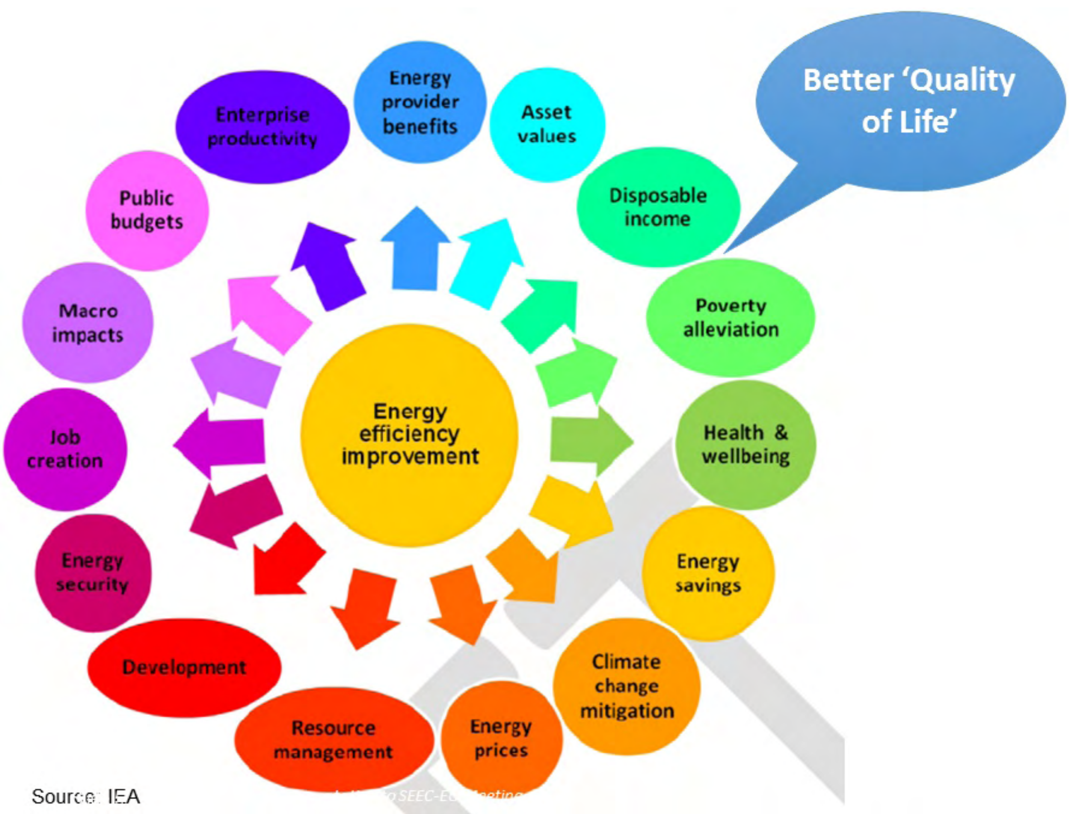


Figure 5: Multiple benefits of energy efficiency (Source: IEA).

[2] *The full documentation is available at www.epbd-ca.eu/outcomes/EED-Article4-composite-document-final.pdf*

It consists of a main document and two annexes. The main document takes the form of a series of nine steps, each containing an introductory narrative that describes the context, role, and a checklist of indicative issues and outcomes sought in that step. This is followed by hyperlinked signposts to two other documents: Annex 1, which contains a selection of 69 case examples of potentially useful approaches (policies, programmes, projects, studies, methodologies), and Annex 2, which offers possible detailed expansions on the checklist of 61 primary questions, which can be regarded as an extended menu.

The indicative nine steps are shown in blue boxes in Figure 6. For each step, the green boxes show the corresponding key elements and the yellow boxes show the corresponding outcomes sought. As an example, issues covered in Step 4 (assessing and overcoming key challenges and barriers) include the following: Have you identified actual and possible barriers to the upscaling of building energy renovation in your country? How do you resolve the dichotomy between societal and private investment perspectives? What are your particular challenges with older buildings? Do you have a national code of practice for building energy renovation? Do you have a national skills plan for building energy renovation? Is there a suitable support system for developing new products/services for building retrofit? Do you have a monitoring and verification system or guidelines for energy efficiency programmes? Is there a forum to co-ordinate the different ministries involved in building energy retrofit?

As examples of the later steps, ‘Policy measures’ cover issues to consider in assessing options to stimulate, coordinate and regulate large scale marketplace delivery of quality renovation activity in each market segment. ‘Shaping the offer’ covers issues to consider in developing actions to create investor trust and confidence across the market segments and is the integrating response to the set of barriers and risks assessed in earlier step 4. Such measures are particularly necessary to attract investors and close the gap between long-term societal cost/benefit and private cost/benefit.

The essence of a successful ongoing renovation strategy is strong, consistent policy leadership and co-ordination with stakeholders to tackle barriers and risks, including addressing the dichotomy between longer term societal vs shorter term investor cost/ benefit.

National strategies need to include a twin approach, which stimulates a major upscaling in the volume of demand by building owners for energy efficiency renovation works, and builds a matching delivery capacity across the building industry supply chain, including finance supply.

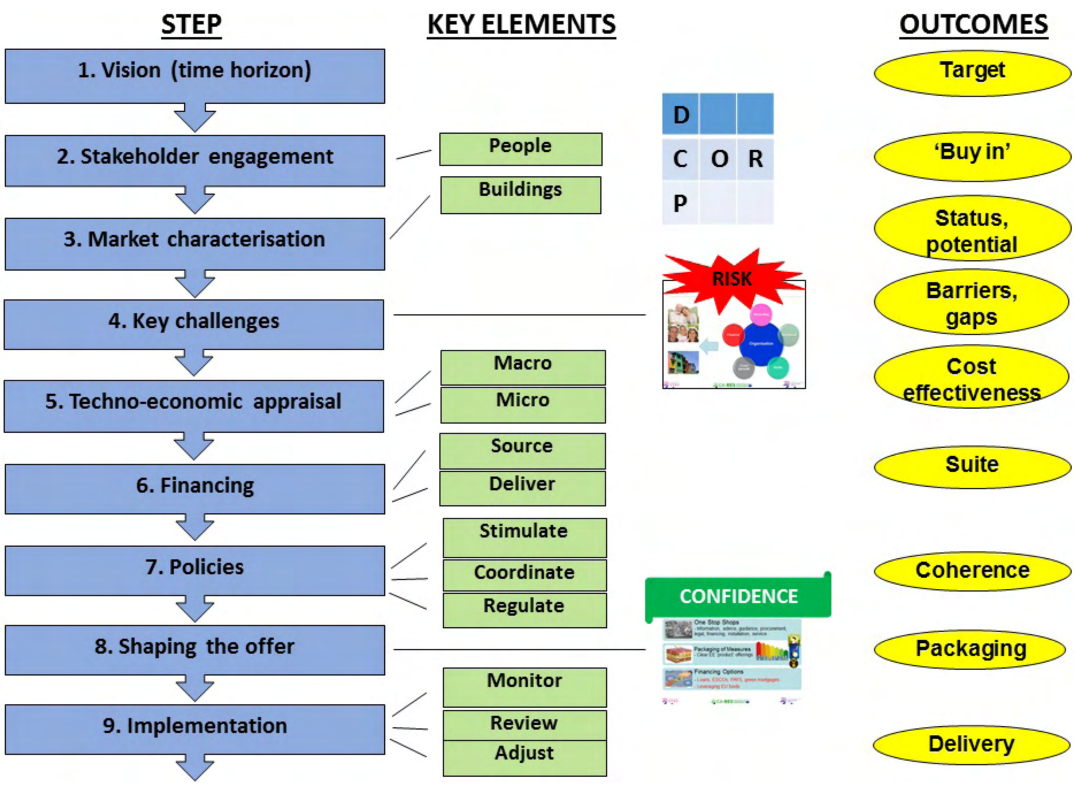


Figure 6: Suggested 9 steps, key elements and outcomes in renovation strategy formulation.

3.3 Accessing, mobilising and leveraging complementary EU, national/ regional and private sector finance

Reflecting the seriousness of policy intent in this arena, extensive attention has been paid to the mobilisation of finance for energy efficient buildings, both to newbuild NZEB in its development phase and especially to renovation. The focus has been on three aspects: sources and scale of finance (particularly at EU level), mechanisms for leverage, and design of instruments for delivery to different market segments. This framework, together with accompanying confidence-building measures to tackle various barriers, is reflected in summary form in Figure 7. The process entails a flow of funds between 'wholesale' financiers, 'retail' financiers and building owners/investors.

EU level financial sources cited in recital 18 of the EPBD, and particularly the expansion in Cohesion Funds, can play a vital role. Over 38 B€ is available over the period 2014-2020 to support the shift to a low carbon economy, of which one third is applicable to energy efficiency in buildings. The conditions of co-funding can be seen as presenting a considerable opportunity to leverage national, regional, institutional and private sources and amplify the overall impact of national instruments. This is illustrated in Figure 8, showing a potential to mobilise investment in excess of 100 B€. But it is important to note that, as a pre-condition for using EU Cohesion Funds for building rehabilitation, certain articles of the EPBD must be correctly transposed by MSs.

A study on the status of these instruments in terms of scale of funds, terms of

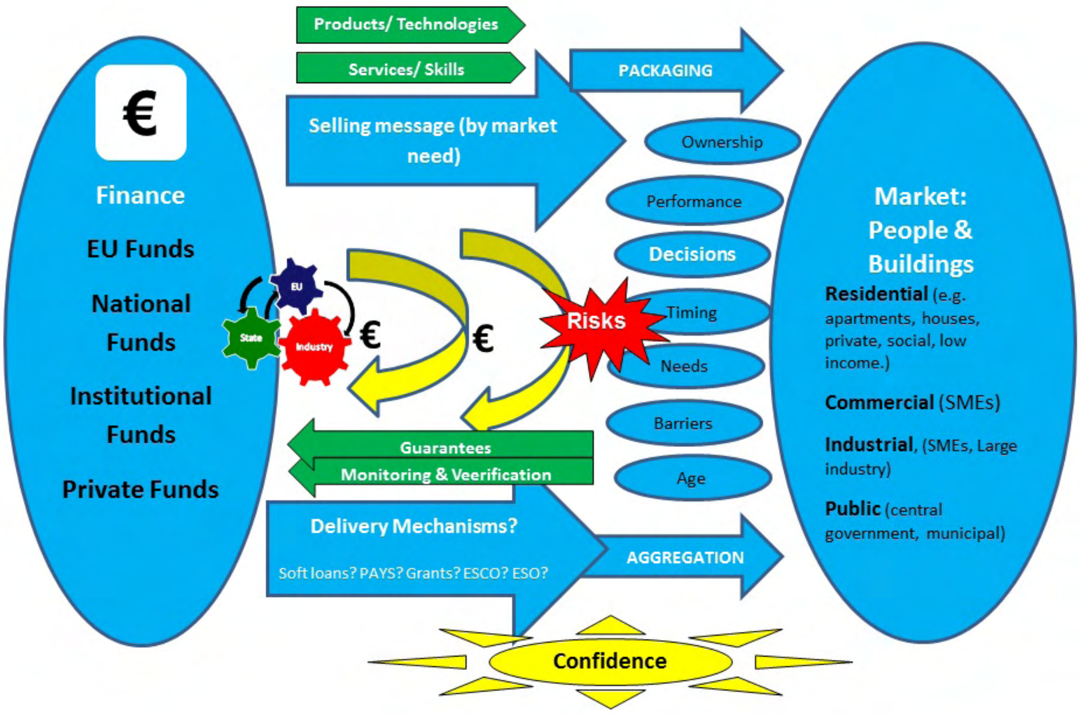


Figure 7: Bringing Finance from Sources to People and Buildings.

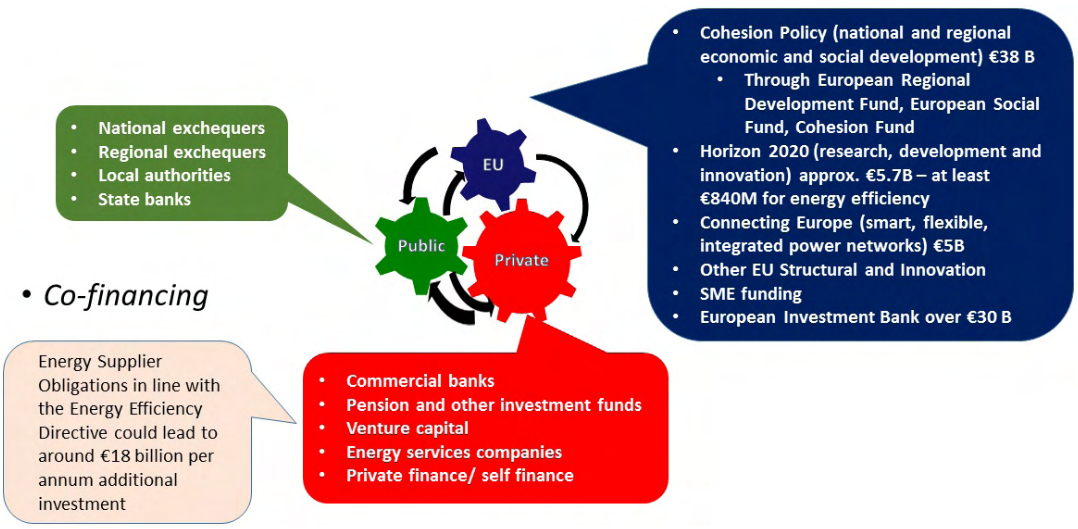


Figure 8: Sources of EU funding and leverage for energy efficiency investment 2014-2020.

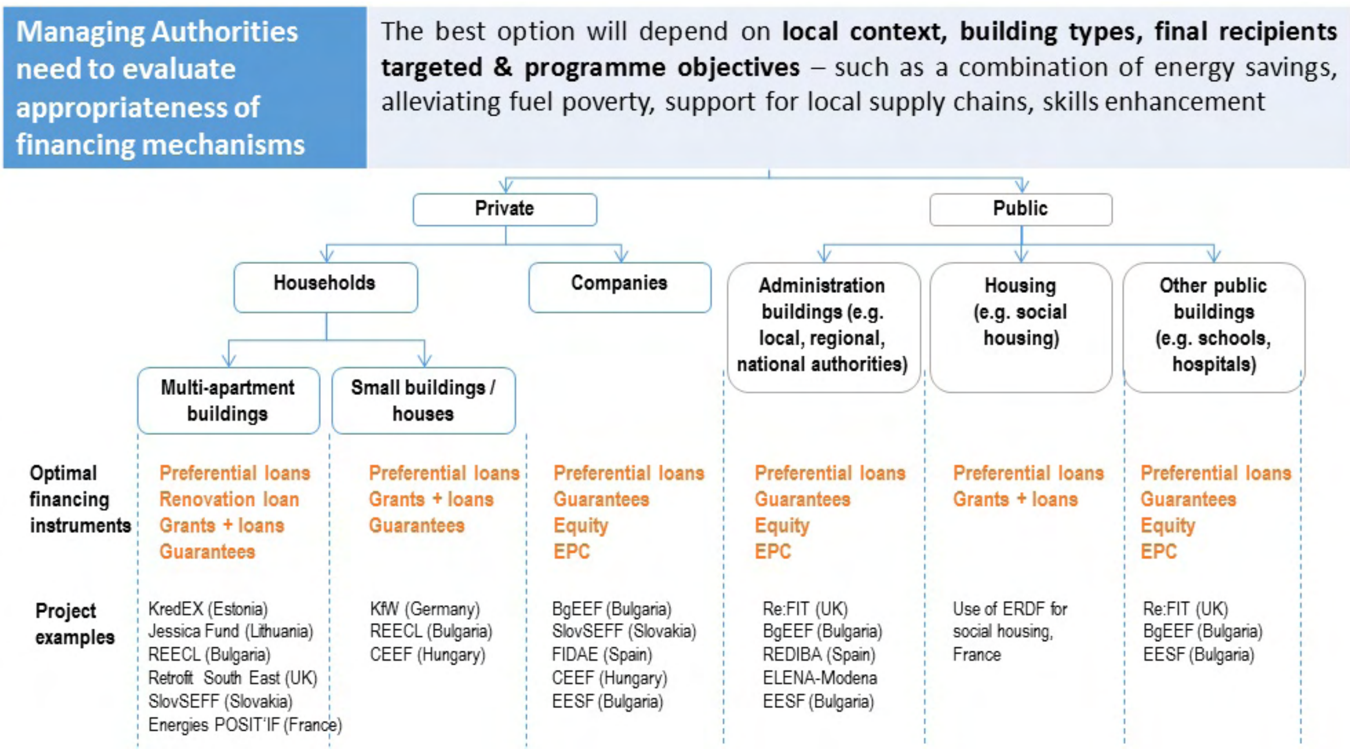
support, sectors and regions of application and experience and impact of applying these funds on the basis of evidence and case examples showed that there was a strong appetite for EU funding in many MSs, but a less strong awareness as to what funds are available, and accompanying conditions. Close liaison between the ministries responsible for energy/economy and structural funds (usually for enterprise, finance or similar) is necessary to avail of this opportunity at MS level.

At least fourteen MSs are using EU or European Investment Bank (EIB) funds to co-finance energy efficiency programmes or schemes in building construction or renovation, in housing or non-residential buildings, principally through preferential loans, grants, and associated 'technical assistance' (TA) (e.g., for training, marketing and procurement set-up) to public authorities, building owners or ESCOs. Despite difficulties caused in some MSs by banking and public finance crises, these initiatives have achieved good results and most are working well. The most common format for success is preferential loans, possibly complemented with a grant and/or TA package.

Experience has shown that it is necessary for financial instruments to be customised to regional/local socio-economic, legal and banking conditions. Frequently, these include the establishment of new legal and administrative mechanisms to administer and leverage the flow of funds from the various co-funding entities, which can involve revolving funds. Typically, these consortium members have included some combination of EU funding bodies, regional governments, energy agencies, municipalities, state banks, merchant banks, local retail banks, energy companies, installers, housing agencies and associations, home owners, ESCOs and project consultants.

Regarding mechanisms for delivery, grants act as a catalyst, but ultimately there needs to be a sustainable market dynamic for energy efficiency, e.g., revolving loans and ESCOs, and there is a gradual move in that direction. Initiatives such as the KredEx model in Estonia and Energies Posit'if in France highlight how central funds can be successfully leveraged. The KfW model in Germany has supported the renovation of over 9 million homes and each 1 € of subsidy has leveraged 9 € in retail bank loans and private investment. Analyses in Germany, France and Ireland of the net financial gain to the state show a typical 5:1 benefit to cost ratio, mainly as a result of the employment and economic benefits stimulated by public funds and resultant tax revenues. The EIB is an important source of leverage for at least eleven MS, partially funding up to 50-75%, mainly in public and social sector building renovation. An example is the renovation of 270 buildings with 23,000 apartments in Bucharest achieving 50% average energy savings through an investment of 140 M€, for which EIB provided a 50% loan. Its normal investment leverage or multiplier is 20:1, but can exceed 50:1.

Figure 9: Extract from guidance report on design of financial instruments.



Buildings' authorities in most, if not all, European countries are in need of guidance on the key challenge of using finance, from whichever source, into well designed financial instruments suitably customised to particular market segments. An example of a useful guide is "*Technical guidance: Financing the energy renovation of buildings with Cohesion Policy funding*", available online[3], which illustrates how many of the funding mechanisms work. Figure 9 indicates how the process of such design can lead to a variety of instruments targeted at different parts of the buildings sector.

Another significant reference is a study by the EU Energy Efficiency Financial Institutions Group (EEFIG), comprising over 120 expert participants, on "*How to drive finance for energy efficiency investments, Part 1: Buildings*", available online[4]. Their report recommends a range of market, economic, financial and institutional actions to help overcome the current challenges to obtaining long-term financing for energy efficiency. These recommended actions are addressed to policy makers and market actors, and include: articulating the benefits to key decision makers, strengthened processes and standards for EPC/energy performance code enforcement, quality generation and presentation of key data to decision makers, and the role of standardised protocols/contracts to assist the investment process.

This work could lay the basis for further work with the financial challenges related to building renovation across Europe. The report specifically recommends measures for better communication between the financial sector and the projects in need for financing - a topic discussed further in 3.4 below. Such measures include the creation of energy and cost databases for buildings and the development of a project rating system to provide a transparent assessment of the technical and financial risks of energy renovation projects for buildings. Furthermore, it emphasises the need to improve building certification methodologies and EPC standards and standards needed in the underwriting process. This partly reflects a need to strengthen the standing of the EPC in MSs, where in almost all cases financing and investment schemes do not yet use the EPC in a formal way. When used, its most common role is to verify energy savings on a 'before versus after' basis.

The EEFIG report also says that barriers to expanding the green mortgage market should be addressed and that there should be a review ensuring that current state aid rules do not unnecessarily burden accelerated energy efficiency investments.

EU level funding has the potential to mobilise investment of over 100 B€ by 2020, but often MSs lack awareness on the required conditions of appropriate programmes and schemes.

There is guidance available on how to develop schemes to trigger measures on energy efficiency in buildings on the ground. A common format for success is preferential loans, possibly complemented with a grant and/or TA package, administered by a well-administered consortium of complementary public and private sector partners.

Energy efficiency support schemes typically yield a net financial gain to the state. But most MSs are not yet taking advantage of these opportunities, often due to lack of familiarity with them.

Important enablers to investment are quality generation and presentation of key data to decision makers and the role of standardised protocols/contracts.

3.4 Communicating and working with financial institutions

A key weakness in the expert technical community (whether employed in the market or by public authorities) seeking to promote investment in building energy efficiency projects and programmes is an inability to understand the perspectives, language, processes, rules and other needs of decision makers and investors in the banking/financing sector (and indeed in engaging with ministries of finance). The success of the energy efficiency mission depends vitally on the ability of this technical community to 'speak the language' and understand the processes necessary to gain the confidence and commitment of the financial community - i.e., to succeed in securing the necessary levels of investment finance from that community. Consideration of this issue, including input from bankers, has provided significant learnings.

[3] *ec.europa.eu/energy/sites/ener/files/documents/2014_guidance_energy_renovation_buildings.pdf*
[4] *ec.europa.eu/energy/en/news/new-report-boosting-finance-energy-efficiency-investments-buildings-industry-and-smes*

In seeking funding for a programme, scheme or project, the fundamental need is to present a professional and successful 'business case'. From the bank's perspective, the emphasis is often less on the reward to risk relationship than it is on the need to identify, explain and satisfactorily mitigate all sources of perceived risk. An analysis of a range of project proposals submitted to a particular (sympathetic) bank was instructive. It showed that short payback proposals did not necessarily receive finance and that long payback proposals did not necessarily fail, as other motivating factors may be more important than energy savings. Often more important than the predicted savings or return on investment is the strength of the project team – which may only be considered to be as strong as the credit risk rating of its weakest member. Thus, the status of the people can be more important than the projected return on the project. This can be a barrier for Small Medium Enterprises (SMEs), which may have difficulty convincing banks of their viability beyond, say, a 5-year time horizon.

The predicted energy savings and the technical methodology used to compute these savings is of course significant. In this regard, banks often like to rely on 'technical assistance' in the form of independent expertise on which they can draw to evaluate the technical energy performance risks. This may entail an 'investment grade' energy audit, in the case of building renovation proposals. To be secure regarding the cash flow and 'bankability' of a project, a bank may also wish to obtain some form of energy performance guarantees (which might be accompanied by a monitoring and verification protocol). Likewise, the use of products or systems that are accredited by independent authorities (for example, with performance listed on a public register) is a source of confidence. It is noteworthy that in general across MSs, the information in EPCs regarding cost effective improvement options is not considered by financiers to provide a sufficiently clear and reliable basis for committing investment finance. This EPC information might possibly play a role if it were produced by a process, and adapted to a format, that is acceptable to financiers. However, it would still need to be supplemented with other information relevant to banks.

Banks tend to prefer simplicity over complexity as the latter is perceived as risk, so significant effort may need to be applied by proposal teams in making the complex simple. In particular, banks employ standardised documentation and adminstrative procedures and it is wise to minimise deviations from such systems. To minimise transaction costs, projects of larger scale may be more attractive to a bank than small-scale projects – provided this avoids undue complexity and risk. In some instances, bundling or aggregation of projects may be appropriate, in which case intermediaries may be required to co-ordinate and synthesise the overall project (e.g., there is a government 'insurance' scheme in Bulgaria that takes this type of perspective, and is reported to be working well). This might apply, e.g., to projects being assembled by an ESCO or an energy utility (e.g., under EED energy supplier obligations). A potential benefit with aggregation is to reduce risks of an individual project failing to deliver, and a loan could be based on a pre-set failure rate that is considered realistic and tolerable.

Overall, it is also advantageous to try to establish a performance record with a particular banking institution, which again will gain confidence. In this regard, if possible, it is beneficial to choose and work with an institution that has prior experience of funding the type of project or scheme being proposed.

In almost all MSs, national authorities and agencies responsible for energy efficiency in buildings have been active over the past five years in engaging with banks, and in understanding and resolving these issues. This has been happening in the process of seeking to establish specific energy efficiency funds, including jointly developing special purpose fund administration mechanisms, and risk sharing or mitigation measures. This needs to continue.

Energy experts need to engage, educate and persuade the financial community on the case for investing in energy efficiency in buildings. Establishment of shared training initiatives would be beneficial.

Banks favour 'standardised' administrative and technical methodologies to maximise confidence and minimise transaction costs.

National authorities need to continue to work deeply with the banking sector to achieve mutual goals and understanding of energy efficiency investment requirements.

For example, EPCs are not sufficient to meet bank needs but steps could be taken to adapt or supplement them to provide the necessary evidence and declarations to meet those needs.

3.5 Experiences with Energy Service COmpanies (ESCOs) initiatives

Development and promotion of systems by MSs to support ESCOs (as required by EED Article 18) has an important potential to stimulate significant activity in improving the energy efficiency of buildings.

ESCO markets in Europe are at diverse stages of development, so MSs have much to learn from each other in supporting these markets. Some countries have many ESCOs (e.g., over 500 in Germany, over 300 in France, 80 in Italy) but most have typically less than 20 ESCOs established (14 countries each have 10 or less), complemented by engineering consultancies and technology providers offering solutions with elements, e.g., equipment leasing and performance guarantees. Steady growth took place from 2007-2013 in Denmark, Sweden and Romania and to a lesser extent in Spain, Italy, France and Ireland, with very few countries showing a decline[5]. On average, ESCO markets have been developing in volume and complexity when compared to 2010, driven by regulatory frameworks, financial incentives and increasing awareness. The inclusion of an energy (cost) saving guarantee in the offer is considered particularly important.

However, for a high proportion of ESCOs, revenues from energy supply contracting and/or Energy Performance Contracting still represent less than half of their business revenue. For example, for about 60% of Germany's 540 ESCOs, such revenues are less than 5% of their total turnover, and only around 10 of its ESCOs are exclusively focused on these forms of contracting.

Therefore, while energy efficiency related activity of this sector is estimated at up to 1,6 B€ in 2013, it is far from reaching its estimated 50 B€ potential. There are only a few mature markets, e.g., Germany, the Czech Republic, France, and Austria, and these are expected to grow substantially in the future. The markets are driven as much by market forces (e.g., energy prices, impact of the financial crisis, client interest, developing partnerships between demand side and supply side players, and between the companies and subcontractors), as by dedicated policy measures, regulations and financial solutions. Among the indicators and facilitators of success are the availability of model contracts, standards and/or intensive information dissemination carried out by third parties/market facilitators or intermediaries, engagement of a wide array of companies, including energy supply utilities, consultants, etc., indicating an open and competitive market, and the establishment of ESCO associations. Many governments offer tax reduction and/or some form of funding to support the energy services market, most have legislation to promote the market, but one third of MSs have no financial support.

The motivation for energy supplier involvement may not be extra profit from their ESCO projects directly (although that can be the case), and they are often driven more by regulations on Energy Efficiency Obligations (EEOs) or Demand Side Management (DSM) programmes (e.g., Denmark, Latvia, Slovenia), and/or they offer energy services to attract new customers and increase loyalty of current ones. The perceived complexity of the business model, including Energy Performance Contracting and the associated procurement and verification processes, is a deterrent to many potential clients and financiers, which highlights the value of model contracts and facilitators who can offer specialised knowledge in technology, financing, management and communication. A small number of MS authorities have developed model contracts, and specialist facilitation is being provided by national (or local) energy efficiency agencies, private energy audit companies, procurement advisors and some legal advisors.

Because of the transaction costs, larger scale projects are preferred, which are mainly in the public and commercial sectors. Gaining the awareness and confidence of banks is also a challenge. While, in principle, availability of finance might not be a constraint, a significant difficulty can exist in relation to the credit risk status of the client company or of particular suppliers, particularly for contracts extending beyond 5 years (similar to the SME risk mentioned in 3.4 above).

Public bodies are expected to take a lead in using the ESCO model. While this market is perceived to be relatively well-developed in public administration buildings, hospitals and schools in a few countries, it can still face significant

[5] *Energy Service Companies Market in Europe - Status Report 2013 JRC Scientific and Technical Reports: publications.jrc.ec.europa.eu/repository/handle/JRC89550*

challenges with national exchequer or treasury accounting rules and procurement rules. In the commercial sector, the ESCO market is most developed in buildings such as hotels and large retail premises. Barriers to uptake in office buildings have included the split incentive problem and a mismatch between the long-term nature of an ESCO project and the volatile nature of companies that own office buildings.

It is perceived that to date, ESCOs and Energy Performance Contracts have been applied mainly to improving the energy efficiency of technical systems such as lighting and HVAC systems, and in energy supply solutions such as Combined Heat & Power (CHP), with relatively short payback periods compared with building envelope investments, and thus have not been applied to very deep renovation. The main intervention by MS authorities has been to use national or EU funds to support preferential loans (lower interest rates) for ESCO projects.

The ESCO instrument is least developed in housing for many reasons – diverse ownership, fragmentation/lack of scale, low energy intensity, split incentive problem, etc. However, this sector has been given attention in the form of pilot initiatives in at least Italy, France, Norway, Denmark, Hungary, Estonia, France, Poland, Latvia, The Netherlands, Sweden, Germany and The UK. These projects are usually in the social housing sector and combine some form of national or EU financial incentive with the ESCO finance. An example is the FRESH project[6].

For ESCOs to grow successfully as a force for energy efficient investments in building, independently recognised monitoring and evaluation systems are crucial.

MS need to continue developing model contracts, guarantee mechanisms, opening credit lines, working with public banks and inviting tenders to apply competitive private investment in ESCO services in public sector buildings. Procurement and accounting rules can still be a barrier.

If ESCOs continue to grow in MSs in their present target markets and measures, they can be extended to deep renovation and possibly to housing. But this will require new financing structures and models to be led by MS authorities.

3.6 Experiences with Energy Efficiency Obligation initiatives and alternative measures

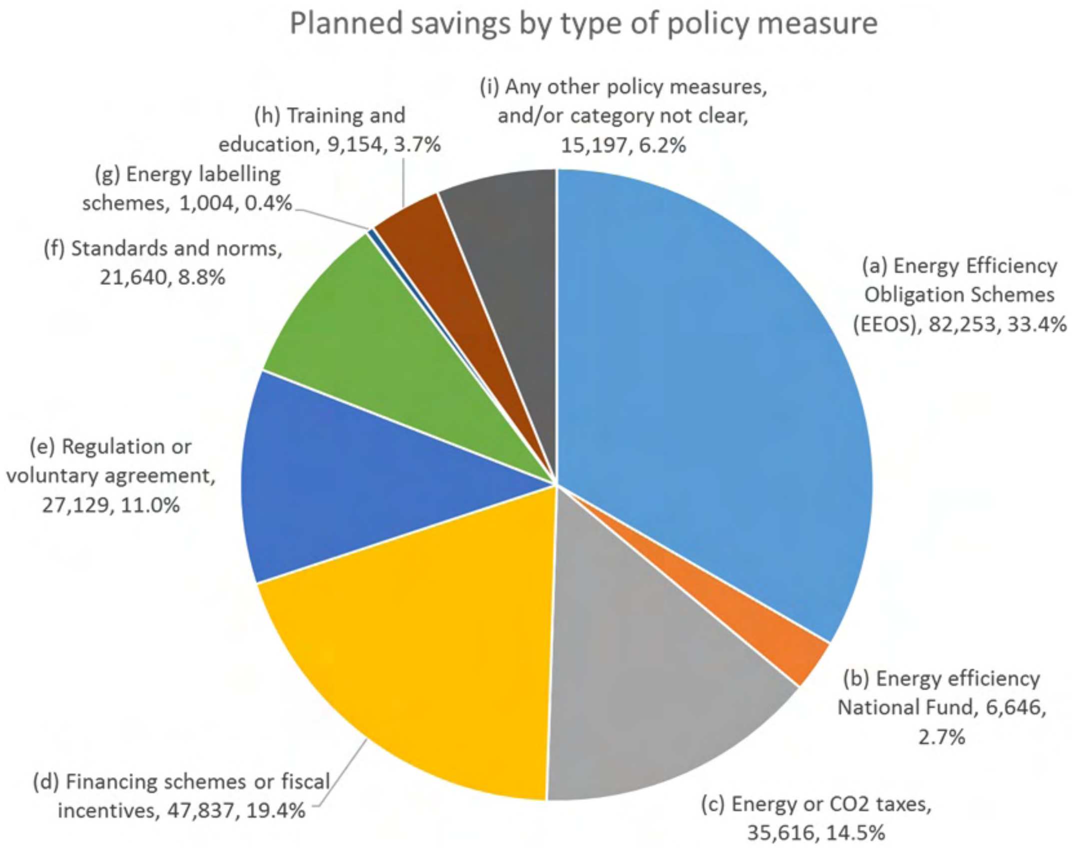
Another important requirement for MSs under the EED (Article 7) is the establishment and operation of an Energy Efficiency Obligation (EEO) scheme or alternative measures that achieve the same amount of energy savings. This has a potential to support significant activity in improving the energy efficiency of buildings. Under the EEO schemes 'obligated parties' (energy companies) are required to achieve new energy savings of 1.5% of annual sales to final consumers, or MSs may choose instead alternative policy measures (e.g., taxes, financial incentives, regulations, voluntary agreements or labelling, training, education and advice) with equivalent effect. MSs are required to lay down the rules on penalties applicable in case of non-compliance with the national provisions adopted in relation to EED Article 7. To date, only Austria is known to have specified the level of such penalties.

EEO schemes have varied from one MS to another, in scope, design features and institutional arrangements at national level. In six MSs (Denmark, France, Ireland, Italy, Poland and The UK), they have transitioned from a voluntary status to a legislated status. In most cases, the obligated parties are the financing source of the measures, and the costs are passed to the final consumer via the energy price or tariff. Careful market analysis, including assessing the most effective channels for energy efficiency investment uptake and savings impact, is important to informing the design of an EEO scheme. Figure 10 is an example of how such a scheme works in The UK, including government oversight, the role of intermediaries and 'counter parties', and provision for trading energy efficiency credits between different energy suppliers.

Schemes are currently in place in eleven MSs (Austria, Bulgaria, Denmark, France, Italy, Ireland, Luxembourg, Poland, Slovenia, Spain and The UK) with good evidence of cost-effective savings, and a further five MSs plan to establish such schemes. As shown in Figure 11, for MSs as a whole, EEO schemes represent 33%, and buildings represent 42% of targeted energy savings under all National Energy Efficiency Action Plans[7] required by the

[6] *www.fresh-project.eu/project*

[7] *This data set contains further information and updated notifications received from the Member States. The target amount of 42% savings generated in the buildings sector combines both EEO schemes and alternative measures.*



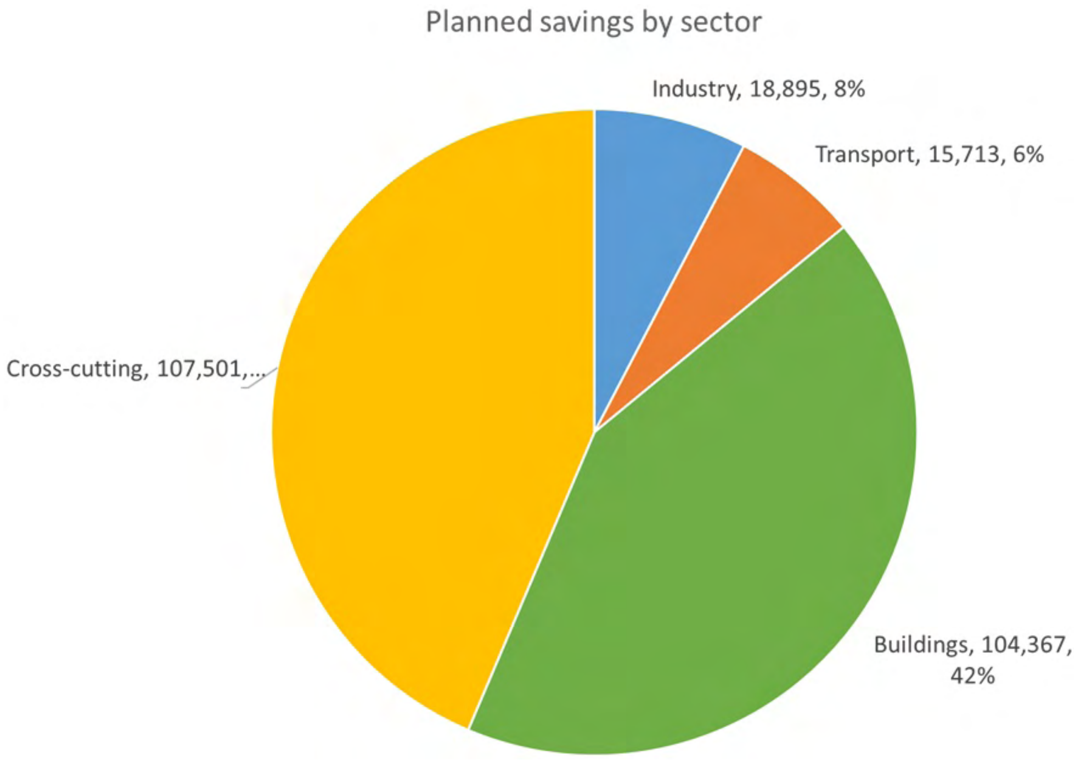


Figure 10: Energy Efficiency Obligation scheme and buildings in the EU: significance and potential.

EED. To this end, EEO schemes can play an important role in meeting shared EPBD goals, and to some extent accelerate the renovation rate. The main focus of existing schemes in relation to buildings has been on retrofitting of Heating, Ventilation and Air-Conditioning (HVAC) and lighting, with few applications to new buildings, innovative technologies or behaviour change. They target low-cost 'shallow' renovation measures for a number of reasons: these are usually the most economically attractive and can be technically standardised more easily than high-cost/complex measures, which enables a streamlined monitoring and verification regime often using 'deemed' savings benchmarks based on representative samples. This approach keeps administrative cost low (less than 0.1% of total cost in The UK).

In their design and evolution of EEO schemes, MSs need to look beyond shallow retrofit actions and set up systems to encourage deeper renovation measures. One initiative reported from two of the active MSs which can help towards this goal is to assign higher credit weightings for 'deeper' and more durable measures.

Based on MSs experience in designing EEO schemes, targets need to be set sufficiently high to mobilise measures that are additional to the baseline market activity, and avoid the risk of 'free riders' and, e.g., excessive distribution of low cost disposable energy efficiency products (e.g., efficient lamps) into households. In the early years of (voluntary) EEO schemes, such rigour was not always the case. A graduated approach to target setting (year 2020 or beyond) is recommended, to allow time for the industry supply chain to develop the capacity to deliver the eligible technologies at the scale required. And as with ESCO initiatives, the operation of suitable systems for monitoring and verification of savings is crucial. Penalties are also seen as an essential component of EEOs, which need to be sufficiently serious to act as a deterrent, and need to be clearly specified and communicated. However none have yet been applied.

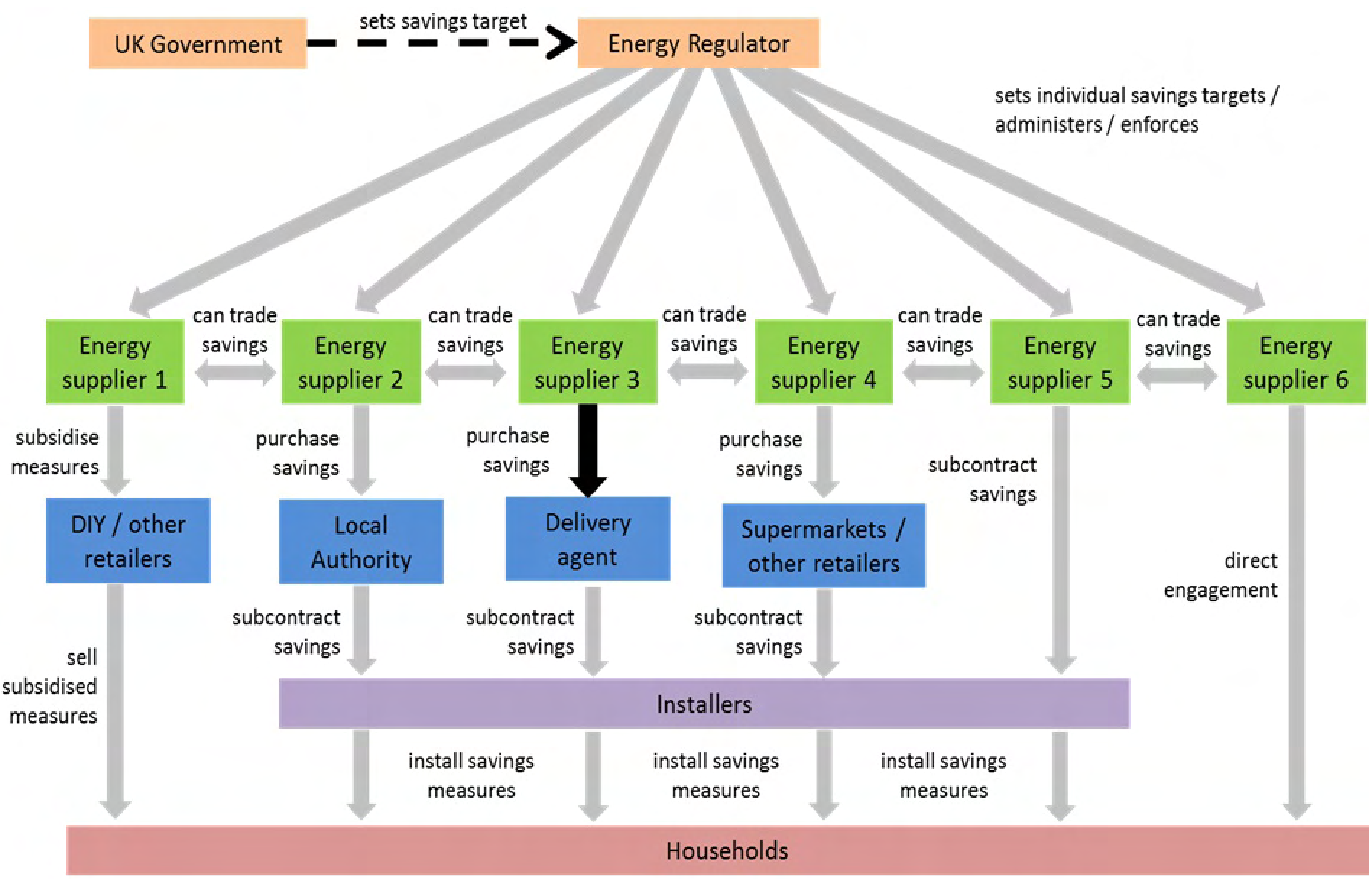
EEO schemes are targeted by MSs to meet 33% of energy savings required under EED Article 7, contributing to the EU 2020 energy efficiency target. Experience shows that with realistic targets and sound monitoring, they can work well and be very cost effective.

MSs need to design the EEO schemes to take careful account of the market conditions.

While EEO schemes have high potential, the limits of their application to 'shallow' measures are likely to be reached in the near future.

MSs need to prepare for EEOs to address deep renovation, e.g., by building incentives into the energy efficiency credits system to reward deeper measures.

Figure 11: Example of how an EEO scheme functions in The UK. Source: Rosenow (AEA-Ricardo) 2012



3.7 Monitoring and evaluation of policies, programmes, schemes and projects

Well designed systems by MS authorities for monitoring and evaluation of policies, programmes and schemes at 'macro' level, and of projects at 'micro' level, are important for ensuring progress to targets, assessing effectiveness and value for money of different schemes and instruments such as EEO schemes, Energy Performance Contracts, subsidy schemes, funds and tax incentives. This is also important in order to gain the trust and confidence of decision makers: investors, financiers, building owners and ESCOs – and indeed ministries in relation to introducing market stimulus policies.

The certification and inspection programmes developed in the process of implementing the EPBD have the potential to yield a comprehensive data source on the energy performance quality of buildings. To exploit this potential, central registers of certificates and reports should be equipped with interrogation functions to determine the effectiveness of policy interventions. As example of such data enabling policy action, in Denmark, it was used to calculate scenarios for potential energy savings in different building types and ages, plus the necessary investments, informing the government's energy saving strategy established in 2012. Similarly, Ireland in 2008 launched a pilot grant scheme for home energy efficiency upgrades, which then entered full operational mode in 2009. Evaluation was based on 'before and after' Energy Performance Certificate (EPC) data, calibrated with EPC data modelling, assessment of energy bills from a sample of participants, to inform the final design and evaluation system of a full grant scheme which has supported measures in 15% of the housing stock to date.

At individual project level, the scope of the EPC and perceived quality of the recommendations in its present form is not considered sufficient evidence for an 'investment grade' energy audit. However, a positive development is the emergence of a number of standardised, versatile international protocols to assist the ex ante and ex post evaluation of energy savings, e.g., the International Protocol for Measurement & Verification of Performance (IPMVP, www.evo-world.org) and the Investor Confidence Project (ICP, www.eeperformance.org). These constitute an integrated set of existing standards, practices, and documentation in order to create the data necessary to enable underwriting (guarantee) or managing of energy performance risk. The EC Joint Research Centre (JRC) recommends that performance-based projects are subject to 'measurement & verification' protocols, and regards the IPMVP as a good instrument to be used.

If good data exists on investments in energy efficiency in buildings and energy efficiency improvements, it will be possible to link the effects of policies, programmes, schemes and projects to the energy efficiency improvements. This could be valuable in the evaluation process. However, evidence from MSs suggests that public authorities do not evaluate interactions among policy and programme impacts. Less attention tends to be paid to ex-post performance verification than to ex-ante evaluation of proposed schemes and projects. Few MSs have a protocol for energy efficiency evaluation applied consistently by all agencies, and data collection and evaluation capacity is low. To establish effective evaluation regimes, there is a need to build a monitoring & evaluation culture, methodology and capacity so that impact, process, market and cost are built into the design and implementation of the policy instrument, matching the evaluation approach to the policy objectives and programme design, and with adequate funding for evaluation. At least ten MSs have such solutions already in place or planned. European Bank for Reconstruction and Redevelopment (EBRD) schemes in Slovenia (SlovSEFF) and Bulgaria (REECL) and an EIB scheme in Lithuania (Jessica Holding Fund) could be learning examples for other schemes.

Monitoring & evaluation practice across MSs seems relatively weak at both macro (policy) and micro (project) level. There is a need to normalise the monitoring & evaluation culture in order to determine effectiveness and value for money.

Whether at programme, scheme or project level, there is a need for standardised systems, which balance cost with accuracy – in terms of being simple and workable, and sufficiently rigorous and robust.

Central EPC registries can play a potentially useful role in policy analysis, tracking and targeting.

At project level, protocols such as IPMVP provide useful tracking and evaluation tools and are increasingly used in energy performance contracts.

3.8 Exploiting interactions and synergies with the EED and the RESD

Figure 12[6] shows nine identified areas of potential synergy between the EPBD, the EED and the RESD. In addition to topics covered above (financial instruments, building renovation, EEOs and ESCOs) these include energy certification/auditing, training and accreditation schemes, the exemplary role of the public sector, smart metering/building monitoring, information campaigns, and financial instruments.

A common opportunity exists to deliver information campaigns via energy supply utilities. Targeted financial actions could include tax incentives/reliefs for purchasers of energy-efficient products and grant schemes that facilitate renewable technology deployment.

Training and accreditation schemes are an area of potential synergy, and of significant public/private sector cooperation as almost all MSs have delivered schemes through a combination of government/national agency defined rules, commercial training providers and/or construction professional bodies.

Regarding requirements for training/qualification/accreditation/registration of experts across the three Directives, Europe lacks appropriate training on energy efficiency issues for architects, engineers, auditors, craftsmen, technicians and installers, notably for those involved in refurbishment. MSs are beginning to respond to this need by developing training courses for professionals and actions arising from the BUILD UP Skills initiative (which aims to boost the energy skills of buildings craftspeople and on-site workers and installers across all MSs).

There is clear scope for co-ordinated systems for EPC energy assessors and energy auditors under the EED. Sometimes EPC assessors may have skills in calculation and certification, but may need extended skills in recommending e.g., renovation investments. While there can be administrative efficiency benefits, most MSs do not yet appear to have implemented approaches to benefit from these synergies. Typically, different ministries and institutions are involved, and these and emerging EN/ISO standards can entail lengthy consultative processes. In Poland, Slovakia and Finland, energy auditor schemes link with the EPC

Figure 12: Areas of potential interaction between the EPBD, EED and RESD.

Action area	EPBD Recast	EED	RESD
Target	No	Indicative/ Binding	Binding
Scope	Heat, power	Heat, power, transport	Heat, power, transport
Action Plan required	No	Article 24	Article 4
Reporting	Yes	Article 24	Article 22
Building renovation	Article 7	Article 4	No
Public/ visited buildings	Articles 9, 11, 12	Article 5, 6	No
Information & training	Article 20	Articles 16, 17	Article 14
Energy certificates/ audits	Articles 11, 12	Article 12	
Competent persons/ auditors	Article 17	Articles 8, 16	Article 14
Funds and financial instruments	Article 10	Articles 9, 11, 20	Some
Energy Efficiency Obligations	No	Article 7	Yes
Energy Services/ ESCOs	No	Article 18	No
Metering/ monitoring, billing, information	Articles 8, 20	Articles 9, 10, 11, 12	Some

[6] *Note that a 'no' entry in this table means 'no mention' in the Directive concerned, but it does not mean that the item has no relevance to that Directive.*

schemes for buildings and are good examples to follow. The scheme in Finland has also undergone successful evaluation, highlighting the benefits of including training, monitoring, quality control, tools and models as central elements from the start. Slovenia has a common training/certification article in its legislation for all three Directives and is achieving synergies by implementing a co-ordinated modular training approach.

Suitable systems to enable cross border mutual recognition have also been slow to emerge. There are important barriers and it could be useful to investigate opportunities for a framework allowing transnational recognition of specialists (as mandated by the RESD). The analyses from the BUILD UP Skills initiative in individual MSs could also be a powerful resource to assist implementation and deliver common benefits, given the importance of buildings in the EED and e.g., in relation to installation of technologies such as solar thermal and electric systems, heat pumps and biomass systems (RESD).

The exemplary role set on the public sector in both the EED and EPBD aligns well with the EU policies and national actions on Green Public Procurement (GPP). Such plans typically include the goal of a minimum life cycle cost, and can include elements such as setting ambitious energy performance standards for buildings and products, use of EPCs, ESCOs and registers of energy efficient products (boilers, lighting, etc.). While there appears to be limited exploitation of this synergy within MSs, there are some positive examples of actions being stimulated by GPP policies, e.g., advisory services, manuals, databases and training of procurement officials in Finland, Sweden and Spain. It is recommended that EPBD authorities investigate and pursue possible synergies with colleagues responsible for GPP policies within their national administrations.

Coordination between government ministries and agencies responsible for transposition and impementation of the three Directives will improve policy coherence, stakeholder communication, and the effectiveness of delivery of measures.

A ‘one stop shop’ type service integrating and offering a full suite of information and guidance on energy efficiency improvements for buildings may be a useful mechanism.

Nine main topics of synergy between the three Directives have been identified (Figure 12).

4. Main Outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Support initiatives	The variety of sources and types of financial and information support initiatives offer strong opportunities for combined actions by multiple actors, targeted to specific sectors.	MSs still consider grants and soft loans as leading instruments for residential and commercial buildings. Policy authorities must provide the leadership, focus, coherence and specific interventions to tackle barriers, and stimulate and sustain market confidence and commitment.	Migrate from capital grants to more sustainable market based instruments. One stop shops and packaging of technical and financial solutions - including favourable loans, tax reliefs, ESCOs and guarantees could help markets develop.
Developing strategies for mobilising upscaled investment in deep energy efficiency renovation	Annual investment in building energy renovation needs to grow by a factor of 5. There is useful guidance documentation to assist MSs in developing effective holistic strategies.	The essence of a successful strategy is strong, consistent policy leadership and co-ordination to tackle barriers and risks, including addressing the dichotomy between long-term societal versus shorter term investor cost/benefit.	National strategies need to include a twin approach, which stimulates an upscaling in demand by building owners, and builds a matching delivery capacity across the building industry supply chain, including finance supply.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Accessing, mobilising and leveraging complementary EU, national/regional and private sector finance	Energy efficiency support schemes yield a net financial gain to the state. EU level funding has a potential to mobilise investment of over 100 B€ by 2020, but MSs sometimes lack awareness on the required conditions of appropriate programmes and schemes.	There are huge opportunities for leverage of EU level funding. Good guidance and best practice examples are available on the sources of 'wholesale' finance, design and administration of financial instruments customised to different sub-sectors, including risk sharing mechanisms.	Important elements to trigger action are quality generation and presentation of key data to decision makers. Standardised protocols/contracts to assist the investment process are needed.
Communicating and working with financial institutions	National authorities and energy experts need to engage, educate and persuade the financial community on the case for investing in energy efficiency in buildings. They must learn and apply bankers' language and frameworks of risk assessment and decision making.	Banks favour 'standardised' administrative procedures and technical methodologies for project evaluation, monitoring and verification to maximise confidence and minimise transaction costs. Trust in a project team is based on the credit risk rating of its weakest member.	Shared training initiatives between banks, energy experts and national authorities would be beneficial. Proposers should ensure projects are comprehensively synthesised and address all risk factors.
Experiences with ESCOs	The ESCO sector in MSs is growing gradually, at varying stages of development. While relatively well-developed in public buildings, accounting and procurement rules can be a barrier. Monitoring and evaluation are crucial.	ESCOs are seldom being applied to deep renovation or to housing. Extending to these areas will require new financing structures and models to be led by MS authorities.	MSs need to promote model contracts, guarantee mechanisms and invite tenders for ESCOs. The public sector needs to continue taking an exemplary role.
Experiences with EEO	EEO schemes are designed by MSs to meet 33% of the 2020 energy efficiency targets. They are so far established in less than a quarter of MSs. But experience shows that with realistic targets and monitoring, they can work well and be very cost effective.	EEOs are being applied to shallow renovation only. While they have much potential, the limits of their application to shallow measures are likely to be reached in a short number of years.	National EEO schemes should be carefully designed to employ most effective channels for investment uptake and savings impact. MSs also need to prepare for EEO schemes to address deep renovation, for example by using the credits system to reward deeper measures.
Monitoring and evaluation of policies, programmes, schemes and projects	Monitoring & evaluation practice across MSs seems relatively weak at both macro and micro level. Few countries follow a consistent approach in assessing the energy savings from their energy efficiency measures, to verify effectiveness and value for money.	It is crucial to build a monitoring & evaluation culture and tools into a programme or project from concept stage. Central EPC registries can be useful for policy analysis, tracking and targeting - but, for project investors, an EPC is unlikely to be seen as sufficient evidence.	Whether at programme, scheme or project level, there is a need for robust, affordable monitoring & evaluation systems. Project protocols such as IPMVP provide tracking and evaluation tools, are increasingly used and are encouraged.
Interactions and synergies with the EED and the RESD	Areas of potential synergy include certification/auditing, training/accreditation, information, building monitoring, public sector, EEOs, ESCOs and financial instruments. Where responsibility for Directives is led by different agencies, synergy to date seems limited - but improving.	More coordinated approaches between ministries and agencies are needed at national level to exploit synergies, improve policy coherence, stakeholder communication, and delivery effectiveness.	Encourage ministries/agencies to facilitate synergies. A 'one stop shop' type service integrating and offering a full suite of information and guidance on energy efficiency improvements for buildings may be a useful mechanism.

5. Lessons Learned and Recommendations

Three key objectives continue to inform the work on the topic of ensuring the effectiveness of the EPBD implementation regarding provision of financial instruments and information services in the EU construction and property marketplace.

> Firstly, it is vital that MS authorities show leadership in articulating goals, clear roadmaps and adopting robust arrangements (regulatory, financial and promotional) to catalyse the necessary transformation of both new buildings and the existing building stock towards NZEB levels, addressing gaps and mobilising the range of institutional and professional actors. Examples of this are the assistance documentation developed on (deep) building renovation strategies, and on translating 'wholesale' finance such as EU Cohesion Funds into well-designed and targeted stimulus instruments.

> Secondly, it is desirable that all possible opportunities are identified and pursued in exploiting the potential synergies between the EPBD, the EED and the RESD, for example through the work required on financial instruments, ESCOs, EEOs and expert training.

> Thirdly, a priority area is that of ensuring that the energy efficiency community is well acquainted and skilled in communicating and working effectively with the financial community - particularly because, while a role will remain for grants, the scale of the challenge requires more sustainable market based instruments.

In general, positive (but not rapid) progress appears to be continuing in most MSs in terms of improving the focus, leverage and impact of informational and financial initiatives. There is a consistent need to emphasise to the general public and all stakeholders that a building cannot be 'high quality' unless it is an energy efficient building. Further insight into the decision-making process and motives for building owners and consumers is needed, and more experiences and learnings would be valuable. Often energy efficiency is not the main driver and there are different stakeholder perspectives, so instruments need to be sectorally differentiated.

It has been demonstrated that subsidies for building renovation investment frequently yield a net financial gain to the state. However, a significant weakness is that monitoring the results and effectiveness of policies and programmes remains underdeveloped among most MSs. Incorporating the need for both ex ante evidence base and ex post evaluation into policy and programme planning will help identify data needs and collection approaches, and there is scope for standardised systems to minimise administration costs.

To date, comprehensive knowledge of the building stock is limited in many MSs. However, the certification and inspection programmes implemented under the EPBD have the potential to yield extensive data on the energy performance quality of buildings. To maximise the potential of this data source, central registries of certificates and inspection reports should be equipped with interrogation functions to determine the effectiveness of policy interventions.

The public sector is required to take an exemplary role in leading the transition to low-energy buildings but is in a climate of limited public sector capital. It therefore needs to employ the third party financing available through the energy performance contracting/Energy Services COmpany (ESCO) model and to highlight the benefits in order to stimulate similar action in commercial buildings, but there are barriers to this model extending to deep renovation on a wide scale. Barriers to ESCO application are relatively severe in the residential sector, because of its often moderate energy intensity, higher transaction costs (e.g., for metering and allocation), fragmentation of ownership and small scale, the split incentive problem etc. But useful findings may emerge from a series of pilot projects underway in the social housing sector and using national or EU financial incentive in conjunction with the ESCO finance.

Recommendations to improve the effectiveness of support initiatives by MS authorities:

> Actions to facilitate a deepening structured engagement by national authorities and technical experts with financial institutions as vital players in the investment arena, to understand

and inform their perspective, secure their confidence, and develop suitable risk sharing and mitigation measures, especially in relation to funding energy efficiency renovation of buildings.

> Active use of guidance on the leveraging and alignment of financial instruments - according to type, target group and institutional framework - with the different needs of different building type and ownership sectors.
> Making the business case for prioritisation relative to competing (non energy) investments, by consistently highlighting that building energy renovation investment, whether through subsidy or market instruments, justifies itself through a short term net financial gain to the state as well as wider private and societal gains.
> Improved awareness and leverage of EU level funding by relevant MS authorities for the improvement of the new and existing building stock. A growing volume of good examples can help MSs to become more active and ambitious in this regard.
> Enhanced operation of awareness, information, training and confidence building initiatives to stimulate building owners to improve the energy efficiency of their buildings.
> Adoption of unified/standardised methodologies for monitoring and evaluating the effectiveness of policies and programmes (guidelines, principles, strategies) – possibly in liaison with the CA EED.
> Promotion of the ESCO sector, including model contracts, performance protocols, guarantees and other confidence building measures, in commercial and public sector buildings, and exploration of whether and how it can be extended to deep renovation.
> A more coordinated approach to exploit the potential synergies within the three Directives (EPBD, EED and RESD), such as modularisation of training and registration of experts.
> Active sharing with the BUILD UP Skills as a significant resource in implementing common practical on-site delivery actions necessary to successfully implement the three Directives.

Part B – Country Reports

Implementation of the EPBD in Austria

STATUS IN DECEMBER **2014**

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1. Introduction

The implementation of the Energy Performance of Buildings Directive (EPBD), Directives 2002/91/EC and 2010/31/EU, has been a challenging task to launch in the nine provinces (Bundesländer or simply Länder) of Austria, but it was also an opportunity to harmonise and develop a common calculation methodology, as well as to apply new regulations for technical building systems.

Before the implementation of the EPBD, the issuing of Energy Performance Certificates (EPCs) was, in several provinces, already partly performed, but it was limited to only a few energy indicators relating to the U-value of the building's thermal envelope. The implementation of the EPBD resulted in further complementary actions, e.g., new regulations for heating and ventilation systems, as well as for their regular inspections. Following the implementation of the Directive 2010/31/EU, the presentation of the EPC is mandatory by law as of April 2012 (Energieausweis-Vorlage-Gesetz: the law on the presentation of the EPC) when purchasing or renting a building. Since December 2012, this law has been tightened through the imposition of a fine or penalty in case of non-compliance.

The Austrian national plan on the requirements of Nearly Zero-Energy Buildings (NZEBs) for residential and non-residential buildings has been published and is being implemented in the building regulations of the Länder.

The transposition of the EPBD concerning the inspection of the Heating Ventilation and Air-Conditioning (HVAC) systems and Domestic Hot Water (DHW) systems into building regulations of the Austrian provinces was completed in 2014. All Austrian provinces have adapted their building regulations regarding the inspection and reporting intervals of different systems according to the size and type of the system.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

In Austria, building regulations are under the jurisdiction of the nine federal provinces. In 2006, in order to transpose and implement the EPBD, a harmonisation process was launched to develop a common calculation methodology for EPCs and labelling, as well as for inspecting the HVAC systems. The Austrian Institute of Construction Engineering (OIB www.oib.or.at) was assigned to manage this process. A working group of representatives of the nine provinces was authorised to work and agree on the common methodology. The outcome of this committee is the OIB Guidelines, whose contents are implemented in each of the

NATIONAL WEBSITE www.oib.or.at

[1] *Source: www.oib.or.at/de/guidelines/oib-richtlinie-6-nationaler-plan*

respective provinces' building regulations. The first guidelines were published in 2006, and the regulations of the Länder, according to these guidelines, entered into force in the first half of 2008. The new OIB Guideline 6 was published in June 2014[2].

The OIB Guideline 6[3] regulates the energy saving and heat retention of both residential and non-residential buildings. There are no specific regulations regarding public buildings, therefore, these buildings follow the same requirements as all non-residential buildings.

Non-residential buildings are divided into 13 categories: office buildings, kindergartens and schools, colleges and universities, hospitals, nursing homes, boarding homes, hotels, restaurants, event sites, sports facilities, retails, indoor swimming halls and other conditioned buildings. The OIB Guideline 6 deals mainly with the requirements on heating and cooling demand and final energy demand related to space heating and DHW, for new buildings and existing buildings undergoing major renovation. The U-values of the different building elements of new buildings or existing buildings in case of renovation (either major or smaller renovation, i.e. replacement of windows), are also defined in the OIB Guideline 6. The revision of the guideline in 2011 tightened the maximum U-values (Table 1).

The national plan on the minimum energy performance requirements of 2020 for NZEBs (new buildings) has been elaborated and implemented in almost all provinces. This plan also describes the minimum requirements for major renovations in case where the renovation measure is technically feasible, or accepted by the building law. In the latest published version of the national plan by OIB in March 2014, the requirements for the NZEBs (non-residential) are also defined.

In the past few years, a few of the Austrian standards (ÖNORM) regarding the total energy efficiency of buildings, including principles and verification methods for heating and cooling demand, were updated.

Table 1: Minimum requirements for U-values.

Building elements	U-value [W/m².K]
Exterior wall	0.35
Roof	0.2
Window	1.4
Floor	0.4

I.ii. Format of national transposition and implementation of existing regulations

The issued and amended OIB Guideline 6 on the minimum energy efficiency requirements and energy performance of buildings, including the calculation methodology, was revised at the end of 2011. With this, the technical transposition of the Directive 2010/31/EU was finalised. Its legal implementation started first in Carinthia at the end of 2012, while Vienna, Vorarlberg and Styria followed in January 2013, and Burgenland, Upper Austria, Tyrol and Lower Austria followed later. The implementation process was completed with the adoption of the building regulation in Salzburg, in October 2013.

Building requirements include in the calculation (among other relevant inputs): U-values for walls, infiltration, thermal bridges, thermal comfort and indoor air quality. These can be default values, but can be overruled by the real values if their exact calculation is available.

The minimum U-values set for building elements (walls, roof, floors and windows) were defined in the OIB Guideline 6, 2011. The same values will also apply for the NZEB 2020 buildings as well.

Calculation of indoor air quality (ventilation and ventilation rate) is treated differently in residential and non-residential buildings. In residential buildings, the air volume flow is calculated for either window ventilation (natural ventilation) or domestic mechanical ventilation with heat recovery. For non-residential buildings, the ventilation rate is based on the hygienically required air exchange and night air exchange through a HVAC system, or through window ventilation (natural ventilation) for cooling.

The ratio of infiltration or airtightness is given as a default value ('*Falschluftrate*': default air ratio) depending on the kind of ventilation chosen (natural or mechanical ventilation, with or without heat recovery) according to the Austrian standard ÖNORM EN 13829. According to this standard, the default air ratio depends on the results of the blowerdoor tests for three different levels of airtightness: existing buildings, new buildings and buildings at passive house standards level.

[2] *OIB Guidelines consist of a set of regulations for buildings with six parts and OIB Guideline 6 is the part setting requirements related with energy economy and heat retention in the buildings.*

[3] *www.oib.or.at/de/guidelines/oib-richtlinie-6*

The value for thermal bridges is also a default value given as a percentage of the whole heat loss, which is calculated according to the Austrian standard ÖNORM B 8110-6. An updated version of this ÖNORM standard is available since August 2014.

For the calculation of the buildings' performance, shading devices can be added; these are especially important to prevent overheating in the summer, according to the Austrian standard ÖNORM B 8110-3. Orientation of the windows and influence of the surroundings (e.g., trees and neighbouring buildings) are also considered in the calculation for the EPC. In the simple calculation, there are two different default values for shading coefficients (according to the Austrian standard ÖNORM B 8110-6): a) for single-family or terrace houses, and b) for other buildings.

I.iii. Cost-optimal procedure for setting energy performance requirements

There have been some studies on the cost-optimality of the energy performance requirements of NZEB 2020 buildings concerning both their construction and their life cycle.

The calculation of cost-optimality in order to define NZEBs 2020 was carried out by OIB in March 2013. This calculation was based on three surveys conducted by the Austrian Energy Agency (AEA), the *Energie Markt Analyse* (e7) and the Technical University of Vienna[4].

To calculate cost-optimality, virtual buildings were chosen, which represented four different building categories, namely:

> single-family house;
> multi-family house;
> multi-storey residential building;
> office or commercial building (non-residential building with natural ventilation).

Energy efficiency measures defined and applied to the buildings were divided in the following four groups:

> thermal characteristics of the building's envelope elements (walls, roof, floors and windows);
> type of heating, DHW system and Renewable Energy Sources (RES);
> set of parameters (residential and non-residential – new buildings and major renovations), e.g., regarding to the location, geometrical variations and age of the building;
> indoor air quality and other relevant comfort aspects.

The calculation of the cost-optimality included the calculation of space heating demand, primary energy demand, CO_2 emissions (according to the conversion factors in the OIB Guidelines, Table 2) and the total energy efficiency factor f_{GEE} (the relation between the final energy demand of the building and the final energy demand of the same building built in compliance with the requirements of 2007). It consisted of a comparison between the value of the energy savings achieved using the different improvement packages and the costs that are directly and indirectly related to those energy efficiency measures alone. This calculation included the predicted trends of inflation rate, estimated life and life cycle costs, energy prices, and taxes.

For major renovations, similar calculations were performed.

Based on these outcomes, the requirements for achieving NZEB levels – for both residential and non-residential buildings – were defined (see the tables for NZEB 2020 buildings).

According to the cost-optimality report, the cost difference on a monthly basis between the requirements in 2014 and NZEB 2020 is less than 1 €/m^2. In conclusion, the 2014 energy efficiency requirements can be classified as nearly cost-optimal. This is due to the low energy and the high investment costs for

Table 2: Table of factor conversion according to OIB Guideline 6, 2011.

Energy carrier	f_{PE} [-]	$f_{PE, n en}$ [-]	$f_{PE, ern}$ [-]	f_{CO2} [g/kWh]
Coal	1.46	1.46	0.00	337
Oil	1.23	1.23	0.01	311
Gas	1.17	1.16	0.00	236
Biomass	1.08	0.06	1.02	4
Electricity (Austrian mix)	2.62	2.15	0.47	417
District heating from renewable energy sources	1.60	0.28	1.32	51
District heating from non renewable energy sources	1.52	1.38	0.14	291
District heating from high efficient cogeneration (default value)	0.92	0.20	0.72	73
District heating from high efficient cogeneration (best value)	≥ 0.30	according to individual certification		

[4] *Source: http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm*

	residential building new		residential building major renovation		non-residential building new		non-residential building major renovation	
year	primary energy demand [kWh/m².year]	CO_2 [kg/m².year]	primary energy demand [kWh/m².year]	CO_2 [kg/m².year]	primary energy demand [kWh/m².year]	CO_2 [kg/m².year]	primary energy demand [kWh/m².year]	CO_2 [kg/m².year]
2014	190	30	230	38	230	36	300	48
2016	180	28	220	36	210	33	280	45
2018	170	26	210	34	190	30	260	42
2020	160	24	200	32	170	27	250	39

Table 3: Development of primary energy demand and CO_2 requirements for new and renovated residential and non-residential buildings until 2020 (NZEB).

the buildings. A new residential or non-residential building meeting the 2014 requirements and having an efficient heating system could already be considered as a NZEB 2020.

Improvement of the CO_2 emission reduction range of NZEBs and buildings meeting the 2014 requirements lies between 15% and 25%. A best practice example of a residential building can be seen in Figure 1.

Figure 1: Prize winning residential building in Vienna: A residential building with space heating demand 15.5 kWh/m².year, final energy demand 68.5 kWh/m².year, primary energy demand 132.6 kWh/m².year (including energy for heating, DHW and electricity for appliances), CO_2 emission 11.7 kg/m².year.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The Austrian NZEB is defined as an energy efficient building with a good thermally insulated envelope and an environment-friendly heating system, which is not attached to a specific building concept, e.g., 'Passive House'.

The first draft of the Austrian national plan on NZEBs was published in 2012. This document was agreed on by the majority of the provinces and included minimum standards for four energy indicators for residential buildings. NZEBs are thus defined by four indicators or parameters:

> space heating demand (kWh/m².year);
> primary energy demand (kWh/m².year);
> CO_2-emissions (kg/m².year);
> total energy efficiency factor f_{GEE}.

The national plan indicates a stepwise tightening of the requirements towards 2020 (in 2014, 2016, 2018, and 2020). The revised document containing the minimum requirements for non-residential buildings was published in March 2014. The minimum requirements for the energy performance of NZEBs are shown in the Tables 4 - 7, for new and major renovations of residential and non-residential buildings. Compliance with these requirements can be achieved by two methods:

> through tightened requirements on space heating demand (HWB), which means better building envelope in order to reduce the heating/cooling energy needed, and not considering the f_{GEE}. This is reflected in the formula for NZEB 2020 buildings 10x(1+3/lc) where lc is the characteristic length (usually known as the building's 'shape factor');
> through installation of a more energy efficient technical system for heating and DHW. The total energy efficiency factor (f_{GEE}) reflects the type of energy use and production (the target space heating demand of this building is calculated with the following formula: 16x(1+3/lc).

In both cases, the maximum values for primary energy demand and CO_2 emissions are defined.

The minimum energy performance requirements on these four indicators are related to the Austrian reference climate.

Figures and statistics on existing NZEBs

In the past ten years, there have been considerable efforts to reduce energy consumption in the building sector. Implementation of new building regulations relating to the energy demand of buildings, as well as subsidies for energy efficiency measures in new buildings and renovations, prove the intensity of these efforts. Promoting energy efficient constructions, e.g., at the 'Passive House' level with very low space heating demand, or other certifications, has contributed to an increase in the number of buildings with low energy consumption. There are, however, no statistics on the number of buildings meeting the NZEB 2020 requirements. Nevertheless, an IEE-supported project in 2014 showed that about 30% of the buildings which have been renovated between 2010 and 2014 through subsidies in the province of Salzburg could be considered as NZEBs.

Subsidies for high energy efficiency of residential buildings will be continued in the future. This is an agreement between the federal government and the provinces.

Table 4:
Minimum energy performance requirements for new residential buildings NZEB 2020. Source: OIBGuidelines; Guideline 6, National Plan Draft, March 2014.

	HWB_{max} [kWh/m².year]	EEB_{max} [kWh/m².year]	$f_{GEE,max}$ [-]	PEB_{max} [kWh/m².year]	CO_{2max} [kg/m².year]
2020	$10 \times (1 + 3.0 / \ell_c)$	using $HTEB_{Ref}$		160	24
	or				
	$16 \times (1 + 3.0 / \ell_c)$		0.75		

Table 5:
Minimum energy performance requirements for new non-residential buildings NZEB 2020. Source: OIB Guidelines; Guideline 6; National Plan Draft, March 2014.

	HWB_{max} [kWh/m³.year]	EEB_{max} [kWh/m².year]	$f_{GEE,max}$ [-]	PEB_{max} [kWh/m².year]	CO_{2max} [kg/m².year]
2020	$3.33 \times (1 + 3.0 / \ell_c)$	using $HTEB_{Ref}$		170	27
	or				
	$5.50 \times (1 + 3.0 / \ell_c)$		$f_{GEE,DLGneu,max}$		
	$f_{GEE,DLGneu,max}$ ... These values are the result of a stricter space heating demand and the use of reference technical equipments for energy supply.				

Table 6:
Minimum energy performance requirements for existing residential buildings in case of major renovation NZEB 2020. Source: OIB Guidelines; Guideline 6; National Plan Draft, March 2014.

	HWB_{max} [kWh/m².year]	EEB_{max} [kWh/m².year]	$f_{GEE,max}$ [-]	PEB_{max} [kWh/m².year]	CO_{2max} [kg/m².year]
2020	$17 \times (1 + 2.5 / \ell_c)$	using $HTEB_{Ref}$		200	32
	or				
	$25 \times (1 + 2.5 / \ell_c)$		0.95		

Table 7:
Minimum energy performance requirements for existing non-residential buildings in case of major renovation NZEB 2020. Source: OIB Guidelines; Guideline 6; National Plan Draft, March 2014.

	HWB_{max} [kWh/m³.year]	EEB_{max} [kWh/m².year]	$f_{GEE,max}$ [-]	PEB_{max} [kWh/m².year]	CO_{2max} [kg/m².year]
2020	$5.67 \times (1 + 2.5 / \ell_c)$	using $HTEB_{Ref}$		250	39
	or				
	$8.50 \times (1 + 2.5 / \ell_c)$		$f_{GEE,DLGsan,max}$		
	$f_{GEE,DLGsan,max}$ ... These values are the result of a stricter space heating demand and the use of reference technical equipments for energy supply.				

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

According to Article 4 of the Directive 2012/27/EU (Energy Efficiency Directive - EED), Member States (MSs) have to set energy efficiency targets in their respective countries. In April 2014, the first Austrian National Energy Efficiency Action Plan (NEEAP) was published, in line with the EED.

This plan describes the way towards increasing energy efficiency and standardising the energy efficiency regulations in Austria until 2020. According to this plan, the demand for energy efficient services should be increased (energy suppliers should provide energy efficient measures and services), while energy consumption should be reduced, and the demand for nuclear energy should be pushed back. Furthermore, the energy costs for households should be reduced and the fight against energy poverty should be enforced. The government has to set an example of implementing energy efficiency in publicly-owned buildings. Through these measures, the government aims to reduce energy consumption by 20% compared to 2007 (equivalent to 1,100 PJ)[5] .

The Austrian NEEAP 2014 was developed by the Federal Ministry of Science, Research and Economy, together with the Austrian provinces. The measures for the

[5] *Source: http://www.bmwfw.gv.at/EnergieUndBergbau/SicherheitImBergbau/Documents/NEEAP%2030042014.pdf*

building sector are focused on the following categories:

> subsidies for residential buildings, e.g., renovation subsidy *Sanierungscheck*. For 2015, the subsidy is up to 30% of the investment in energy efficiency, e.g., insulation of the building envelope;

> subsidies for district heating, e.g., heat transfer station;

> operational and environmental subsidy schemes for companies in Austria;

> energy efficiency measures in building regulations, e.g., definitions in the OIB Guidelines regarding energy efficiency.

According to Article 5 of the EED, MSs have to renovate 3% of the total floor area of heated and/or cooled buildings owned and occupied by their central government each year until 2020. In a report prepared by the Ministry of Science, Research and Economy in December 2013, based on a survey on the Austrian public buildings (> 788,000 m² used area owned and used by the central government), 48,145 MWh of energy will be saved until 2020. In this survey, all buildings with more than 250 m² total useful floor area have been considered. In Austria, this goal could be reached by:

> energy contracting (amount of energy saved: 8 GWh);

> implementation of Energy Management Systems (amount of energy saved: 0.5 GWh).

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The minimum requirements for heating, cooling, DHW and large ventilation systems are defined in the OIB Guideline 6, 2011, and are based on the Austrian standards ÖNORM H 5056 (updated in August 2014), H 5057, H 5058, H 5059 and ÖNORM EN 13829. The use of highly efficient alternative energy systems (systems with renewable energy use, cogeneration systems, district heating / cooling with high efficiency -as long as they are available on-site- and heat pumps) is required for both new buildings and major renovations.

In residential buildings, with some exceptions, there should generally be a central communal heating system if there are more than 3 apartments or units in the building.

The OIB Guideline 6, 2011 also specifies the requirements for parts of the building's technical systems, as follows:

Heat distribution: There are minimum insulation requirements, which should be implemented in case of new buildings, as well as in replacements or major repairs of the heat distribution systems and hot water pipes, including fittings.

Heat recovery: Ventilation systems have to be combined with heat recovery measures in case of new buildings, new installations in existing buildings, or major repairs.

Ventilation systems: There are minimum requirements for specific electrical consumption (specific fan power) for ventilation systems, according to the ÖNORM H 5057, which should be met in case of new buildings, as well as in replacements or major repairs of the ventilation systems displayed in Table 8.

Minimum requirements for systems in order to receive subsidies have been defined in the provinces.

Some of the Austrian provinces require production of DHW in the residential building sector (new buildings) through solar thermal plants or other RES, e.g., in Styria, the production of DHW for new buildings in the summer should be performed through solar thermal plants or other RES, as well as through district heating from RES.

II.i. Encouragement of intelligent metering

In Austria, metering is one of the regulated activities of the electricity distribution system operators (DSOs). The majority of

Table 8: Specific fan capacity of ventilation systems in Austrian standard (ÖNORM) H 5057 following Austrian standard ÖNORM EN 13779.

	specific capacity P_{SFP} in W/(m³/s)		
	inlet air, fully air-conditioned	inlet air, ventilation system	exit air
single device	< 500	< 500	< 500
single-family house, multi-family house without central ventilation system	≥ 500 to 750	≥ 500 to 750	≥ 500 to 750
multi-family houses	> 1,250 to 2,000	> 750 to 1,250	> 750 to 1,250
non-residential building ≤ 15,000 m² GFA	> 3,000 to 4,500	> 2,000 to 3,000	> 2,000 to 3,000
non-residential building > 15,000 m² GFA	> 4,500	> 3,000 to 4,500	> 3,000 to 4,500

the 5.8 million metering points are still equipped with conventional electromechanical meters. Since the full liberalisation of the electricity market in 2001, about 30,000 customers with an annual consumption of more than 100,000 kWh and a power rating of more than 50 kW have been equipped with intelligent meters.

In an amendment to the Austrian Electricity Act (ElWOG) in 2011, the Minister for Economy was authorised to determine a mandatory rollout plan for intelligent electricity meters. In 2012, a Smart Metering Landscape report was developed in the context of the EU-funded project Smart Regions. Because of the unclear legal framework for the rollout of intelligent meters, Austria was assessed as an 'ambiguous mover' in this report[6].

In 2012, the Minister enacted a decree which obliges DSOs to install intelligent meters according to the following timeframe:

> 10% of all customers until the end of 2015;

> 70% of all customers until the end of 2017;

> 90% of all customers until the end of 2019.

There are additional decrees of the Energy Regulatory Authority (E-Control Austria) which specify, e.g., the technical requirements of intelligent meters.

By the end of 2014, the majority of the Austrian DSOs was in an early rollout stage. In the first rollout projects and in other pilot projects there are about 200,000 customers who already use intelligent meters.

Many DSOs provide information to their end users through their websites or by contacting them directly.

II.iii. Encouragement of active energy-saving control (automation, control and monitoring)

In many Austrian provinces, there are subsidies for energy efficiency related measures for buildings – e.g., for the building envelope and heating system. There are also subsidies set by the federal government for energy efficiency measures, such as the '*Sanierungsscheck*' (renovation cheque). These could be used for heating systems, e.g., biomass heating, heating system inspection and heat pumps, as well as for solar energy use, e.g., solar collectors, photovoltaics and energy storage. However, these measures are not obligatory.

Salzburg, for example, provides a cost-free online energy accounting for building owners and managers, encouraging them to enter the real energy consumption of the building, and have an annual or monthly overview on its energy use. This way, the energy consumption of buildings can be monitored both by the owner and by the province. There are over 275 buildings in this programme.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

Issuing an EPC is mandatory since 1 January 2006, when purchasing or renting a building or a building unit in a residential or non-residential building, at the stage of applying for the building permit. The EPC is valid for ten years. Providing or presenting an EPC is binding through the federal law *Energieausweis-Vorlage-Gesetz* (EAVG). In December 2012, this law was tightened by foreseeing a penalty in case an EPC is not provided by the owner.

In Austria, the issuing of EPCs is performed by a person or entity authorised according to the relevant regulations of the trade, or by a person qualified through cooperation between building trades, e.g., building constructors, electricians, building technicians, and architects. These persons receive their trade's license by authorities in the Länder. However, there is no official list of EPC assessors in Austria. Furthermore, up to now, there are no national databases for EPCs (a national database is under construction).

Nevertheless, there are a few regional databases where the EPCs are registered, monitored and used for evaluations and subsidies, as well as for statistical matters. The EPC data in these databases is available only to the authorities of the provinces and the property owner. Extracts of EPC data not containing personal details can be used by research institutes or universities for surveys.

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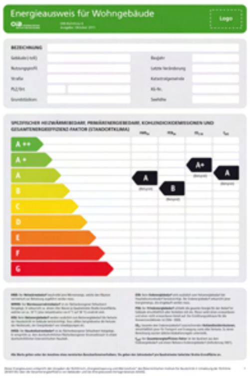
[6] *Regulation and implementation of smart metering in Europe:*
www.energyagency.at/aktuelles-presse/news/detail-archiv/artikel/oesterreich-stellt-weichen-fuer-smart-metering.html

How flats are certified in apartment buildings

All apartments or building units, as well as the whole building, should have an EPC at the point of rent or sale. In case of selling or renting an apartment in the building, only the EPC of the specific apartment needs to be produced.

Figure 8: Frontpage of the suggested EPC by OIB Guideline 6. 'Energieausweis für Wohngebäude' means: EPC for residential buildings. Source: OIB Guidelines, 2011 www.oib.or.at/en/oib-guidelines.



Format and content of the EPC

EPCs are issued for residential and non-residential buildings. Their format and content is described in the OIB Guideline 6.

Different provinces use different formats of EPCs, with specific indicators used for labelling the building. The OIB Guideline 6 recommends the use of four indicators on the cover page of the EPC, but every Austrian province may use other indicators in labelling, according to its own regulation (e.g., the Province of Lower Austria only indicates the space heating demand on the front page). An example of an EPC's front page as described in the OIB Guideline 6, 2011, where all four indicators are shown, is as follows:

> space (useful) heating demand (HWB) in kWh/m².year;
> primary energy demand (PEB), in kWh/m².year for residential, and kWh/m³.year for non-residential buildings;
> CO_2 emissions in kg/m².year;
> total energy efficiency factor f_{GEE}.

There are nine labelling categories, ranging from G (lowest rating) to A++ (highest rating). The value limits for each labelling category are shown in Table 9.

All other relevant indicators, e.g., final energy demand, energy for DHW and electricity, are displayed on the other pages of the EPC.

EPC activity levels

Since there is no national or central EPC database in Austria yet, the number of issued EPCs can only be estimated from the information regarding subsidy activities of the Länder, the ZEUS-Database and the Federal Real Estate Company (*'Bundesimmobiliengesellschaft' - BIG*), which rent buildings mainly to the government administration and educational sector. There are 112,000 EPCs (25,500 of which are from Styria) registered in the ZEUS-Database, covering the Länder Salzburg, Carinthia, and Styria (Source: Gizmocraft 25.09.2014). According to BIG, 99% of the buildings they manage have an EPC.

Until 2011, the percentage of the issued EPCs for buildings was estimated at 20% of the building stock[7]. There are more than 2.19 million buildings in Austria.

A total of 40,220 EPCs were registered in 2013 in the ZEUS-Database. More than 2,820 EPCs were issued for existing buildings after renovation. The total number of issued EPCs is, of course, higher, but precise numbers are not known.

Table 9: Energy label scale in Austria (according to OIB Guideline 6, 2011).

Label	$HWB_{Ref,SK}$ [kWh/m².year]	PEB_{SK} [kWh/m².year]	CO_{2SK} [kg/m².year]	f_{GEE} [-]
A++	10	60	8	0.55
A+	15	70	10	0.70
A	25	80	15	0.85
B	50	160	30	1.00
C	100	220	40	1.75
D	150	280	50	2.50
E	200	340	60	3.25
F	250	400	70	4.00
G	> 250	> 400	> 70	> 4.00

Typical EPC costs

The costs of preparing an EPC depend on the building's size or configuration. For existing buildings, cost could range from 150 € for a small building, up to 2,000 € for a building size of around 2,500 m². For new buildings, the range is between 150 € for a small building and 4,000 € for a 5,000 m² apartment building. The average cost for single-family houses is between 300 € and 500 €. The cost averages 1 €/m² for larger buildings (with a living area over 1,000 m²)[8].

Assessor corps

As mentioned before, the issuing of EPCs in Austria is performed by a person or entity authorised according to the relevant trade regulations. Training courses for the calculation of EPCs are on a voluntary basis.

Enforcement with building owners and real estate actors

Since 2006, a copy of the EPC has to be presented by the owner at the point of sale or rent. The EAVG law was revised in 2012 and a penalty was foreseen in case of infringement, which could be up to 1,450 €. This administrative penalty is imposed by the city's authorities. No penalty has been imposed until the end of 2014.

Quality Assurance (QA) of EPCs

On a regular basis, the Austrian provinces conduct random automated EPC control checks. In 2013, 11,039 EPCs were checked[9].

[7] *Source: www.epbd-ca.eu/product/austria, 25.09.2014*
[8] *Source: www.wkimmo.info/i/wko/service/leporello_energie.pdf, 18.03.2015*
[9] *Source: http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/certificates-and-inspections, 18.03.2015*

The EPC databases (e.g., the ZEUS-Database) perform automatic EPC data entry checks and produce 'test protocols'. EPCs with incorrect data are not included in statistical evaluations. The EPC assessor is liable for the correctness of the EPC. Incorrect EPCs of buildings with application for subsidies have to be recalculated. The municipalities help the assessor to enter the correct data in the EPC database. There is no record of any penalty ever having been imposed and it is unclear who can issue them, the federal government or the provinces.

A few provinces started implementing an independent control system for regulations and certifications –controlling the measures needed for subsidies– after the transposition of Directives 2002/91/EC (in 2008) and 2010/31/EU (in 2012). They set up an EPC central database to monitor subsidy activities (‘*Wohnbauförderung*’: subsidy for residential buildings). A central national database ‘Building and apartment registration: *Gebäude- und Wohnungsregister (GWR)*’ is under preparation; all EPC data will be collected in this database. Thus, installing a common quality management system will be possible for all provinces.

III.ii.Progress and current status on public and large buildings visited by the public

Overview

In 1992, the management and administration of public buildings (federal buildings) was to a large extent transferred to the newly established Federal Real Estate Company (‘*Bundesimmobiliengesellschaft - BIG*’). These 2,800 buildings cover an area of about 7 million m². A minor share of public buildings is still directly owned by the central government (see section 2.I.v., Implementation of the EED)[10]. According to the 2013 sustainability report of BIG, 40% of the buildings are schools, 25% are offices and apartment buildings, 23% are universities and 12% are other buildings with specific use. Of these buildings, 99% already have an EPC. An average of 500,000 people visit these buildings every day.

All public buildings have EPCs, but the buildings displaying them are mainly public buildings owned by the public authorities and visited by the public, including the buildings managed by BIG. Displaying the front page (label) of the EPC in buildings frequently visited by the public is mandatory, but there is no enforcement for displaying the whole EPC in these buildings.

Format and content of the EPC

The format and content of the EPC for public buildings is defined in the OIB Guideline 6, and follows the same methodology as the EPC for non-residential buildings. EPCs for public buildings are aimed to be registered in the EPC monitoring system (‘*Gebäude- und Wohnungsregister*’).

Frequency of updating

Issued EPCs for non-residential buildings must not be older than ten years, as is the case for the EPCs for residential buildings.

Activity levels

Ninety nine percent (99%) of the buildings managed by BIG have an EPC. According to BIG's 2013 sustainability report, 28% of public buildings are rated A or B, 46% are rated C and the rest (25%) are rated D or lower.

III.iii. Implementation of mandatory advertising requirement

Since 2012, if a building or building unit is advertised (either in print or online) for sale or rent, the space heating demand (in kWh/m².year) and the total energy efficiency factor (f_{GEE}) should be provided. In almost all advertisements, in newspapers or online, the space heating demand is indeed indicated, while the indication of the total energy efficiency factor is rare and is sometimes replaced by other indicators, e.g., final energy demand. In § 9 of the EAVG 2012 (the federal law for providing EPCs), a penalty of up to 1,450 € is foreseen for not including the required energy indicators in advertisements, but there is no record of any penalty having been imposed until the end of 2014 (it is unclear which authority issues fines, the federal government or the provinces).

Since the awareness for energy efficiency and EPCs is developing slowly, and the market need for apartments is high, the inclusion of energy indicators or energy issues in advertisements, especially for rental buildings or building units, is not a priority for the market. Consumers concentrate more on other qualities of the property.

[10] *Source: http://www.big.at/fileadmin/user_upload/Media/01_Ueber_uns/Nachhaltigkeit/Nachhaltigkeitsbericht_2013_Creimer.pdf*

III.iv. Information campaigns

As mentioned before, in some Austrian provinces, EPCs have been issued for buildings (for granting subsidies) for many years and are therefore well known. But since the introduction of the Directive 2010/31/EU, comprehensive efforts have been undertaken to provide information both to the public and to professionals, at energy and building exhibitions, congresses and competitions.

In Austria, a large number of new buildings and major renovations, especially in the residential sector, are financially supported by subsidy programmes (‘*Wohnbauförderung*’: residential building subsidy) provided by all nine Länder. The conditions under which these subsidies are granted include tighter requirements for building quality, also in terms of better energy performance, i.e., buildings with lower space heating demand and lower greenhouse gas emissions.

In the Austrian residential building subsidy scheme, one of the main criteria is the thermal quality of the building, which is evaluated through the EPC. Since 2009, e.g., there has been a federal support every year for the private residential renovation sector (‘*Sanierungsscheck*’: renovation cheque), aiming at the thermal envelope and heating system of buildings which are 20 years or older. In 2014, this subsidy covered 30% of the costs related to the energy improvement of the building, up to 6,000 € for the thermal envelope and 2,000 € for replacement of the heating system. The use of environment-friendly solutions, e.g., insulating or use of renewable energies for heating system, could receive subsidies of up to 500 €.

Figure 9: Exhibition folder of the building, energy and living in Tulln, 2015.

In the renovation campaign of 2014 (*Sanierungscheck* 2014), the requirements for, e.g., space heating demand, are 14% to 43% less than the requirements defined in the OIB Guideline 6, 2011. The building's EPC before the renovation and with recommended measures is one of the main documents to be submitted when applying for the grant.

The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management’s ‘*klimaaktiv*’ initiative ‘*Bauen & Sanieren*: building and renovation’ (launched in 2008) is the main promoter of energy efficiency in buildings in Austria. Since 2012, the yearly granted state prize for architecture and sustainability is awarded to outstanding achievements in energy efficient buildings.

III.v. Coverage of the national building stock

There are about 2,191,280 buildings in Austria[11]; more than 217,300 are non-residential buildings. Since there is no national database to collect information on the EPCs of buildings yet, the exact percentage of buildings with EPCs cannot be provided. However, based on the known number of EPCs issued (143,800 including ZEUS, Vorarlberg and BIG), as well as on information from the real estate market, it is estimated that 20% of the available buildings have EPCs.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

According to the agreement[12] between the federal states of Austria relating to Articles 14 and 15 of Directive 2010/31/EU regarding on-site inspections of heating and air-conditioning (AC) systems, these systems have to be regularly inspected and their emissions have to be monitored. Inspection regulations are available in the provinces, and the inspection reports are being uploaded in the databases where available.

IV.i. Progress and current status on heating systems

In Austria, there is a long tradition of boiler inspection concerning the coefficient of performance and emissions, but this does not correspond to the requirements of the EPBD. This well-established system would have to be changed without loosening the former requirements for emission reduction, which are considered equally important for boiler efficiency. The process of change is ongoing.

Overview, technical method and administration system

A new inspection report, including both traditional data and data corresponding to

[11] *Statistik Austria, census 2011: Source: https://www.statistik.at/web_de/statistiken/menschen_und_gesellschaft/wohnen/wohnungs_und_gebaeudebestand/index.html*

[12] *Vereinbarung Art. 15a B,-VG;Kleinfeuerungen, Feuerungsanlagen und Blockheizkraftwerk*

Article 16 of Directive 2010/31/EU, has been developed and tested in the EU project MOVIDA. The Länder have already introduced a relevant legislative part in their building codes or other laws, taking into account the additional requirements.

This model of inspection is being regularly updated.

Arrangements for assurance, registration and promotion of competent persons

Austria has a so-called 'profession law', which automatically provides the right to perform an inspection by those who have a certain technical degree: usually, for professionals with a three year degree, after they complete additional educational training, that is adjusted to their specific profession, and, for engineers and architects with a five year degree[13], after they have at least three years of practice. There are also voluntary trainings for professionals aiming to update their knowledge in the respective field.

Promotional activities

Promotion of heating systems inspection had usually been provided by inspectors, as well as by different activities of the provinces, e.g., through mailing information and brochures, but since the inspection has become mandatory by law, the promotional activities are decreasing. Currently, the '*klimaaktiv Heizungs-check: klimaaktiv heating system inspection*' campaign provides inspection for existing heating systems, as well as information on energy savings through modernisation and optimisation.

Enforcement and penalties

Up to now, no sanctions are foreseen for non inspection of heating systems (including boilers).

Quality control of inspection reports

According to the building regulations of the provinces, the inspection of HVAC systems should be performed by a technical expert. The expert records the inspection in the form of an inspection report, including recommendations for improvement, and registers it on the database when available. These reports are examined by the authorities of the province.

Inspection activity figures

In 2013, 203,587 independent inspections for heating and AC systems took place. These reports are registered in the regional databases.

Impact assessment

The impact of emission control had widely influenced the quality and thus the efficiency of boilers. Efficiency of boilers could be raised from around 50% or 60% to more than 90% for biomass boilers (replacing simple stove-like technology by ventilation supported burners for solid biomass, and by fully automatic wood chip and pellet burners), from around 75% to more than 95% for fuel oil and natural gas boilers (replacing most atmospheric burners by condensing ones, especially when using natural gas). An additional effect of Article 16 of Directive 2010/31/EU may concern other elements, e.g., storage, pumps and insulation, probably to a very limited extent, since these are also regulated by current standards.

Costs and benefits

Inspection costs range between 150 € for simple systems and 1,160 € or more for more complex systems[14]. There have been no studies comparing the costs and benefits of heating systems inspections yet.

Table 10:
Regulatory framework of Austrian provinces regarding the inspection of heating systems.

Province	Time intervals
Burgenland *(Burgenland)*	1-year interval: < 50 kW old 2-year interval: > 50 kW old 3-year interval: < 26 kW new
Kärnten *(Carinthia)*	diff. intervals : > 20 kW according to the type of fuel
Niederösterreich *(Lower Austria)*	3-year interval: between 6 and 50 kW 1-year interval: > 50 kW
Oberösterreich *(Upper Austria)*	3-year interval: < 15 kW 2-year interval: between 15 and 50 kW 1-year interval: > 50 kW
Salzburg *(Salzburg)*	diff. intervals: > 20 kW according to the type of fuel
Steiermark *(Styria)*	1-5 year intervals: > 8 and > 50 kW according to the kind of fuel
Tirol *(Tyrol)*	1-5 year intervals: according to the type of fuel
Vorarlberg *(Vorarlberg)*	2-4 year interval: according to the type of fuel for > 100 kW < 15-year interval: > 20 kW
Wien *(Vienna)*	1-year interval: > 50 kW 2-year interval: > 15 kW 5-year interval: > 15 and < 26 kW (gas)

[13] *In Austria one always needs a certain period of practice after school plus an exam to be able to become a professional, e.g., an architect.*
[14] *Source: www.wien.gv.at/recht/landesrecht-wien/rechtsvorschriften/html/b4400550.htm, 30.1.2015*

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

Inspection of AC systems is within the competence of the regulatory framework of each of the nine Austrian provinces; therefore, there are slight differences among them. The common inspection intervals are one, three, five or twelve years, or a combination, depending on the scope of the inspection and the type and size of the system. In all nine provinces, AC systems with over 12 kW total rated output in a building (refrigerating capacity) have to be inspected. Table 11 displays the intervals of the inspections (Table 10).

Inspections are carried out according to the Austrian standards ÖNORM EN 15240 (for AC systems) and ÖNORM EN 15239 (for ventilation). The Austrian standard ÖNORM H 6041 on the energy efficiency of AC systems is being developed.

Arrangements for assurance, registration and promotion of competent persons

Qualification of the experts carrying out inspections is based on the Austrian trade law, which allows experts having a trade license for planning, installing, modifying, maintaining and auditing AC systems, to carry out the inspection. The auditing entities, public authorities and engineering firms with relevant competence can also conduct inspections.

Promotional activities

In some of the Länder, advanced courses for professionals are provided in order to raise the quality of inspections. These courses are not mandatory; experts participate on a voluntary basis.

In other cases, the regional governments provide information to inspectors.

Table 11: Regulatory framework of Austrian provinces regarding the inspection of AC systems.

Province	Time intervals
Burgenland *(Burgenland)*	3-year interval: > 12 kW
Kärnten *(Carinthia)*	3-year interval: > 12 kW 5-year interval: > 12 kW
Niederösterreich *(Lower Austria)*	5-year interval: > 12 kW
Oberösterreich *(Upper Austria)*	1-year interval: > 50 kW 3-year interval: between 12 and 50 kW
Salzburg *(Salzburg)*	diff. intervals: > 12 kW
Steiermark *(Styria)*	1-year interval: > 12 kW 3-year interval: > 12 kW 12-year interval: > 12 kW
Tirol *(Tyrol)*	5-year interval: > 12 kW
Vorarlberg *(Vorarlberg)*	3-year interval: > 12 kW
Wien *(Vienna)*	3-year interval: > 12 kW 12-year interval: > 12 kW

Enforcement and penalties

Enforcement of AC inspections is not yet implemented. There are no penalties for non-inspection of AC systems yet.

Quality control of inspection reports

The provinces are responsible for compliance and control of AC system inspections. Quality management systems will be introduced, together with databases for AC inspections; these are still under construction. In some of the provinces, the heating and AC databases will be linked to the EPC database (e.g., ZEUS-Database[15], see also the success story below). Until the end of 2014, independent controls of AC inspection reports have taken place.

Inspection activity figures

In Austria, up to 30% of non-residential buildings (the number of non-residential buildings is > 135,000) and less than 2% of residential buildings (the number of residential buildings is > 1.5 million) have AC systems. Inspection reports of HVAC systems can be uploaded on the inspection databases provided by regional municipalities. The number of inspections concerning only AC systems is not exactly known in every province; however, in 2013 and 2014, around 400 inspections fulfilling the requirements of the Directive 2010/31/EU had been performed in Upper Austria, Styria and Vienna. A common inspection report is still under development and will be introduced in 2015 in all provinces, due to the fact that the latest relevant regulatory frameworks will have to be introduced within this year.

Costs and benefits

Inspections of all AC systems have to be paid by the end user or building owner. The inspection cost depends on the size and complexity of the system (between 150 € for simple systems and 1,160 € or more for more complex systems). Inspections could show the potential for the system's energy efficiency and reduce the maintenance costs. So far, there are no studies comparing the costs and the benefits of AC systems inspection, but Austria has taken part in the European projects dealing with benchmarking HVAC systems.

[15] www.energieausweise.net/homepage/

3. A success story in EPBD implementation

Austria has a long tradition of governmental support in the form of subsidies in the building sector, for both new constructions and renovation activities. The subsidy programme called '*Wohnbauförderung*' (subsidy for residential buildings), aiming to help Austrian citizens have an affordable dwelling, is about hundred years old. In recent years, implementing energy saving measures on the building's thermal envelope and energy supply system has become more important. This makes the building's EPC one of the main documents that have to be provided for receiving subsidies for renovation, both before and after the implementation of the renovation measures.

After the publication of the Directive 2002/91/EC, three Austrian Federal States, Carinthia, Salzburg and Styria, joined together in simplifying the administration of EPCs. Together, they developed an EPC database in 2007 (ZEUS[16]). ZEUS-Database was designed as an internet application and was used for registering and saving EPCs, as well as for analysing the available data for different monitoring activities. The database is still used intensively by EPC assessors and building authorities. It is also the largest and most relevant EPC database in Austria. The database is also used by research institutions, as well as for monitoring the building stock. Statistics regarding the development of some of the energy indicators are provided on the website mentioned earlier[17].

All EPCs of buildings receiving subsidies from the provinces (Carinthia, Salzburg and Styria) are registered in this database. Through this common central recording and electronic file processing EPC database, it is not only ensured that the data is transmitted to the person or administration responsible, but also that the building owner can have access to all EPC versions (before and after renovation).

Since April 2013, this database has been extended by an energy accounting programme for private building or home owners, communities, and building developers and managers. By entering data on a regular basis, building owners can check the energy performance of their buildings.

In some Länder, e.g., Salzburg, in order to be able to receive subsidies for heat pumps and photovoltaics, the applicant needs to enter the data on the energy production of these appliances in the energy accounting programme. The recording of the amount of energy a building needs or produces (e.g., electricity produced by heat pumps, photovoltaics, or solar thermal plants) in the energy accounting system, constitutes important information for policy makers, in order to design a more accurate roadmap for the future steps in order to reach the climate protection targets.

An important and effective action which could lead to energy efficiency in the building sector is supporting the building owner or tenant through consultancy by energy experts. Energy experts create awareness about the building's energy performance and provide the energy efficiency related amortisation of the needed investments. The province of Salzburg, e.g., provides trained experts (1.5 hours of consultation free of charge) who visit homes and advise the owners on the kind of renovation measures that are needed. Information on energy efficiency measures collected in these home visits is also uploaded in the database.

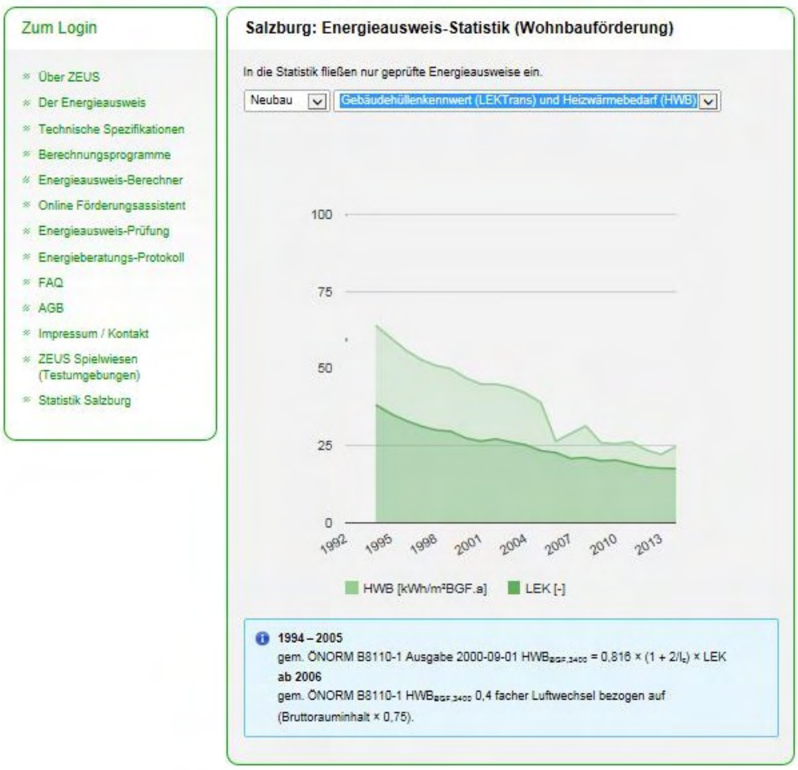


Figure 4: Example of statistics on space energy demand Land Salzburg. Example: the development of space heating demand for new buildings[18].

[16] *www.energieausweise.net/homepage/?cmd=about*

[17] *www.energieausweise.net/statistik-salzburg*

[18] *Source: www.energieausweise.net/homepage/?cmd=statistic, 12.08.2014.*

By collecting the data of the registered EPCs, the information can not only be used for a better overview on the energy use of the building stock, but also for developing strategies for ensuring sufficient energy supply and energy saving measures.

Energy efficiency is one of the main issues in Europe's 2020 strategy for a smart and sustainable economy. A key element to have an overview of the energy consumption is to establish a relevant monitoring system. The established ZEUS-Database is the important first step to have a holistic overview of the energy performance of buildings in Austria.

4. Conclusions, future plans

Austria has taken many steps to fulfil the requirements set out by the European Directives 2002/91/EC and 2010/31/EU (EPBD). The national implementation of the EPBD and attaining the Austrian climate protection goals determine important ecological conditions for buildings, either newly built or renovated. Comprehensive launching of EPCs and subsidies for environment-friendly measures for single- and multi-family houses support the achievement of those goals. The increase of energy prices, especially for fossil fuels, shows how important it is to have comparable and reliable information on buildings' energy costs. This makes the use of renewable energy carriers essential, both in renovations and in construction of new buildings. This way, energy efficient buildings will have a clear market advantage in the future. It is therefore very important to ensure that all stakeholders, consumers and professionals, have access to information and tools in order to comply with the requirements for energy efficient buildings.

The majority of the articles of the Directive 2010/31/EU have been implemented in the building regulations of all Austrian provinces or Länder. The definition of NZEBs for 2020 for residential and non-residential buildings has been published in the national plan, which contains the minimum requirements for new buildings, and describes the minimum requirements for major renovations when the renovation measure is technically feasible or accepted by the building law. This will allow different approaches for an energy efficient building. Implementation of the Directive 2010/31/EU in building regulations regarding the inspection of HVAC systems is completed, and reports on these activities are recorded in the available databases. Data evaluation can help municipalities have an overview on the impact of regular inspections.

A specific national database, the '*Gebäude- und Wohnungsregister*' (GWR), where all EPC data is going to be registered, is under preparation. Thus, installing a common quality management system will be possible for all provinces.

Implementation of the EPBD in Belgium

STATUS IN DECEMBER **2014**

Brussels Capital Region

1. Introduction

The implementation of the Energy Performance of Buildings Directive (EPBD) in Belgium is a regional responsibility. In the Brussels Capital Region, the EPBD is under the combined responsibility of the regional Minister of Energy and the regional Minister of Environment.

The first EPB ordinance[1] dates from June 2007; some minor changes were introduced in May 2009 and in February 2011. In May 2013, this ordinance was replaced by the ordinance on the Brussels Air, Climate and Energy Code (COBRACE), which reorganises and integrates Brussels' legislation in the areas of air, climate and energy, and fully transposes the 2010/31/EU Directive. COBRACE revises the established procedures to facilitate the work of professionals in the sector of building energy efficiency, defines the concept of Nearly Zero-Energy Buildings (NZEBs), highlights the exemplary role of the public authority buildings and extends the use of Energy Performance Certificates (EPCs). COBRACE also integrates the energy performance of buildings into a broader legal, environmental and energy framework. Indeed, going beyond the EPBD, COBRACE expresses the intention to reduce the energy and environmental impact of the building sector as a whole.

2. Current status of implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

The energy performance requirements have been mandatory for buildings for which a building permit has been requested since July 2008. The applicable energy performance requirements are on primary energy consumption, insulation level, ventilation rate, overheating, technical installation, etc., and are different for new buildings, major or simple retrofits, and existing buildings.

Only the new units[2] or units assimilated to new buildings[3] which are designated as individual housing units (houses and apartments), offices and service buildings, or educational buildings have to respect all the energy performance requirements. These 3 types of units constitute the greater part of the building sector in the region, with a very significant share accounting for housing. Units similar to new buildings are governed by the same requirements as new units, but have 20% more flexibility on some requirements.

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[1] *Moniteur Belge: Ordonnance de la Région de Bruxelles-Capitale du 7 juin 2007 relative à la performance énergétique et au climat intérieur des bâtiments.*

[2] *"Unit" = a set of adjacent rooms in one and the same building that can be sold or let independently and whose use comes within the scope of application of the EPBD.*

[3] *"Unit assimilated to a new-build" = a unit that had more than 75% of its sources of heat loss renovated and also had all its technical installations replaced.*

These requirements concern public buildings, as well as private.

The energy performance requirements have varied over time:

Prior to EPB regulation (July 2008), the only requirement was an overall insulation level of K 55[4]. In 2008, all EPB requirements came into effect, except for the one on energy performance. In 2009, the E90 requirement level[5] came into effect for new housing units, offices and schools. After these requirements came into effect, a 17% reduction in energy consumption in comparison with buildings not subject to EPB (before 2008) was observed.

Table 1: U-value requirement before & after 2014.

Main U-value requirement for EPB	U-value (W/m².K)	
	before 2014	2014
Roof	0.3	0.24
External walls (above ground)	0.4	0.24
Ground floor	0.4	0.3
Windows (U_w)	2.5	1.8
Curtain walls (U_{cw})	2.9	2.0
Glass (U_g)	1.6	1.1

In 2011, the E-requirement level was tightened and became E70 for housing and E75 for offices and schools; moreover, a requirement on thermal bridges was introduced. After these 2011 requirements came into effect, a new reduction of 25% in energy consumption in comparison with buildings subject to the 2008-2011 requirements was observed.

As of 1 January 2014, the U-value requirement was tightened. Table 1 summarises the U value requirement before and after 2014.

As of 1 January 2015, the E and K requirement levels are replaced by two new requirements, referred to as 'very high performance' requirements, one concerning the total primary energy consumption, and the other concerning net heating, for all new construction permit requests. The requirements set for 2015 should reduce primary energy consumption of buildings constructed between 2011 and 2014 by another 60%.

Table 2: Requirements for new units by unit type set for 2015.

Requirements	New Units: Individual housing unit (single family house or flat)	Offices and services/Schools	Common Residential Healthcare Culture and Leisure Restaurants & Cafes Shops Sports Facilities	Other Allocations/ Common Areas
Net heating energy requirement (NHR)	15 kWh/m².year or X kWh/m².year	15 kWh/m².year or X kWh/m².year	-	-
Net cooling energy requirement (NCR)	-	15 kWh/m².year	-	-
Primary energy consumption[6] (PEC)	45 kWh/m².year or 45+(1.2*(X-15)) kWh/m².year	95-(2.5*C) kWh/m².year or (95-(2.5*C))+(1.2*(X-15)) kWh/m².year	-	-
Airtightness	n50=0.6Vol/h Requirement applied as of 2018	n50=0.6 Vol/h Requirement applied as of 2018	-	-
U_{max}/R_{min}	(see Table 1)	(see Table 1)	(see Table 1)	(see Table 1)
Ventilation	Annex VI	Annex VII	Annex VII	-
Thermal bridges	Annex V	Annex V	-	-
Overheating	Max 5% of the time above 25°C	Requirement applied as of 2016	-	-
Technical installations	Annex VIII	Annex VIII	Annex VIII	Annex VIII

[4] *K-level is a function of the average U-value of the building envelope weighted by areas and correlated with compacity.*

[5] *For a definition of the E-level, please see the chapter Belgium – Flemish Region in this book.*

[6] *For primary energy consumption calculation purposes C is equal to the value of the compactness of the unit and cannot exceed 4.*

The requirements by types of units are presented in Table 2. The Annexes referenced in Table 2 determine the requirements that must be met and can be found at the Brussels Environment (IBGE) website[7].

Units considered new (over 75% change in the envelope and replacement of the technical installations) are subject to the same requirements as new units, aside from a 20% loosening of the net heating and net cooling energy requirement, as well as the primary energy consumption (idem for airtightness as of 1 January 2018). This loosening of requirements has been established to encourage renovations, as opposed to demolitions.

The net heating energy requirement has also been loosened (alternative formula with the X factor) for projects that, in the Brussels urban context, do not have sufficient solar heat gain to ensure the very-high-performance nature of the building (a very-high-performance building is a building insulated to the extent that all the heating could be provided by ventilation air). The net heating energy requirement goes in this case from 15 kWh/m^2.year to X (variable, > 15 kWh/m^2.year).

The 'X' is an alternative requirement that has been designed for EPB units whose poor orientation or compactness makes it unfeasible to enforce compliance with a net heating energy requirement of 15 kWh/m^2.year (for instance because the insulation that would have to be put in place would be far too thick). In that case, the EPB software will display a new threshold (X) that needs to be respected, calculated on the basis of different assumptions (e.g., minimum U-values for walls, etc.). Table 3 summarises the average performance of new units built in Brussels since 2008.

I.ii. Format of national transposition and implementation of existing regulations

In 2013, COBRACE replaced the 2007 EPB ordinance and transposed Directive 2010/31/EC.

Several decrees (available on the Brussels Environment website[8]) describe the procedures to be followed, the calculation method and the requirements to be met. A set of resources are available to construction sector professionals, e.g., a handbook, info-sheets, FAQ, available on the Brussels Environment website[9].

The calculation procedure is defined in an execution order that was adopted on 21 February 2013. The method is similar to those established in the Flemish and the Walloon Regions. The calculation method for primary energy already includes the input of Renewable Energy Sources (RES), e.g., solar energy (thermal and photovoltaic), biomass heating, geothermal heating and heat pump systems, as well as passive cooling techniques.

Professionals responsible for monitoring new buildings and major renovation projects must be accredited. To become accredited, they must have an architecture or engineering degree and must have followed 5-day training sessions, as well as retraining every two years. Monitoring and support for EPB advisors are provided by Brussels Environment.

An independent organisation performed an inspection of the quality of the work of 30 EPB advisors in 2012. This first inspection did not aim at imposing penalties, but solely at collecting information on the quality of work of the EPB advisors in the market. The results were quite positive and to date, no EPB advisor has been suspended.

EPB Units	Type of unit	Number of units	kWh/m^2.year	Average index	Level E	Level K	Total m^2
Offices and services (buildings and building units)	Offices	28	91.55	B+	67	30	44,989
Schools	Schools	16	187.32	C	74	34	9,942
Individual housing units	Apartments	2303	82.45	B-	51	29	228,421
	Houses	133	109.34	C+	64	32	33,565
TOTAL		2480	87.29		52	29	316,917

Table 3: Summary of the average performance of new units built in Brussels since 2008.

[7] *IBGE stands for Institut Bruxellois pour la Gestion de l'Environnemnet (Brussels Institution for Environment Management) and is commonly referred to in Belgium as "Brussels Environment" http://document.environnement.brussels/opac_css/elecfile/IF_NRJ_ExigencesPeb2015_FR*

[8] *www.environnement.brussels/thematiques/batiment/la-peb/construction-et-renovation/legislation*

[9] *www.environnement.brussels/thematiques/batiment/la-peb/construction-et-renovation?view_pro=1*

I.iii. Cost-optimal procedure for setting energy performance requirements

The cost-optimal study for the Brussels Capital Region, concluded in June 2013, was concerned with the requirements applicable in 2012 and those valid from 1 January 2015 to several types of buildings (Table 4). The results are presented in Table 5.

The study thus showed that the 2012 requirements were insufficient to fulfil the cost-optimal obligation. On the other hand, the requirements planned for application as of 2015 completely meet the cost-optimal requirements, and, therefore, no amendment to existing legislation has been deemed necessary (see Table 1).

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

In the Brussels Capital Region, the NZEB obligation arising from Article 9 of Directive 2010/31/EU has been integrated in COBRACE and will make NZEBs obligatory by 2021 (2019 for public buildings). COBRACE was adopted on 2 May 2013 and the NZEB definition it adopted is based on the definition given by the EPBD.

Table 4:
Reference buildings for the cost-optimal study.

Scope of reference buildings		
Item	**Quantity**	**Notice**
Categories of buildings	4	single-family buildings apartment blocks/multi-family office school
Reference buildings for each category	3	1 new building 2 existing buildings
Sets of improvement package applied for each reference building	Between 1,000 and 2,000	Optimal cost is calculated for each set.

Table 5:
Results of the cost-optimal study in 2013.

Results for the 12 reference buildings

Applicable requirements in 2012	
Requirement	Deviation compared to the cost-optimal
E	-22%
K	-8%
U_{roof}	-11%
U_{wall}	-27%
R_{floor}	-72%
U_w	-13%

Applicable requirements as of 01/01/2015	
Requirement	Deviation compared to the cost-optimal
Primary energy	5%
Net heating requirement	40%
Net cooling requirement	57%

Green: Minimum requirements **more restrictive** than the cost-optimal => cost-optimal obligation fulfilled

Orange: Minimum requirements **less restrictive** than the cost-optimal with deviation < 15% => cost-optimal obligation fulfilled

Red: Minimum requirements **less restrictive** than the cost-optimal with deviation > 15% => does not fulfil the obligation

In the meantime, the Brussels Capital Region has set up ambitious energy standards for new constructions to be applied starting in 2015. These standards, inspired by the 'passive standard' and targeting 'nearly zero or very low energy consumption' and achieved through high energy performance, are assimilated to the NZEB requirements. These standards are presented in Table 2.

The 2015 EPB requirements are very ambitious for an urban context, and fulfil the nearly zero-emission objective. The requirements are in fact reduced to their minimum (from a cost-optimal perspective) and compensation by renewable energy is drastically reduced by the high number of low built area available in the city. Recourse to renewable energy is implied by the necessity to fulfil the maximum primary energy consumption requirement (45 kWh/m².year), however the RES share is not quantified.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The third Energy Efficiency Action Plan (EEAP-3) for the Brussels Capital Region was sent to the EC in May 2014. It provides an overview of the measures implemented to improve energy efficiency in the region. The EEAP-3 targets not just final energy consumption but the entire energy chain, in line with the intentions of the Energy Efficiency Directive (Directive 2012/27/EU – EED).

The EEAP-3 establishes the roadmap to a strategy for building renovations (Article 4 of the EED) which includes an overview of the building stock, identification of profitable approaches to renovation, policies and measures aiming to stimulate major renovation, future orientations, and estimates on energy savings.

The implementation of Article 5 of the EED was detailed in a plan sent to the EC in compliance with the EED in December 2013. The mechanism used to implement this article is the local energy management action plan.

Implementation of Article 5 of the EED is feasible due to the alternative proposed by Article 5.6 EED. In order to reach an amount of energy savings equivalent to the one that would be obtained by refurbishing 3% per year of the total floor area of central government buildings, the region has adopted, as part of

COBRACE[10], the implementation of a local action plan for energy management (known as PLAGE). The methodology to set up PLAGE is founded on a coherent and coordinated set of measures, which aim at identifying the potential for energy savings and priorities for action. The methodology is planned over a period of 4 years, the first of which is dedicated to setting up an energy accounting, developing an action plan, and defining a target, while the following 3 years to carrying out the action plan, making an assessment report, and verifying the results. PLAGE first (starting in 2005) was voluntary, but became compulsory through COBRACE. Experience so far has shown a reduction potential of 10% in energy consumption without major investments (measures such as isolating energy pipes, setting reflectors behind heaters, etc.).

I.vi. Other relevant plans

The draft regional Air-Climate-Energy Plan (PACE draft) has its legal foundation in COBRACE. This plan provides for more or less 130 measures that are distributed over ten areas oriented towards the sectors of energy consumers and emitters of greenhouse gases and air pollutants (buildings, transport, and all other types of energy consumption). It was adopted on first reading on 26 September 2013. This plan has been submitted to a study of environmental impact and should soon be adopted by the government in 2016. Afterwards, the plan will be submitted to public scrutiny.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

Heating systems - all the components necessary for heating the air and/or water in a building - with boilers of an effective rated output for space heating purposes of more than 20 kW, and air-conditioning (AC) systems - the combination of all the components necessary to ensure a type of treatment of the air in a building - of an effective rated output of more than 12 kW, are subject to energy requirements (Table 6). These limitations will soon be rendered redundant, extending the requirements to every heating and AC system, but even with the current limits in place, this requirement already covers the great majority of heating and cooling systems in the Brussels region.

The extent to which the systems involved comply with the requirements is monitored by accredited professionals during the various inspections provided (acceptance, periodic inspections - see section IV).

These requirements are detailed in documents drafted by Brussels Environment and are available at the Brussels Environment website.

Requirements	Type of system	
	heating	cooling
Combustion efficiency and emissions of boilers in operation	x	
Modulation of power of boiler burners	x	
Chimney draft	x	
Ventilation of boiler room	x	
Tightness of exhaust gas and combustion air supply ducts	x	
Insulation of pipes and accessories	x	x
Partitioning of water and air distribution	x	x
Control	x	
Logbook	x	x
Energy metering	x	x
Heat recovery on exhaust air	x	
Variation of the flow of fresh air by actual occupation (for spaces with variable occupation)	x	x
Energy accounting (measure, analyse and report the energy consumption)	x	x
Sizing	x	x

Table 6: Requirements for heating and cooling systems.

[10] *www.environnement.brussels/thematiques/air-climat/laction-de-la-region/air-climat-et-energie-vision-integree?view_pro=1&view_school=1*

II.ii. Regulation of system performance, distinct from product or whole building performance

The energy performance of heating and AC systems is included into the calculation of the energy performance of new buildings. The various requirements that apply to heating and AC systems (thermal insulation, partitioning, regulation, heat recovery, etc.) set a minimum performance for these systems, including replacement and upgrade, even for renovations not needing a building permit. Administrative follow-up of facilities not compliant with the provisions of the regulations is provided by Brussels Environment.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

The requirements apply to all heating and AC systems that fall within the scope of the regulations, whether the buildings pre-exist, are under renovation, or new, regardless of whether there is an urban planning permit requested.

Table 7 lists the factors that trigger the application of each individual requirement.

II.iv. Provisions for installation, dimensioning, adjustment and control

New cooling or heat installations must undergo a dimensioning calculation, the principal steps and results of which must be listed in a design calculation.

The following systems must be inspected by an accredited professional:

> heating systems with a new boiler (gas or fuel);
> heating systems with a new boiler body or a new burner;
> heating systems when the boiler (gas or fuel) is moved;
> new AC systems;
> upgraded AC systems when the effective rated output of the added or replaced part is 50% or more of the effective rated output of the AC system after works.

This inspection includes verification of certain operating parameters and features, e.g., adjustment of the settings for heating or AC systems, airtightness of the ducts for air intake or evacuation of the combustion gases, compatibility of the boiler and the ducts for evacuation of the combustion gases, etc.

II.v. Encouragement of intelligent metering

Up to now, there is no specific encouragement of intelligent metering but the installation of meters that can be read remotely is mandatory.

II.vi. Encouragement of active energy-saving control (automation, control and monitoring)

The EPB heating and AC regulations require establishment of energy monitoring and control.

Table 7: Factors triggering the requirements for heating and cooling systems.

Requirements	Triggering factor
Combustion efficiency and emissions of boilers in operation	-
Modulation of power of boiler burners	New boiler
Chimney draft	-
Ventilation of boiler room	New boiler room / work on the walls of an existing boiler room
Tightness of exhaust gas and combustion air supply ducts	-
Insulation of pipes and accessories	New boiler or new cooling installation / New pipes or new accessories
Partitioning of water and air distribution	New heating or air conditioning system / new distribution network
Control	New boiler
Logbook	-
Energy metering	No triggering factor except for electrical metering on cooling towers and air coolers, for which the requirement applies only to newly installed equipment
Heat recovery on exhaust air	New ventilation system
Variation of the flow of fresh air by actual occupation (for spaces with variable occupation)	New ventilation system
Energy accounting (measure, analyse and report the energy consumption)	-
Sizing	New boiler or new cooling installation

III. ENERGY PERFORMANCE CERTIFICATES (EPCS) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

EPB certification began in May 2011 for sales of residential houses and apartments, as well as office spaces larger than 500 m², and has been mandatory since November 2011 for rental of similar properties. EPCs are only issued by accredited experts. The validity of the EPC is 10 years, unless updated due to renovation, or revoked due to error(s) in its preparation.

Brussels Environment, the administration in charge for the Brussels Capital Region, oversees the whole scheme for the government and provides all needed materials for the issuance of EPCs, including the software.

The mandatory software to be used for issuing EPCs for single-family houses and apartments operates in combination with a central registry. This software has various graphical user interfaces, and allows the expert to input specific elements, e.g., special windows or complex skylights, with ease. The software also includes automatic controls for a comprehensive list of possible discrepancies, thus avoiding many possible mistakes.

How flats are certified in apartment buildings

Each apartment must have its own certificate; an apartment building cannot be certified as a whole. The certifier has a simple copy-paste function in the software to reduce costs in the event of multiple certifications required for similar apartments. On the contrary, office buildings can be certified either as a whole, or by floor or group of floors; the choice is on the owner.

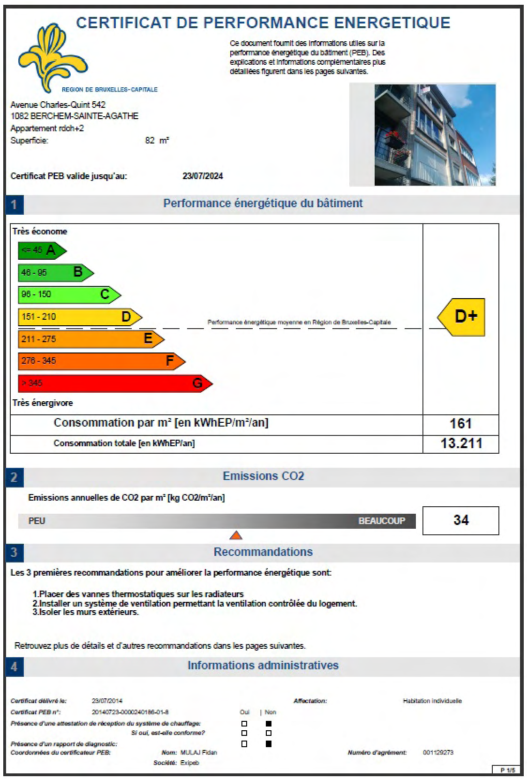
Format and content of the EPC

The certificate consists of several pages. The first page (Figure 1) presents the energy performance index, directly based on the theoretical specific primary energy consumption, the total consumption, the floor area, the CO_2 emissions and three recommendations.

The second page of the certificate (Figure 2) provides explanations of the data listed on the first page and briefly explains the assumptions in the calculation.

The next pages contain the complete list of recommendations for improvement of the energy performance specific to the residential sector, as well as a one-page list of actions and advice for achieving daily savings.

For existing housing, the reference values determining the energy label are the same as those for new housing (Tables 8 and 9, and Figure 3).


CERTIFICAT DE PERFORMANCE ENERGETIQUE

Avenue Charles-Quint 542
1082 BERCHEM-SAINTE-AGATHE
Appartement rdch+2
Superficie: 82 m²

Certificat PEB valide jusqu'au: 23/07/2024

1 Performance énergétique du bâtiment

Très économe
<= 45 A
46 - 95 B
96 - 150 C
151 - 210 D
211 - 275 E
276 - 345 F
> 345 G
Très énergivore

D+

Consommation par m² [en kWhEP/m²/an]	161
Consommation totale [en kWhEP/an]	13.211

2 Emissions CO2

Emissions annuelles de CO2 par m² [kg CO2/m²/an]
PEU — BEAUCOUP: 34

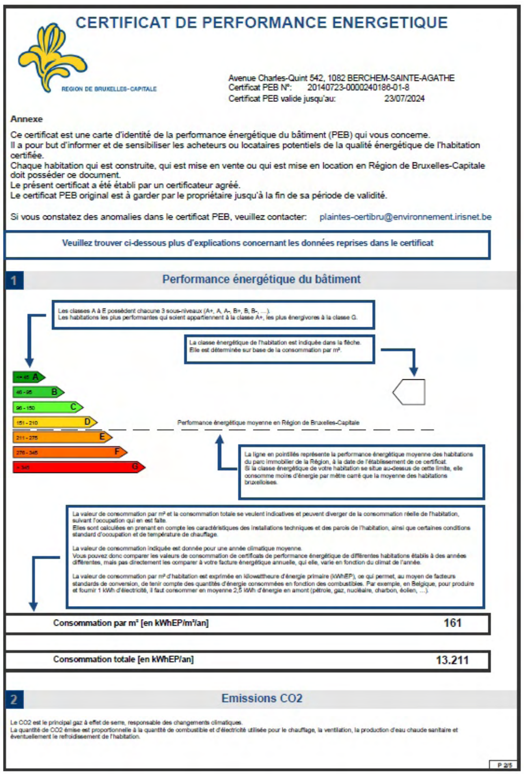
3 Recommandations

Les 3 premières recommandations pour améliorer la performance énergétique sont:
1.Placer des vannes thermostatiques sur les radiateurs
2.Installer un système de ventilation permettant la ventilation contrôlée du logement.
3.Isoler les murs extérieurs.

Retrouvez plus de détails et d'autres recommandations dans les pages suivantes.

4 Informations administratives

Figure 1: First page of the energy performance certificate.


CERTIFICAT DE PERFORMANCE ENERGETIQUE

Avenue Charles-Quint 542, 1082 BERCHEM-SAINTE-AGATHE
Certificat PEB valide jusqu'au: 23/07/2024

Annexe

Ce certificat est une carte d'identité de la performance énergétique du bâtiment (PEB) qui vous concerne.
Il a pour but d'informer et de sensibiliser les acheteurs ou locataires potentiels de la qualité énergétique de l'habitation certifiée.
Chaque habitation qui est construite, qui est mise en vente ou qui est mise en location en Région de Bruxelles-Capitale doit posséder ce document.
Le présent certificat a été établi par un certificateur agréé.
Le certificat PEB original est à garder par le propriétaire jusqu'à la fin de sa période de validité.

Si vous constatez des anomalies dans le certificat PEB, veuillez contacter: plaintes-certibru@environnement.irisnet.be

Veuillez trouver ci-dessous plus d'explications concernant les données reprises dans le certificat

1 Performance énergétique du bâtiment

Consommation par m² [en kWhEP/m²/an]	161
Consommation totale [en kWhEP/an]	13.211

2 Emissions CO2

Figure 2: Second page of the energy performance certificate.

Table 8: Energy labels for houses – subclasses and consumption.

Energy class		kWh_{EP}/m^2.year		kWh_{EP}/m^2.year
A++			<	0
A+	from	0	to	15
A	from	16	to	30
A-	from	31	to	45
B+	from	46	to	62
B	from	63	to	78
B-	from	79	to	95
C+	from	96	to	113
C	from	114	to	132
C-	from	133	to	150
D+	from	151	to	170
D	from	171	to	190
D-	from	191	to	210
E+	from	211	to	232
E	from	233	to	253
E-	from	254	to	275
F	from	276	to	345
G	≥	346		

Table 9: Energy labels for offices – subclasses and consumption.

Energy class		kWh_{EP}/m^2.year		kWh_{EP}/m^2.year
A+			≤	0
A	from	1	to	31
A-	from	32	to	61
B+	from	62	to	93
B	from	94	to	124
B-	from	125	to	155
C+	from	156	to	186
C	from	187	to	217
C-	from	218	to	248
D+	from	249	to	279
D	from	280	to	310
D-	from	311	to	341
E+	from	342	to	372
E	from	373	to	403
E-	from	404	to	434
F	from	435	to	527
G	>	527		

EPC activity levels

The number of EPCs issued as of 31 December 2014 is shown in Figure 4, whereas Figure 5 shows the office area for which a valid EPC is available, and Figure 6 the office area for which EPCs were issued each month from March 2011 to December 2014.

Typical EPC costs

The government has not set a fee for drawing up EPCs, but has ensured that an adequate number of certifiers are active in the market to satisfy the demand. Prices are thus set by the market depending on the accepted hourly rate for this type of activity and the average time needed to draw up an EPC.

The approximate average prices are as follows:

> 250 € including VAT for an apartment;
> 375 € including VAT for a single-family house.

The lowest prices found on the market are 100 € for a studio and 175 € for a house.

For offices, there is always a fixed part and a variable part, depending on the floor area. Average market prices are:

> 1,200 € including VAT for an area of 1,000 m²;
> 3,500 € including VAT for an area of 5,000 m²;
> 7,000 € including VAT for an area of 20,000 m².

Figure 3: Energy labels for houses and apartments.

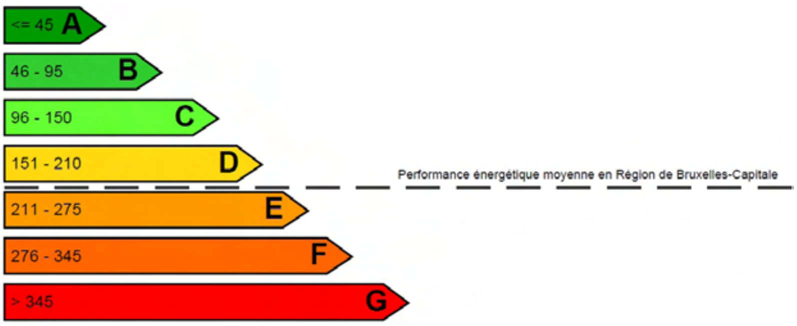
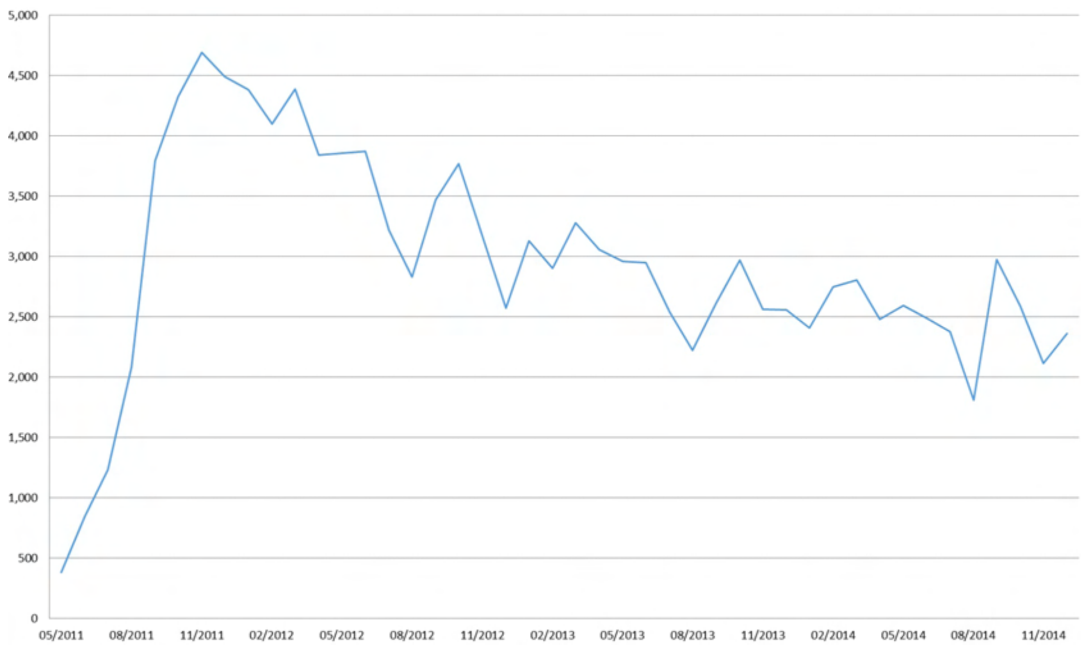


Figure 4: Number of EPCs for residential units per month.



Assessor corps

All Qualified Experts (QEs) (no minimum requirements) have to follow a specific training programme (course and exam) to obtain a certificate of competency, and to request accreditation from the Brussels Environment. The training is conducted by private training centres according to the regulation rules. At the end of 2014, 7 centres have been accredited, and there are about 1,500 registered QEs for residential, non-residential, and public buildings, whose information can be found on the Brussels Environment website.

Three years after the start in May 2011, the government decided to amend the law to improve the quality level of the certifiers. The new legislation requires certifiers to be engineers, architects, or other professionals familiar with EPB. This is nowadays the case for 1,300 certifiers already accredited. The new legislation also specifies that when there are major changes in the certification system (regulations, calculation method, software or working protocol), certifiers must be retrained and take an examination anew.

Compliance levels by sector

To ensure enforcement of the legislation, the administration has agreed with the notary association on the obligation to report every real estate transaction for which a valid EPC is not available. For sales of houses and apartments, the regulations are followed for virtually 100% of the cases.

Beyond advertising, there is also an obligation to provide a copy of the EPC at the time that the building (residential or non-residential) is sold or rented.

The office building market has also responded very favourably, with almost 100% of transactions accompanied by an EPC so that no penalties have been necessary as yet.

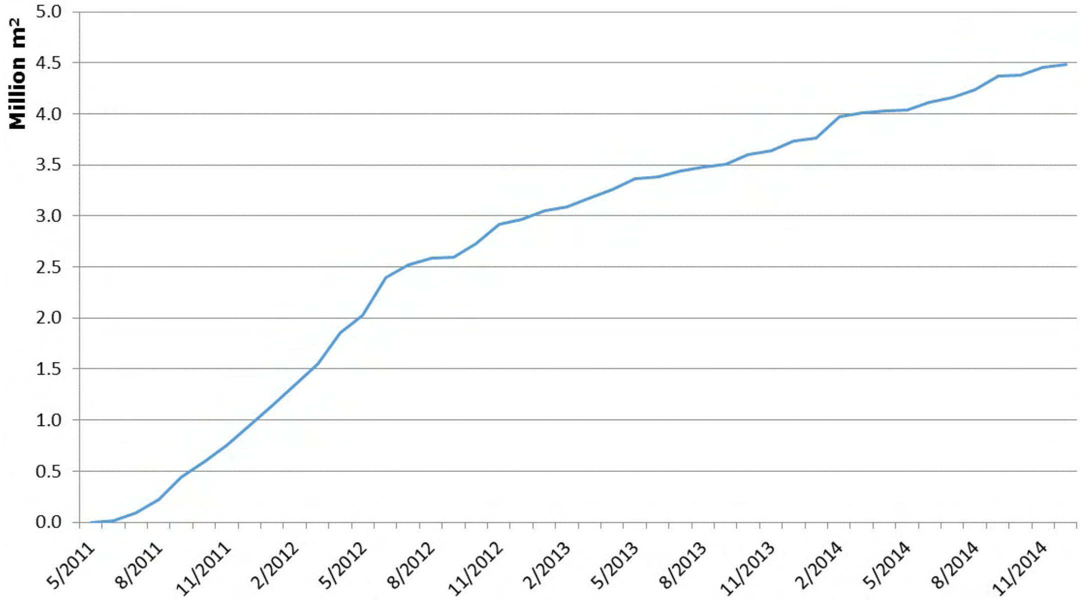


Figure 5: Cumulative area of offices for which a valid EPC is available.

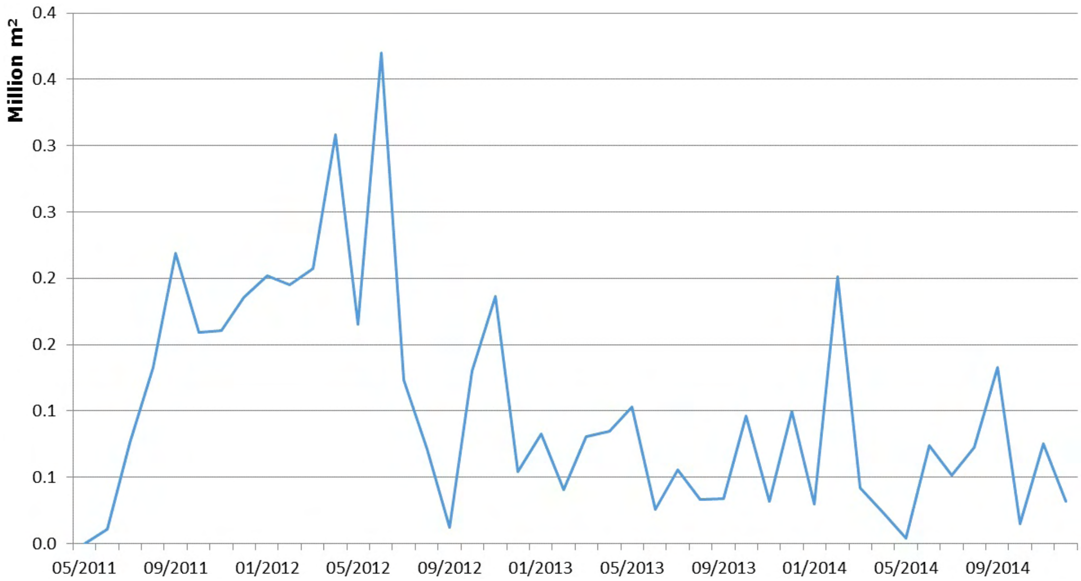


Figure 6. Area of offices for which EPCs were issued each month.

Enforcement with building owners and real estate actors

The administration has focused its inspections on the presence of EPC results in sale and rental notices. Due to the tight market for housing, no complaint has been received, in three years, related to an event in which a prospective tenant wanted to obtain an EPC and it was unavailable. Some cases were reported where the buyer and the seller mutually agreed on a settlement without an EPC, which is prohibited and in such cases the sellers incur a fine. A small number of fines have been imposed till the end of 2014, but many others are in the pipeline (fines require a long procedure).

Quality Assurance (QA) of EPCs

The government has set up a Quality Assurance (QA) scheme. A private body has been hired in order to monitor QEs issuing EPCs for houses and apartments, and to improve the scheme. In 2013, 38 QEs and 156 EPCs were controlled, and in 2014 this concerned 59 QEs and 236 EPCs. For 15% of the controlled EPCs, the body in charge of quality control visits the house, makes a new EPC and then compares the two EPCs.

Most experts and most of their EPCs are chosen randomly by Brussels Environment, but approximately 20% of them are targeted by Brussels Environment due to complaints concerning the QE.

A list of frequently made mistakes was drawn up based on the first annual report of the quality control body wherein mistakes with the most significant impact on the quality of the EPC were sent to the QEs.

Due to the lower number of issued EPCs for office buildings, their QA has been managed so far by Brussels Environment itself, often with the support of the issuing QE, before or during the issuance of the EPC.

Penalties may be imposed on the QE if relevant errors are discovered and confirmed. The number and significance of the errors determine whether the EPC should be revoked. If the certifier has several certificates revoked over a short period, and/or if he does not fulfil his administrative obligations, his license may be suspended for a maximum period of 120 days. Whenever a second suspension is required, Brussels Environment can request withdrawal of the accreditation. Fines for QEs are not applicable yet but will start to be in 2015.

Approximately 60 certifiers have already had their accreditation temporarily suspended. The first withdrawals of accreditation are planned for the near future.

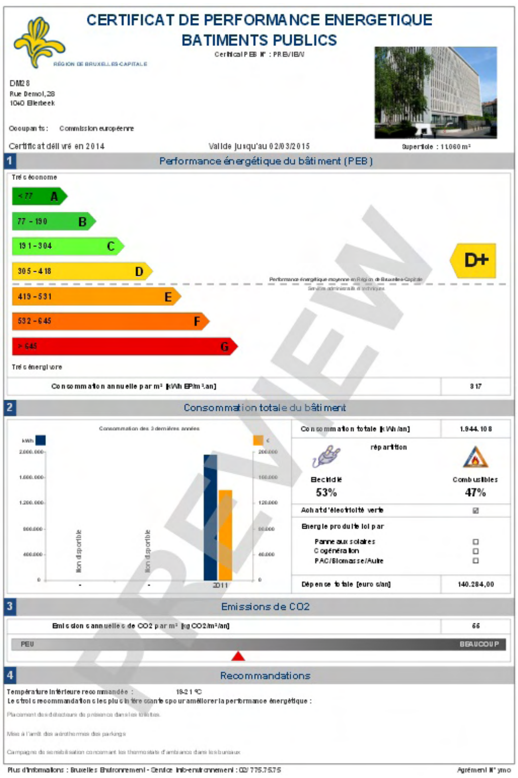


Figure 7: First page of the energy performance certificate for public buildings.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

Since 1 July 2012, any public body building that occupies more than 1,000 m² floor area must display an EPC on the front door or in the main lobby of the building. As of 2015, the threshold drops to 250 m². The certificate is to be issued by a QE using the relevant web app, and applying the protocol provided by Brussels Environment. The public building EPC is based on the actual consumption data and the areas occupied.

If a public building is owned by a public institution, it is required to install a meter for each energy source and for each building individually within 24 months from the date on which the executive order came into force.

Format and content of the EPC

The certificate displays the index of CO_2 emissions, as well as other information, e.g., financial data, information on on-site production systems, recommendations selected from a list of typical cost-effective measures, and a histogram of the consumption over the last three years (fully completed after three years – see Figure 7).

The EPC reflects the energy performance level of the public building, and places it in one of 14 label categories, e.g., town halls, parliaments, judicial buildings, crèches, high schools and university buildings, hospitals, health centres, swimming pools, etc. The mean energy performance level for the building categories in the Brussels Capital Region is illustrated as a dotted line in the scale. The certificate is based on consumption data for electricity and fossil fuels used for all purposes, based on meters or invoices and, where applicable, on data on the on-site production of electricity. Measurement of the data may commence the earliest 24 months from the date of the certificate issuance, and must cover a continuous period of 11 to 13 months. The energy performance indicator is calculated on the basis of the occupied floor area.

The scales are specific to each category of public building, and the consumptions are greater there than those of buildings subject to transaction, as they also include the consumption of the electronic apparatus: computers, coffee machines, microwave ovens, medical machinery, etc.

Frequency of updating

The energy performance certificate for public buildings is valid for a one-year period and must be updated within this timeframe.

Activity levels

Already 450 public buildings have a certificate, updated every year.

Not each public body makes every endeavour for their buildings to comply with the obligation to display an EPC. More control, support, and penalties have to be implemented by the administration.

Costs

EPCs for public buildings can be drawn up by employees of the public body, or by private certifiers.

The size and complexity of the building do not actually increase the price of the certificate, as it is based on the operational rating. The cost for an EPC drawn up by a private firm is approximately 1,300 €, VAT included.

Assessor corps

There are no minimum requirements for QE qualifications. The training is conducted by private training centres, according to the regulation rules. At the end of 2014, 3 centres were accredited. The length of training varies from 25 to 45 hours depending on the academic and/or professional background of the applicant.

It is also provided that when there are major changes in the certification system (regulations, calculation method, software or working protocol), the certifiers must be retrained and take an examination again.

Quality Assurance (QA) of EPCs

Before the web application became available (in June 2013), the quality of the EPC was checked preventively by the administration prior to its issuance, and a report was provided to the certifier. Since the web tool came into use in June 2013, the potential for entry errors became much more limited and checks are sporadic.

The information regarding all public buildings to be certified was collected in 2013 (address, area, contacts and whereabouts, meters, etc.), and Brussels Environment then performed a control to 145 public buildings EPCs, to confirm the validity of their inputs.

III.iii. Implementation of mandatory advertising requirement

The EPC aims at informing the potential buyer or tenant of the energy performance level of a building, and thus must be issued and be readily available prior to any advertising or real estate transaction. Therefore, since 2011, the law states that the reference values shall appear clearly on all advertisements. These reference values are currently the energy class, the energy performance (kWh/m².year) and the CO_2 emissions.

Contacts with major and minor real estate agencies, as well as with owner unions, made compliance with the requirements possible in about 50% of the advertising. Some real estate agencies fully observe the requirement to display the results of the EPC in their notices. However, despite the progress made, an equally large proportion of agencies still do not fully observe the requirement to display EPCs in their advertisements.

At first, for greater efficiency, the certificates check is being focused more on professionals who put properties up for sale and rental, that is, real estate agencies. An administrative fine that can go up to 625 € per notice in violation can be levied on real estate agencies that do not observe the rules for display at the time the property is put on the market, or do not provide a copy of the EPC to prospective buyers and tenants.

Over one hundred agencies have been checked at random from September 2013 to September 2014 on the basis of notices in their window displays or on internet websites, and several formal reports have been drafted that will result in administrative fines. At the end of 2014, a real estate agency received the first fine. In addition to new random checks, the next checks will in particular target agencies that have repeatedly published advertisements that do not post the results of the EPC.

III.iv. Information campaigns

In order to encourage the mandatory drafting of EPCs and heating system inspections, advertising campaigns have been realised in 2011 and 2012 on the radio, the press, and in public transport, as well as with banners on the administration website (see example in Figure 8). In addition, professionals are continuously informed through newsletters and specific seminars, in collaboration with professional associations. A significant amount of information has since been available on the Brussels Environment website.

A new campaign is planned in 2015 on websites publishing notices and on the radio to improve compliance with legislation.

Figure 8: Illustration of the campaign for promoting EPC.

Table 10: Number of EPCs issued by type of residential unit.

	Number of units	Number of EPCs	% certified
Single-family houses	216,382	17,736	8.19%
Apartments	293,350	111,095	37.87%

III.v. Coverage of the national building stock

Residential buildings

The number of single-family houses and apartments with an EPC available is shown in Table 10.

It is expected that the mass media campaigns and the first fines imposed on real estate agencies that do not observe the legislation will increase the number of certificates produced for houses and apartments.

Offices

The building stock of offices consists of 13 million m² (including offices with less than 500 m² floor area). In 2013, 165 office EPCs were issued for a total of 900,000 m². As of 1 December 2014, 4.5 million m² of offices have an EPC, i.e., about 33% of the building stock.

Public buildings

A total of 450 public buildings have an EPC. For now, only buildings occupying more than 1,000 m² are required to display an EPC. This threshold will drop to 250 m² in 2015, which will affect more than 1,000 public buildings with an area of 250 m² or larger that will also have to be certified.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

The Brussels Capital Region has adopted the inspection option for heating and AC systems.

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

Since 1 January 2011, new or upgraded heating systems must be accepted and the boilers must be periodically inspected every year for liquid-fuelled boilers, and every third year for gas boilers[11]. These inspections must be carried out by accredited professionals. At the end of each inspection, the accredited professional must complete an inspection report to be given to the owner of the installation.

A diagnosis of the facility must be performed by an accredited professional according to a method and with a tool made available by Brussels Environment for systems with a more than 15 year old boiler.

[11] *Solid fuel boilers represent only a small part of the boilers in the Brussels Capital Region. They are covered by an old law that will probably be revised soon.*

Arrangements for assurance, registration and promotion of competent persons

Accreditation of QEs by the Brussels Environment is subject to certain conditions, including attainment of a certificate of competency after training, including an examination about the regulations and the techniques (depending on the type of accreditation), compliance with certain obligations (e.g., keeping a copy of the reports, accepting the quality control, using the methodologies and tools supplied by Brussels Environment, etc.) and follow-up refresher training. The accreditation is valid for 5 years and may be extended for 5 year periods.

Accredited professionals are listed on lists available on the Brussels Environment website. At the end of 2013, there were nearly 1,200 professionals who can periodically inspect boilers and over 400 to accept new or upgraded heating systems.

Promotional activities

A guide for owners of heating systems (Figure 9) has been drafted and is available online on the Brussels Environment website or in print format in the municipalities, some associations, etc.

A helpdesk[12] (Figure 10) intended for accredited professionals has been set up to answer their questions and support them in carrying out regulatory activities.

Enforcement and penalties (activity level and statistics on penalties already levied)

If the procedures specified in the regulations are not performed, the owner of a facility is subject to criminal penalties. For the moment, the focus is on high-powered facilities with environmental permits (≥100 kW), together with the verification whether the correct environmental regulation has been applied. The Brussels Environment is in charge of those inspections in case of permit renewal, complaints or regular control.

Penalties are also imposed if a non-compliant installation is not brought into compliance within the deadline provided. To date, no penalty has been levied.

Quality control of inspection reports

Brussels Environment receives and analyses all the attestations of acceptance and attestations of periodic inspection in the event of non-compliance of a boiler, or if it is brought into compliance. For high-powered facilities, an on-site inspection is performed by the administration in some cases (182 inspections done in 2013).

For other installations, a certain number of attestations will be inspected at random on-site by an independent quality control organisation (39 inspection reports controlled in 2013).

Inspection activity figures

On the basis of the attestations of acceptances and periodic inspection received, it is estimated that less than 10% of new boilers (~14.000 new boilers each year) undergo acceptance (~2,000 acceptance reports received in 2013) and less than 1% of the Brussels stock of boilers (~350,000 boilers) has already undergone a

Figure 9: First page of the guide "An efficient heating system?".

Figure 10: Homepage of the helpdesk website.

[12] *www.pebchauffagebru.be/fr/accueil/*

periodic inspection (~250 inspection reports received in 2013[13]).

Impact assessment

The current impact of inspections has not yet been evaluated precisely. However, it is noted that a certain number of periodic inspections lead to replacement of the boiler. Moreover, it is estimated that full implementation of the regulations on heating facilities should reduce CO_2 emissions related to Brussels buildings by 6%.

Costs and benefits

For private individuals, the cost of an inspection generally varies between 100 € and 200 €. This cost includes maintenance of the boiler, which represents the major part of the cost.

Figure 11: Homepage of the AC system periodic inspection tool.

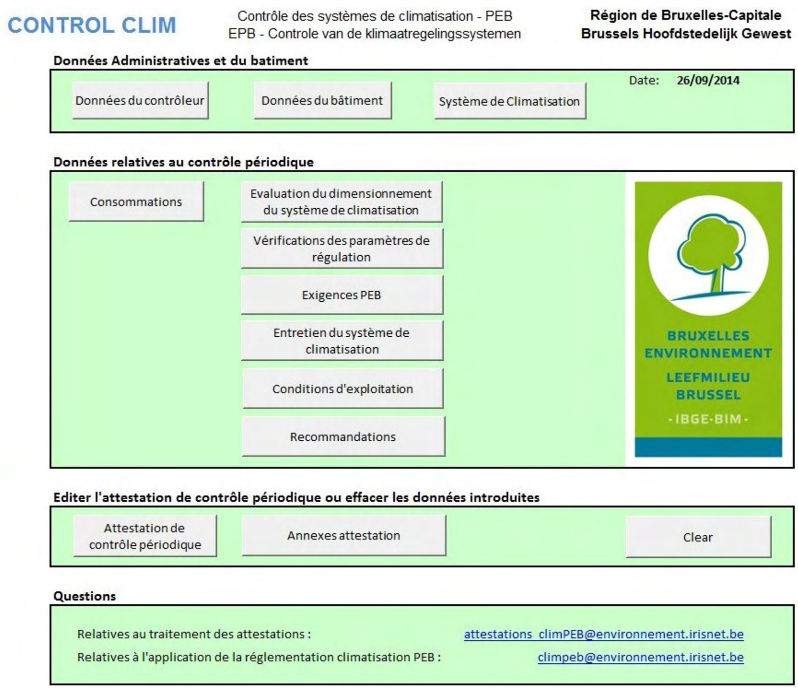


Figure 12: First page of one of the explanatory documents.


La réglementation climatisation PEB

→ Contenu technique à l'attention des organismes de formation

Module réglementaire

Pour professionnels de la climatisation : contrôleurs, technicien climatisation PEB

Version avril 2013

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Email : climPEB@environnement.irisnet.be

BRUXELLES ENVIRONNEMENT
IBGE - INSTITUT BRUXELLOIS POUR LA GESTION DE L'ENVIRONNEMENT

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

As of 1 September 2012, AC systems of more than 12 kW must undergo a periodic inspection performed by an accredited professional according to a method and with a tool made available by Brussels Environment (Figure 11).

Arrangements for assurance, registration and promotion of competent persons

The accreditation procedures are the same as those provided for heating system inspections.

The penalty mechanisms are the same as those provided in the framework of the regulations on heating facilities.

There have not yet been any penalties.

Promotional activities

Various explanatory documents are available on the Brussels Environment website (Figure 12).

Several presentations intended for professionals in the sector have already been held and others will be organised in the coming months.

Quality control of inspection reports

No quality control is currently in place for the inspection reports, only support for the accredited professionals in performing their periodic inspections. Quality controls are planned for the long term.

Inspection activity figures

To date, only about 15 professionals are accredited to perform periodic inspections of AC systems.

The first periodic inspections began at the end of 2013.

Impact assessment

It is estimated that full implementation of these regulations (i.e., regular inspections and mandatory maintenance), should reduce consumption related to AC systems by 5 to 10%, provided the AC system maintenance is correct.

Costs and benefits

There is no relevant information available as yet.

[13] *Brussels Environment only receives reports of non-compliant boilers. For the moment, there is not a good view of what is really done. Wider communication to heating system owners or users is foreseen in 2016.*

3. A success story in EPBD implementation

In 2007, the Brussels Capital Region launched a call for projects, called "Exemplary Projects" (or BATEX - BATiment EXemplaire - Figure 13 and Box 1), with all market participants for very-high-performance buildings in the energy and environmental sectors. While no requirement was then imposed, the *'Passive House'* standard appeared in the best projects selected. Over the course of the six calls for proposals (once a year), the *'Passive House'* standard became progressively apparent as 'the' energy standard, with almost 350,000 m² of buildings selected. Thus, the participants in the region demonstrated their ability to build and renovate buildings of any kind and any size corresponding to very high energy standards. Over half meet the *'Passive House'* standard (56%), equivalent to 350,000 m² of floor area. Those that do not yet meet it, fulfil the low or even very low energy criteria.

This call for projects has also created pressure on the real estate market and has led numerous private and public participants to undertake projects with very high energy performance. The latest inventory drawn up by Brussels Environment counted:

> 800,000 m² of passive buildings constructed, under construction or decided upon;
> 2,365 buildings with high energy performance;
> 216 buildings meeting the *'Passive House'* standard;
> 2,144 (very) low energy buildings.

Based on the experience accumulated, the Brussels Capital Region decided to impose the *'Passive House'* standard on the public sector for all new construction, and the low or even very low energy standard for renovations, as of 2011. In addition, in view of the technical and financial capacity of the market to offer so many passive buildings, the Brussels Capital Region opted in 2013[14] for the maximum energy standard in terms of insulation for its new constructions, 'the passive ambition', as a matter of regulation. This concept was adapted to the Brussels reality, and the resulting requirements were subject to negotiations with the construction sector in 2012.

BATEX[15] is:
> 6 calls
> 6 years
> 361 applicant projects
> 243 Exemplary Buildings
> 39% renovation projects
> 621,000 m² including 350,000 m² meeting *'Passive House'* requirements
> 100 projects with a public contracting client, 143 with private clients
> 18 municipalities
> 15,313 m² of individual housing plus 199,161 m² of collective housing, or 1,866 housing units, including 762 "social" housing units and 505 meeting *'Passive House'* requirements
> 242,609 m² of offices and shops
> 164,421 m² of community facilities, including 4 rest homes, 21 schools and 23 day care centres
> 3,752 m² of thermal solar panels
> 15,272 m² of photovoltaics
> 194 projects with green roofs
> and more...

Box 1: Facts and figures on BATEX.

With this choice, Brussels is avoiding the programmed obsolescence (by the successive increase in energy requirements) of its new buildings successively put on the market. A passive building will never be obsolete, inasmuch as it will no longer be necessary to change its envelope or technology to give it higher performance.

4. Conclusions, future plans

The 2015 EPB requirements are a necessary and essential step toward the mandatory European NZEB standard of 2019/2021, in terms of both timing and ambition.

In view of this NZEB standard in 2019/2021, the finality of very high performance has guided consideration of the passive level of requirements, especially as the Brussels building sector has devoted considerable effort to the subject and shown that these requirements are feasible on a large scale. The multitude of buildings built, under construction and planned in the Brussels Capital Region moreover confirm the theoretical cost-optimal approach. Very high performance can be profitable,

Figure 13: Logo that identifies every Exemplary Project.

[14] *Decree of the Government of the Brussels-Capital Region of 21 February 2013 amending the decree of 21 December 2007 setting energy and indoor climate requirements for buildings.*
[15] *www.environnement.brussels/thematiques/batiment/sinspirer-des-batiments-exemplaires*

provided that significant care is taken in the design, for any building. The construction sector is divided into two fronts, those who have already constructed very high performance buildings and are not opposed to it, and those who have not yet constructed such buildings and are wary.

It is obvious in this regard that stepped-up support for professionals remains necessary.

The region is now among the world leaders with regard to very high energy performance buildings and delegations come from afar to get the knowhow in Brussels.

The actions taken for new construction are an indicator of the trend that the Region shall follow for renovation, for which the stakes are enormous and the energy savings potential greater than for new construction.

At present, renovated buildings are only subject to specific requirements related to minimum values of insulation of the walls (U and R values). As renovation processes are in essence gradual, it is completely possible to arrive, after successive renovations, at a cost and scope of works equivalent to that of a new construction, but with a distinctly lower energy efficiency, for lack of a central emphasis on obtaining a high-performance building at the end of the process.

The new challenge is to delineate the renovation process to maximise energy improvement in the long term.

Implementation of the EPBD in Belgium

STATUS IN DECEMBER **2014**

Flemish Region

1. Introduction

In Belgium, the implementation of the EPBD is the responsibility of the regional governments. The Flemish Energy Agency (VEA) and the Ministry of Environment, Nature and Energy are the responsible public bodies in the Flemish Region. They are also in charge of managing the certification scheme and the accreditation of experts, as well as the compliance checking. A central register is used to archive all certificates, as well as the calculations of new building requirements.

In 2012, an evaluation process of the Flemish legislation was finalised. The Nearly Zero-Energy Building (NZEB) requirements and the path towards 2021 were imposed by the Flemish government in 2013. In general, this path is well accepted and the sector is gradually evolving towards more demanding low and NZEB standards for new buildings. New requirements for Technical Building Systems (TBS) will come into force in 2015. Changes to the expert accreditation system for new and renovated buildings are planned for 2015 as well.

This report presents an overview of the current status of implementation and plans for the evolution of EPBD implementation in the Flemish region. It addresses, among other issues, certification and inspection systems, including quality control mechanisms, training of qualified experts (QE) and information campaigns.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

In Belgium, regulations on building energy performance are set at the regional level. However, the three regions cooperate to establish a common methodology for new and refurbished buildings, leaving each region free to define its own requirements. Also, the three regions use a jointly developed single software tool (Figure 1). VEA is the responsible public organisation for the energy performance requirements in the Flemish Region.

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NATIONAL WEBSITES

Energy performance requirements for builders: www.energiesparen.be/epb/energieprestatieregelgeving

Energy performance requirements for professionals: www.energiesparen.be/epb/prof/home

Energy performance certificates: www.energiesparen.be/epc

Regular inspections of heating installations: www.stook-zuinig.be

Audit of heating installations: www.energiesparen.be/verwarmingsaudit

Inspection of air-conditioning (AC) systems: www.lne.be/themas/erkenningen/airco-energiedeskundige

Figure 1: Software tool for the building energy performance of new and refurbished buildings.

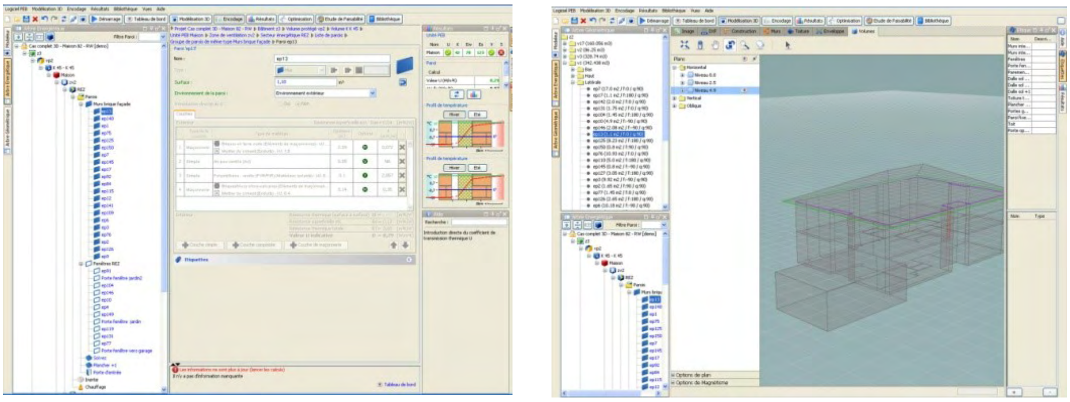
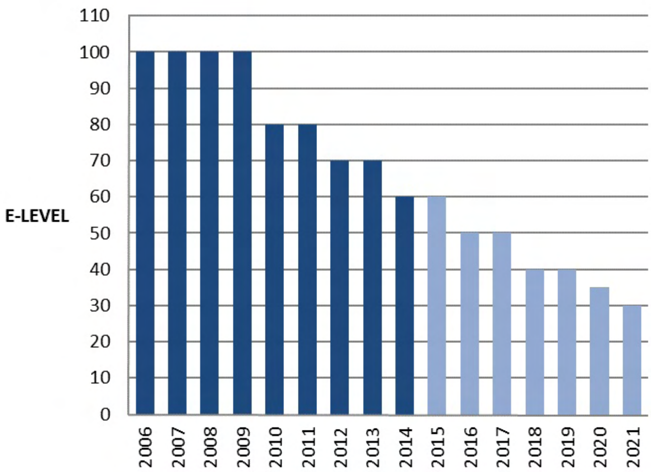


Figure 2: E-level tightening path for new residential buildings towards NZEB.



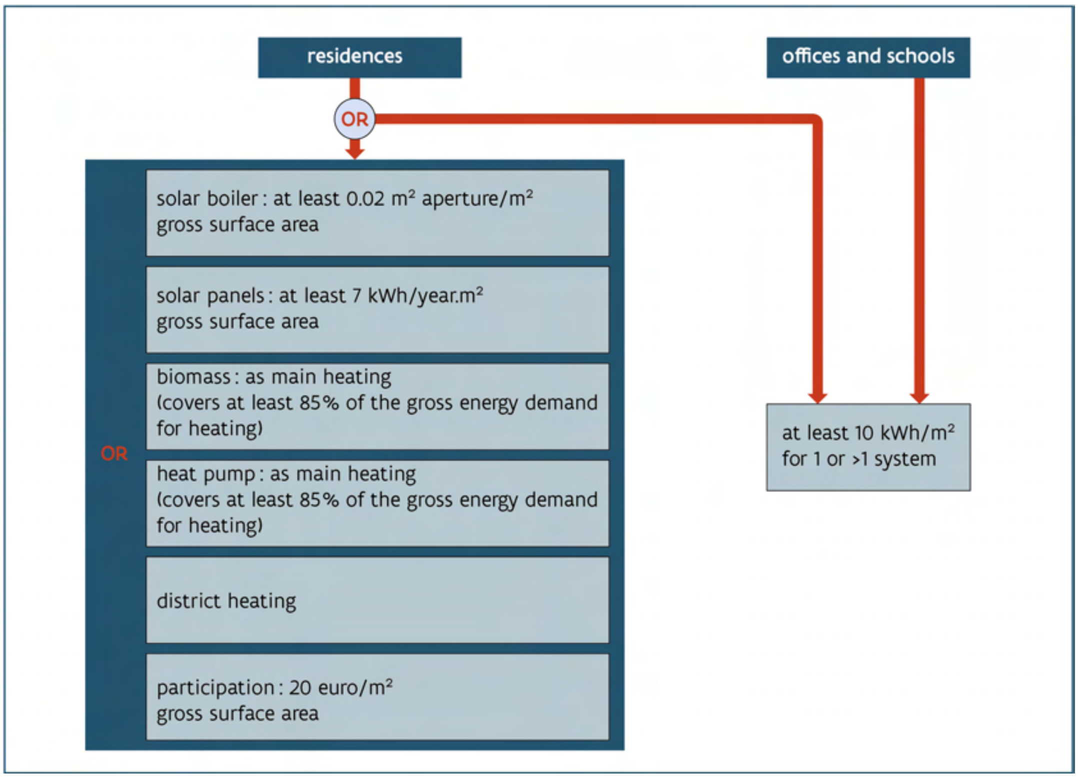
I.i. Progress and current status

The most important requirement concerns energy performance. The dimensionless E-level (the annual primary energy consumption divided by a reference consumption) is the maximum allowed energy performance level for new residential buildings, offices and schools.

Flemish regulations do not yet cover the global energy performance of other non-residential functions. The introduction of an E-level for other residential buildings (hotels, hospitals, retail) is planned in 2017. From 2006 till 2009, the maximum E100-level represented a reference package of measures. Up to 2014, it was subsequently reduced by 40% to E60, based on cost-optimal studies (Figure 2).

Since 2006, all U-values requirements have been strengthened for all new and renovated buildings and the global insulation level was decreased from K45 to K40[1]. A new requirement on the net energy demand for heating was introduced in 2012 for residential buildings (max. 70 kWh/m²). A new requirement on the share of renewables was introduced in 2014, according to which new buildings need a minimum share of at least 10 kWh/m².year) of energy derived from renewable energy

Figure 3: Minimum share of renewable energy sources.



[1] *Non-residential buildings and industrial buildings that do not have an E-level requirement must also fulfil this K-level, U-value and ventilation requirements.*

sources. Alternatively, residential buildings can choose one of six specific and quantitative measures (a thermal solar energy system, a photovoltaic (PV) solar energy system, a biomass boiler, stove or qualitative combined heat & power (CHP), a heat pump, a connection with district heating or cooling on renewable energy, or a participation in a renewable energy project) (Figure 3).

Until 2014, almost 170,000 final declarations (calculations of the energy performance requirements in as-built situations) were sent to the central register (Figure 4). The analysis by the VEA[2] indicates that the average E-level decreases every year. This evolution is most evident for new single-family houses. The amount of single-family houses with an E-level higher than E60 drops from nearly 95% for building permits in 2006 to 65% for building permits in 2010 and 50% for building permits in 2012 (Figure 5). The average E-levels of flats, offices and schools decrease more slowly. These results are shown in (Figure 6).

Another key to success is the alignment of the requirements with targeted support mechanisms. Data on energy performance shows that the support mechanisms are a driver for early-adopters of low E-level building. As shown in Figure 7, in 2011, subsidies for E60 and E40 contributed to the improvement of the E-levels of new residential buildings.

Figure 4:
Total number of final declarations (cumulative).

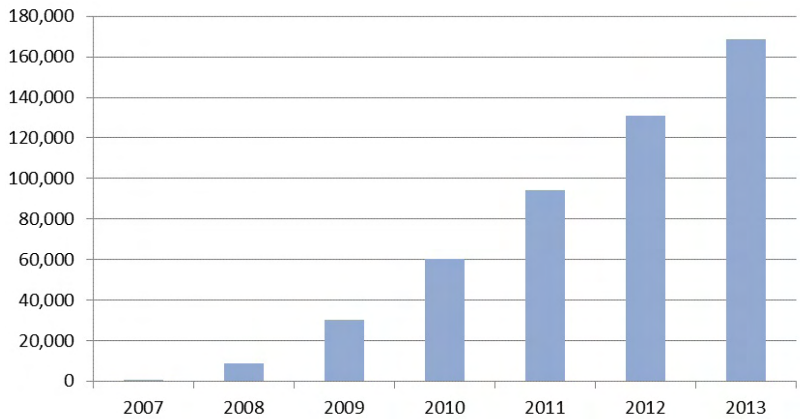
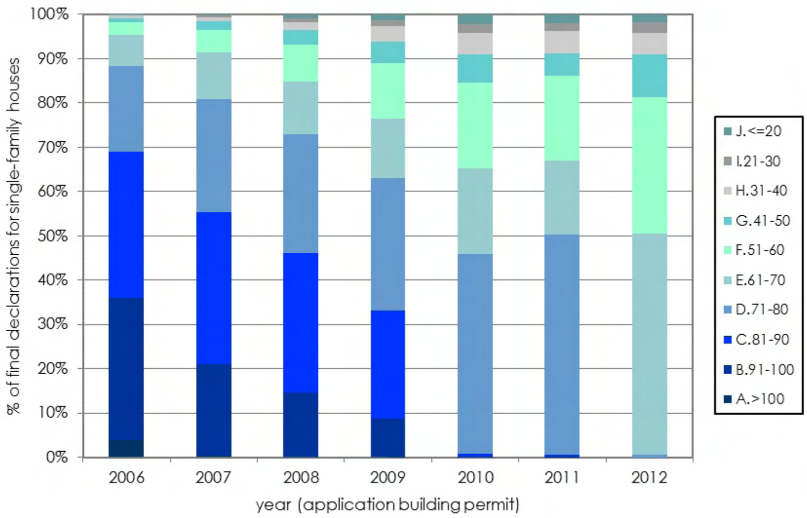


Figure 5:
Distribution of E-levels per year (application building permit).

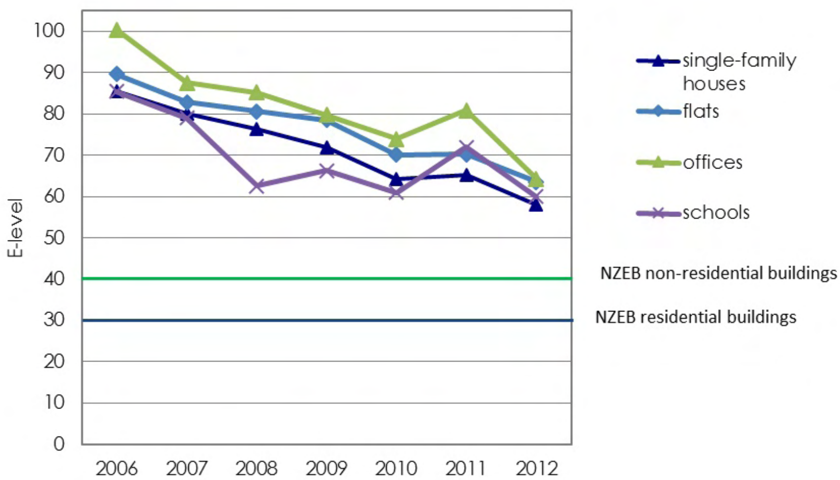


I.ii. Format of national transposition and implementation of existing regulations

Energy performance requirements for new and renovated buildings in the Flemish Region first started in January 2006. The legislation was consolidated in the energy decree of 2009 and the energy law of 2010. Each new building must fulfil requirements on energy performance (E-level)[3], on insulation (U-values and global insulation 'K-level') and on the indoor air quality and thermal comfort (risk of overheating and ventilation). Renovated buildings must meet requirements on insulation and indoor air quality and, from 2015 onwards, requirements on TBS (see Chapter II).

The energy performance level or E-level sets the maximum allowed primary energy use for a building. The calculation

Figure 6:
Evolution of the average E-level per year (application building permit).



[2] *Report of the yearly analysis of the results of the final declarations submitted to the central database.* *www.energiesparen.be/vlaamsenieuwbouw*

[3] *The E-level in the Flemish Region for residential buildings differs from the Ew-level in the Walloon Region, since the reference is calculated differently and the Ew-level is additionally adjusted for the heated floor area. The E-level is the same as in the Brussels Capital Region for residential buildings and identical in the three regions for schools and offices.*

Figure 7:
Spread of E-level (energy performance indicator) for new residential buildings.

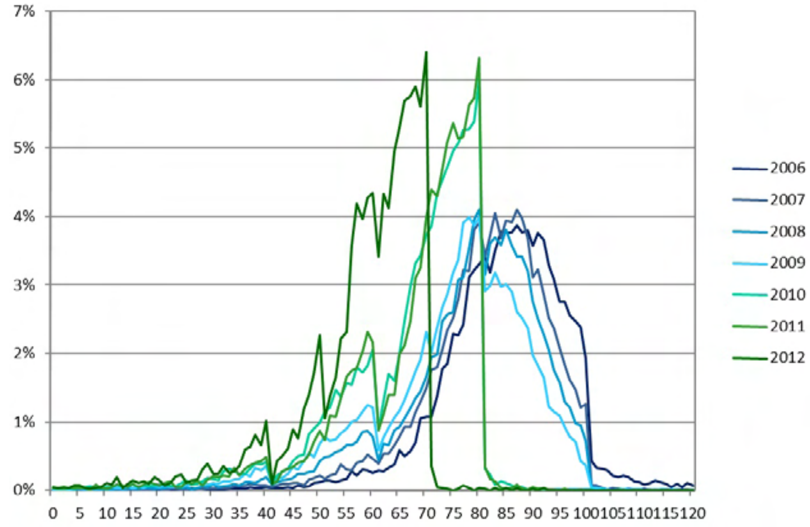


Figure 8:
Amount of calculations for new/renovated buildings filed in the central database per year, at the start of the construction and in the as-built phase.

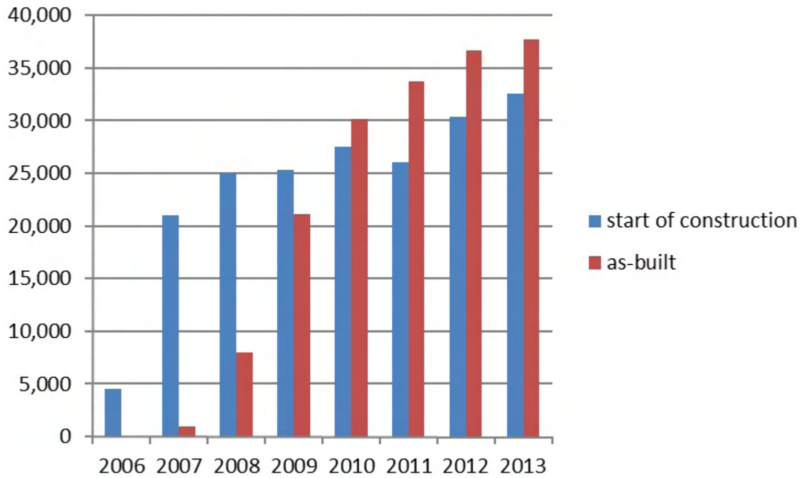
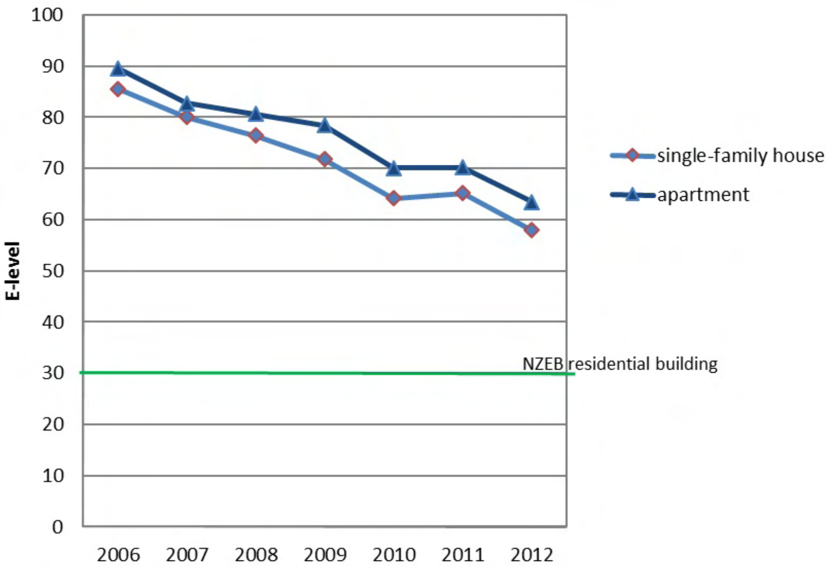


Figure 9:
Evolution of the average energy performance level of new residential buildings, per year of the building permit application.



includes, e.g., thermal bridges, shading devices and infiltration rate. The airtightness measurement has to comply with the requirements of a quality assurance scheme. Two energy performance methodologies are described in the energy law: one for residential buildings, and the other for offices and schools (including public offices and schools). The primary energy factor for electricity is 2.5, and for other sources it is 1.

A methodology for all non-residential functions based on EN standards, has been developed and will be implemented in software during 2015. An updated method including cooling is in use since 2014.

The VEA checks the compliance with the procedures (submitting, to a central database, a calculation at the start and again at the as-built situation) and with the requirements. The amount of calculations submitted at the start of the construction and in the as-built situation is still growing (Figure 8). The evolution of the average E-level shows clear progress in the new building stock over recent years. The small increase in 2011 is due to the obligation then newly imposed to calculate the impact of thermal bridges (Figure 9). In case of non-compliance with the procedures (sample check), the builder receives a warning to submit the calculation to the central database. The number of such warnings amounted 2,000 in the year 2012 and increased to 3,400 in 2013. The central database checks that each individual building meets all the requirements. The compliance rate of new buildings with the E-level and for most other requirements is very high (> 99% for E-level) (Figure 10). For the ventilation requirements however, the compliance rate is lower. In most cases, the ventilation systems are incomplete (e.g., extraction in some rooms is missing). Still, the evolution of the compliance rate since 2006 shows improvement, whereas the tightening of the requirements does not influence the compliance rate. Those responsible for buildings that, after being warned, do not comply with the procedures, or that do not meet the requirements, receive an administrative fine (Table 1).

The VEA checks a building sample on the quality of the as-built calculations. In 2013, 173 calculations (0.5%) were checked, 31 penalties were issued and a limited number of experts were suspended (Table 1).

I.iii. Cost-optimal procedure for setting energy performance requirements

The cost-optimal study of 2012 showed a cost-optimal E-level of E50 for new residential buildings, offices and schools (Figures 11 and 12). The cost-optimal study results were also used to develop a plan for further incremental tightening of the requirements until 2021.

A part of the study investigated the E-level for renovated buildings. Subsequently, a new requirement is set for 'thorough energetic renovations'. From 2015, all major building renovations (residential, offices and schools) involving 75% or more of the building shell or replacement of the whole HVAC system will have to meet the E90 level.

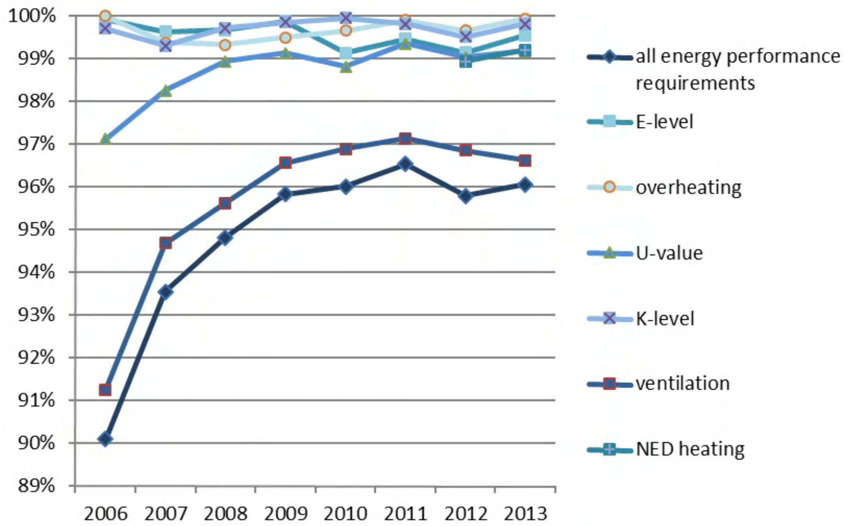
Some U-values were sharpened for all new and renovated buildings. A new set of U-values was created for existing insulated walls (e.g., existing cavity walls). The overview of the required U-values since 2006 is shown in Table 2.

In 2014, a tendering procedure was set up for carrying out cost-optimal studies and evaluating requirements for residential buildings, as well as for all types of non-residential buildings.

		2012	2013
Procedures	at start	24	5
	as-built	127	244
Requirements		2,538	2,642
Experts		44	31

Table 1: Amount of administrative sanctions laid down for infringements of procedures or energy performance requirements.

Figure 10: Compliance rate of new buildings with the energy performance requirements.



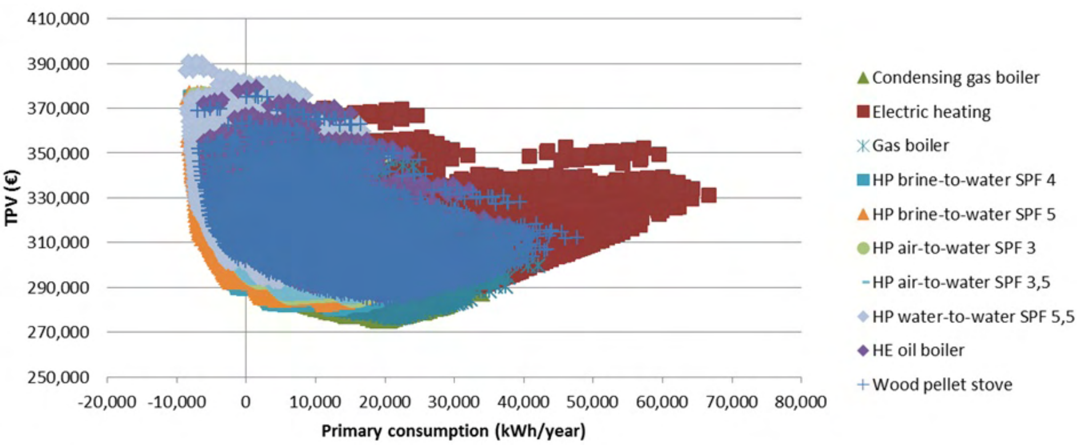


Figure 11: Example of a complete 'cloud' of combined measures.

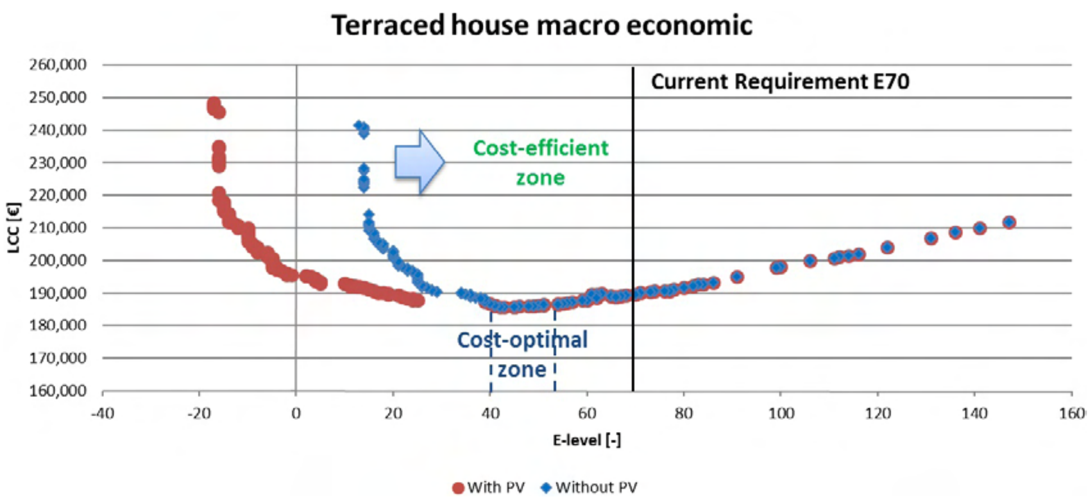


Figure 12: Definition of the cost-optimal and cost-efficient zone for measures with and without PV.

Table 2: Overview of maximum U-values since 2006.

	Maximum U-value (in W/m².K)					
	from 2006 to 31/12/2009	from 2010 to 31/12/2011	from 2012 to 31/12/2013	from 2014 to 31/12/2014	from 2015 to 31/12/2015	from 2016
Roofs, ceilings to attics	0.40	0.30	0.27	0.24	0.24	0.24
Outer walls	0.60	0.40	0.32	0.24	0.24	0.24
Floors on the ground, or above cellars	0.40	0.40	0.35	0.30	0.30	0.24
Windows (profile + glazing)	2.50	2.50	2.20	1.80	1.80	1.50
Glazing	1.60	1.60	1.30	1.10	1.10	1.10
Insulated existing walls (outside)	-	-	-	-	0.24	0.24
Insulated existing walls (cavity)	-	-	-	-	0.55	0.55
Insulated existing roofs	-	-	-	-	0.24	0.24
Insulated existing floors in contact with outdoor environment	-	-	-	-	0.30	0.24

Figure 13: Evolution of the percentage of new residential buildings, per year of the building permit, that fulfil the NZEB level (E30).

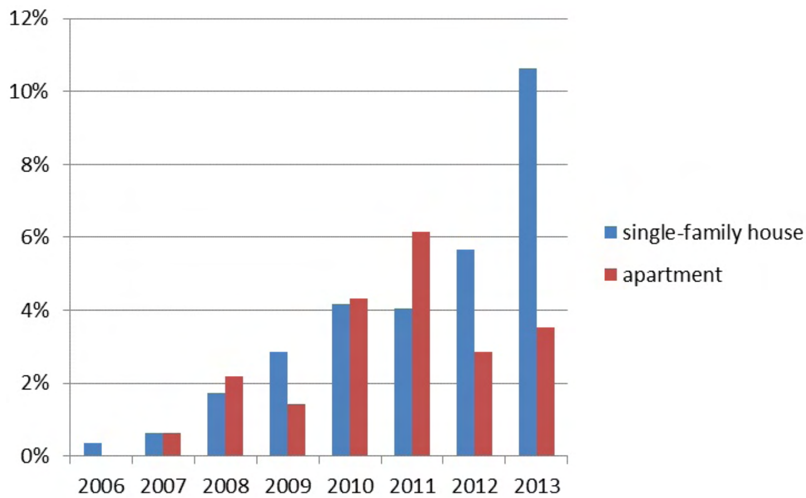


Figure 14: Branding the NZEB-label, available for NZEB frontrunners.

Figure 15: The 'Sustainable Quarter', NZEB houses in Waregem, with focus on affordability.

Figure 16: Zero-energy office, bank office in Gooik.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The cost-optimal study established two NZEB-levels that had an equivalent overall life-cycle cost as the 2012 requirements: the E30 for residential buildings and the E40 for offices and schools. With current costs, the NZEB level is thus beyond cost-optimal, i.e., it is the solution that is closest to zero energy among those that are cost-effective.

On 29 November 2013, the Flemish government imposed requirements to tighten the energy performance indicator (E-level) as follows:

a. for residential buildings: E50 in 2016, E40 in 2018, E35 in 2020 and E30 (=NZEB-level) in 2021;
b. for offices and schools: E55 in 2016, E50 in 2018, E45 in 2020 and E40 (=NZEB-level) in 2021;
c. for public administration offices: E50 in 2016, E45 in 2018 and E40 (=NZEB-level) in 2019.

This incremental tightening (Figure 2) is based on the cost-optimal study for NZEBs, updated in 2012 and 2013, taking into account the methodology framework provided by the European Commission in 2012.

Apart from the E-level, the NZEB definition for new buildings includes additional requirements and an obligation for a minimal share of energy from renewable energy sources (RES).

The NZEB definition for new buildings is thus:

> energy performance: E-level ≤ 30 (residential buildings) or E-level ≤ 40 (offices and schools);

> insulation: K-level ≤ 40 and U_{max} as shown in Table 2, column 'from 2016';

- net energy demand for heating ≤ 70 kWh/m²;
- ventilation and overheating requirements;
- minimum-level of renewable energy, as described earlier.

More information on the Flemish NZEB-definition can be found online[4].

In 2015, further studies will be executed to produce a NZEB definition for existing residential buildings. This definition will probably be more flexible than the one for new buildings.

Figures and statistics on existing NZEBs

In 2012, one in 25 new single-family houses fulfilled the NZEB requirements (Figure 13). Following completion of the NZEB-definition and promotional initiatives undertaken by the government (Figure 14) and the building industry, it is expected that this share will increase.

NZEB demonstration projects are becoming more widespread. Two interesting case studies are the 'Sustainable Quarter' in Waregem (Figure 15) with a focus on the affordability of NZEB-houses (E13, total primary energy use of 6 kWh/m².year), and the 'Zero Energy Bank Office' in Gooik (Figure 16).

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The Flemish strategy for the renovation of buildings (EED Article 4) consists of two parts. The basic part of the strategy is the Energy Renovation Program 2020. The ambition of this program is that by 2020, every citizen of the Flemish Region lives in an energy-efficient house with roof insulation, no single glazing and an efficient heating installation. If, in an existing house, the roof insulation is missing, single glazing is still present or the heating installation is older than 25 years, then the priorities for the energy performance certificate (EPC) are the insulation of the roof, and the replacement of the single glazing and boiler.

The Energy Renovation Program is completed with the strategy 'On the road to NZEB', supporting early adopters. In the coming years, a long-term strategy, to be applied until 2050, will be put in place.

For the implementation of EED Article 5, the Flemish government has chosen the alternative approach. This requires a series of measures to be taken in public buildings with a total of energy savings equivalent to deep renovation of the central government's building stock. A first calculation has shown that 150 buildings with an estimated total usable floor area of 900,000 m² fall under this obligation. These 150 buildings represent only those that fall under the implementation of Article 5.

As a result, the Flemish government has to realise 2.4 GWh of savings under the default approach. According to the first calculations with the alternative approach, it is possible to save 28 GWh. The goal is that the public buildings that fall under Article 5 will, after renovation, improve their energy performance to at least the yellow zone of the EPC.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

New regulations for the energy performance of TBS in existing buildings come into force in the Flemish Region from 1 January 2015. They are part of the energy performance requirements for renovated buildings, as described in Chapter 2.I.

II.ii. Regulation of system performance, distinct from product or whole building performance

Requirements for technical building systems can be found in the environmental regulation for heating and cooling systems as well as in the energy performance requirements for buildings. Minimum energy performance requirements in the Flemish Region are set for the following installations:

- heating systems with space heaters (gaseous and liquid fuels): minimum efficiency;
- heating systems with electrical heat pumps: minimum seasonal performance factor (SPF);
- electrical resistance heating: maximal power;
- electrical boilers and water heaters for domestic hot water (DHW): maximal power;
- stimulation of pipework insulation for heating/cooling systems and DHW

[4] *www.energiesparen.be/BEN/eisen*

(mandatory for forced circulation);
> cooling system with ice-water distribution systems: minimum efficiency;
> ventilation systems with mechanical supply and extraction: minimum efficiency of heat recovery;
> non-residential lighting systems: maximal equivalent specific installed power to prevent poor or oversized dimensioning of the lighting system. The use of modulating systems (e.g., dimming, daylight and presence detection) is stimulated by a correction factor on the installed power.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

The new Flemish energy performance requirements for TBS are created with the purpose of applying them to new, replaced or upgraded systems in existing buildings. The requirements apply to new installations or installations which are altered or expanded in existing buildings with a building permit.

The requirements apply from 1 January 2015. Existing TBS which remain unchanged during a refurbishment do not need to comply with the requirements. Works that do not require a building permit do not need to comply with the requirements either. However it is expected that the HVAC contractors will adopt the requirements as benchmarks for these works. Requirements for renovations carried out without a building permit cannot be enforced. The Flemish government chose to not lay down requirements in cases where enforcement is not possible in practice, or where the extra administrative burden to prove compliance would be too high.

The requirements apply to both large and small modifications to installations in residential, as well as non-residential buildings. If the impact of the modification is so small that it is not technically feasible to meet the requirements, there is a procedure for requesting an exception.

Table 3: Overview of legally-required meters per type of installation.

Type of installation	Power	Type of meter
Heat-production	> 70 kW	Fuel + meter
Heat-production	> 400 kW	Calorimeter
Electrical heat pump	> 10 kW	Meter for electrical consumption
Electrical heat pump	> 100 kW	Meter for the amount of useful energy
Cooling (ice-water)	> 10 kW	Meter for electrical consumption
Cooling (ice-water)	> 100 kW	Meter for the amount of useful energy

II.iv. Applicability to new buildings

The requirements for new buildings apply to the building as a whole (minimal EP-level). So, the evaluation of the energy performance of TBS is part of the energy performance calculation. Since the performance of the installations is taken into account in the EP-level, there is no need for individual requirements. Individual requirements for new buildings are therefore considered an extra administrative burden that in addition reduces freedom in design without a proportionate benefit. For this reason, the requirements for TBS do not apply to new buildings.

II.v. Provisions for installation, dimensioning, adjustment and control

There are no regulations set for provisions for the installation, dimensioning, adjustment, and control of TBS. The use of efficient TBS is stimulated during the design process, as they are integrated within the energy performance calculations of new buildings, as well as in the new regulations for TBS in existing buildings: better systems will result in better global energy performance. The formulas to calculate the performance of the installation take into account certain measures with regard to installation, dimensioning, adjustment, and control. For example, the formula that calculates the efficiency of the space heating system (with a gaseous and liquid fuels heater) takes the following factors into account:

> efficiency of the heater at partial load;
> design temperature of the water in the emission system;
> location of the heater;
> regulation of the burner;
> regulation of the installation;
> insulation of the pipework;
> hydraulic regulation (only for installations in existing buildings with heating power over 400 kW).

II.vi. Encouragement of intelligent metering

The energy performance regulations for TBS contain requirements for energy metering of large installations. Table 3 gives an overview of the requirements. The presence of these metering systems is obligatory but it has no impact on the energy performance of the building and, thus, on its EPC rating. The meters need to comply with standards and they can transmit data by using a form of electronic communication. Smart metering of the whole building is not yet mandatory.

II.vii. Encouragement of active energy-saving control (automation, control and monitoring)

Some control systems (if correctly applied) have a positive effect on the energy performance level of new buildings. Such an example is a balance control in a mechanical ventilation system with heat recovery and flow temperature compensation in function of the outside conditions. Also automatic modulation of the lighting installation, e.g., daylight control, may positively affect the performance level. When such systems are used, it is easier to comply with the energy performance requirements for TBS.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The VEA is the responsible organisation for the implementation of the EPCs. In January 2006, the certification of new buildings started with the implementation of the energy performance requirements. More than 147,000 EPCs for new buildings have been issued in the Flemish Region since 2006.

For existing residential buildings (for sale), certification started on 1 November 2008. In case of the rental of existing houses, certification is compulsory as of January 2009. More than 700,000 certificates for existing residential buildings have been issued since then. Non-residential buildings, in case of sale or rental, do not yet require an EPC. The implementation of the energy certification scheme for the sale and rental of non-residential existing buildings is still under development and it is expected to start only by the end of 2016.

Only a QE can issue an EPC, and the QE has to use a specific certification software, provided by the Flemish government. All EPCs are stored in a (non-public) database[5], which is property of the VEA. QEs can only view their own files/EPCs.

The energy score on the EPC is based on a calculation (asset rating). The EPC includes standardised recommendations (depending on the QE's input).

An EPC has to be available from the moment a building is put up for sale or rent. The buyer receives the EPC, and in case of rental, the tenant receives a copy of the EPC. In case of sale, the notary has to report the absence of an EPC to the VEA. The seller might have to pay a fine when an EPC is not available on time.

The EPC is valid for a period of 10 years. Currently, there is no obligation that in case of renovation, a new EPC should be issued.

How flats are certified in apartment buildings

An EPC is required for each housing unit in apartment buildings, as long as it has all the necessary (residential) facilities to function autonomously, i.e., a kitchen, a bathroom and a toilet. In case of collective facilities, e.g., student housing, one EPC for the entire building is sufficient.

Format and content of the EPC

A calculated (asset) energy index in kWh/m².year (primary energy) is used to describe the energy performance of both new and existing residential buildings. This index is shown on a continuous scale on the certificate (Figure 17).

The EPC includes standardised recommendations that are automatically generated and tailored to the building, depending on the input. Since January 2013, the EPC has been extended with more detailed advice (e.g., the size of a wall that is poorly insulated) and information on the input data.

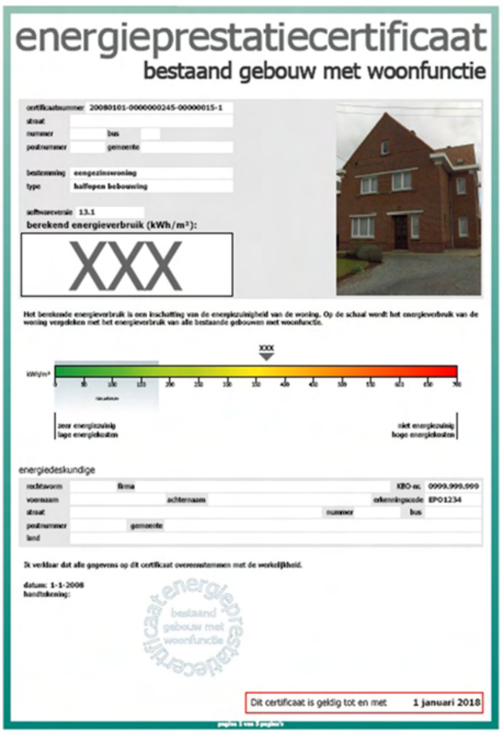


Figure 17: Cover page of the EPC.

[5] *www.energieprestatiedatabank.be*

Figure 18:
Amount of EPCs for new buildings by year.

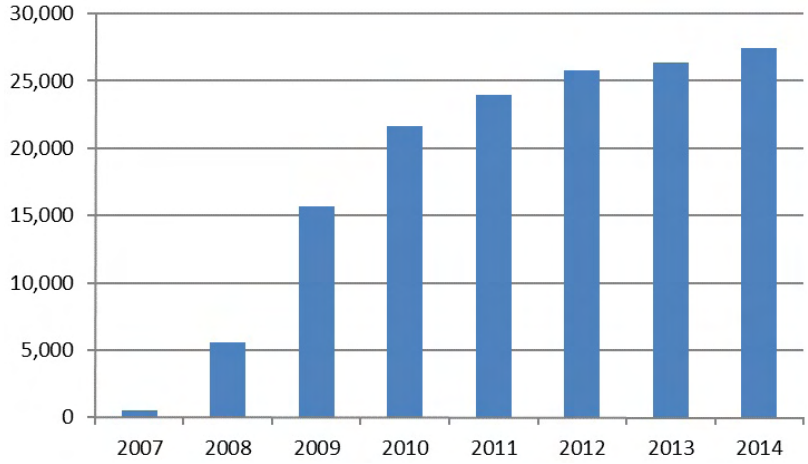


Figure 19:
Number of valid EPCs (existing residential buildings) per year and per month.

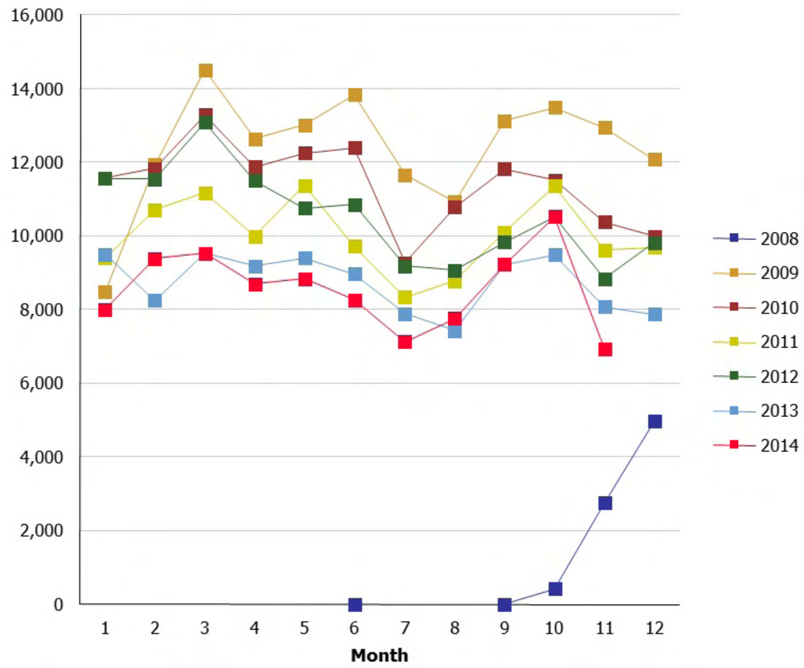
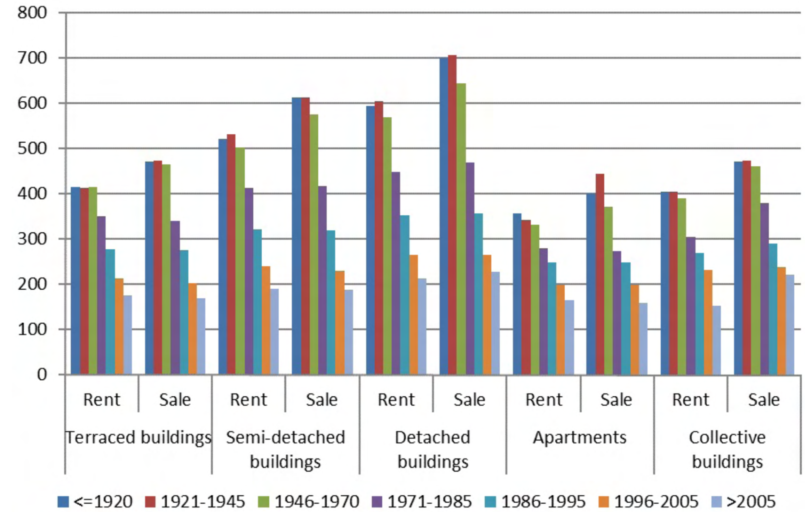


Figure 20:
Average energy consumption (kWh/m²) of existing residential buildings as function of building type and age.



EPC activity levels

Up to December 2014, 147,021 EPCs were issued for new buildings (Figure 18). Up to November 2014, 740,475 valid EPCs were issued for existing residential buildings (both for sale and rent). A building can have more than one EPC, but only the most recent is valid. The number of certificates issued per month and per year is shown in Figure 19. More than half (54%) of the issued EPCs refer to single-family houses, 45% of the EPCs are issued for apartments and only a small fraction (< 1%) of the valid EPCs refer to collective residential buildings based on data at the end of 2013. For all types of houses, most EPCs are issued in the event of sale.

The average energy score in the Flemish Region is 398 kWh/m².year for existing residential buildings (primary energy). There is a difference between the types of houses: apartments have the best (lowest) energy score. Naturally, the energy score also depends on the age of the houses. Fifty-eight per cent (58%) of the existing residential building stock is built before 1970, and these buildings have a huge influence on the average. Twenty-nine per cent (29%) of all residential units are detached houses, and a further 19% are semi-detached houses. Aside from that, there is a slightly better energy score for rentals. The average energy use in kWh/m² per building type and age is shown in Figure 20.

Typical EPC costs

The determination of the price of the EPC is left to the free market. There is no minimum or maximum price imposed. The price depends strongly on the type and complexity of the house, the availability of the building plans or bills of used materials, the travel time for the QE, etc.

Based on a small survey, the average price of an EPC for a large, detached house ranges from 150 € and up to 250 €.

Assessor corps

Only recognised QEs, called 'Energy Experts Type A', can issue EPCs for existing residential buildings. There are about 2,500 QEs for existing residential buildings. There are no predefined qualifications needed for QEs: a candidate QE should follow a recognised training programme and pass the centralised exam organised by the region. This exam is obligatory as of September 2012. The first centralised exam took place in February 2013. There are no diploma requirements to become a QE, and candidate QEs have to pay for the course (which is organised by recognised schools and institutions) and for their access to the exam (150 €). However, they do not need to pay for the use of the software or the database.

In 2013, in relation to the number of candidate QEs following the training course (609), rather few participants (278) took the centralised exam. The success rate was also low: only 43% of the participants succeeded in passing the exam.

The EPC for new buildings is part of the document in which the builder declares conformity or non-conformity of the as-built building with the energy performance requirements. Therefore, the accreditation of QEs for new buildings changed in January 2015. The new requirements include a diploma (e.g., architect or engineer, the former requirement), specific training (at least 95 hours) and a centralised exam. A mandatory scheme of permanent training for new and already qualified experts for new buildings is required from 2015 on. QEs recognised before the new January 2015 scheme keep their accreditation but they must also follow permanent training. There are about 1,200 QEs for new buildings.

Compliance levels by sector

Compliance with the availability of the certificate has stabilised. Ninety-three per cent (93%) of the buildings (for sale or rent) controlled in 2013 had a certificate (95% in 2012). The VEA performs sample tests on advertisements (i.e., checks whether or not an EPC is available and controls buildings on site). Notaries have to report the absence of an EPC. Citizens also have the opportunity to complain about the absence of an EPC. In 2013, there were 55 complaints (for 15 of them, the complaint was incorrect because an EPC was available) and 31 reports of notaries (6 incorrect). Figure 21 shows the number of controls and the compliance level by year (until 2013). These controls, reports or complaints do not reveal a significant difference between rental houses or houses for sale.

The seller or landlord risks a penalty in the range from 500 € up to 5,000 € if there is no certificate available. In 2013, 53 fines of 500 € were imposed (104 in 2012).

Quality Assurance (QA) of EPCs

In addition to the checks on new buildings (173 in 2013), the VEA executes a quality check on the work of a number of QEs, based on possible illogical input of data (desk controls) and on a targeted selection. Besides these desk controls, the VEA investigates a small number of EPCs on the spot (site visit) every year. In addition, the VEA also handles complaints regarding the quality. Controls on the spot are mostly based on complaints.

Since the start of checks in 2010, the enforcement procedure has been systematically tightened:

> In 2010, only warning letters were sent to the QEs who made mistakes.
> In 2011, VEA implemented an enforcement procedure when two or more possible errors were identified.
> As of 2012, an enforcement procedure is initiated as soon as one single possible error is identified.

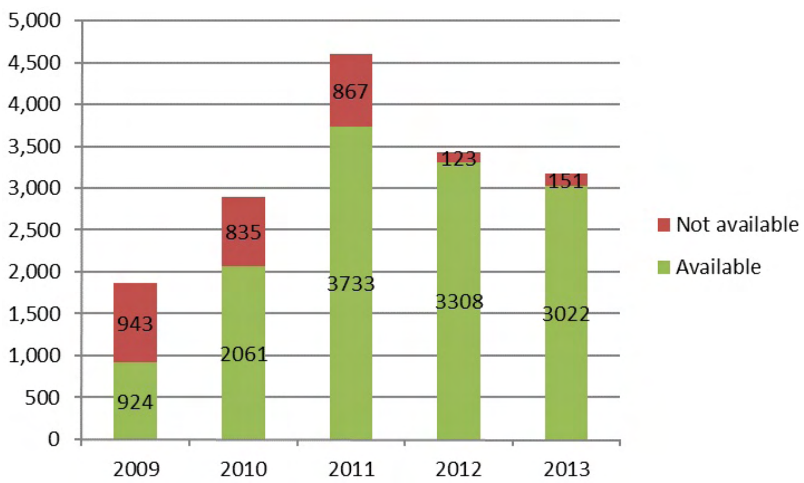
In 2013, 3 EPCs from a targeted selection of 302 QEs were checked by sampling (906 EPCs). Of those, 5 QEs were found to have correctly issued their EPCs, while all the others had to send evidence to back up the data they had inputted into the EPCs. After checking the evidence, 170 QEs were evaluated as OK, 125 experts had to pay a fine, and 2 were suspended. Experts risk a fine of between 500 € and 5,000 € if the control shows that the certificates were not correctly issued. Until now, only fines of 500 € were imposed. In 2013, there were 16 complaints (37 in 2012) and 10 QEs had to pay a fine. These high figures are based on a targeted control. Conclusions on the overall quality of all EPCs cannot be derived from this.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

In the Flemish region, the certification of public buildings has been gradually introduced. Initially (since January 2009), only large (> 1,000 m²) public buildings needed to have an EPC on display. Since January 2013, also public buildings larger

Figure 21: Number of controls regarding the availability of the EPCs (existing residential buildings), both sale and rental and according to year.



than 500 m² need to have an EPC on display. As of January 2015, small public buildings (> 250 m²) are also included. From 2009 until the end of December 2013, 7,631 certificates for public buildings were issued. These certificates are issued on the basis of an operational rating (measured energy consumption).

Public buildings are defined as being buildings of the federal, regional and local governments, schools, and health and welfare institutions.

Private buildings visited by the public are not included yet. In case of rental or sale, an EPC for non-residential buildings will be necessary.

Format and content of the EPC

The EPC for public buildings is based on real energy consumption. The EPC must be put in a place visible to the public. In this way, awareness is increased among both the visitors and the public organisations (Figure 22).

Figure 22: Front page EPC for public buildings.

Frequency of updating

The EPC for public display is also valid for a period of 10 years. In case of a new user or a new building, the public organisation has 15 months after commissioning the building to obtain a revised EPC. As in the case of residential buildings, there is no obligation that in case of renovation, a new EPC should be issued.

Figure 23: Extract from the EPC brochure for residential buildings (sale/rental).

Activity levels

From the 7,631 EPCs issued for public buildings by the end of December 2013, educational institutions represent the largest group (45%), followed by health institutions (15%), buildings for administrations (14%) and buildings for cultural events (13%). Buildings for sports activities, public services (e.g., railway stations, etc.) and police and court houses represent 13% of the EPCs for public buildings.

Figure 24: Image of EPC brochure for public buildings.

Figure 25: Brochure regarding subsidies and fiscal advantages (regarding energy-saving investments in residential buildings).

Costs

The price of the EPC is determined by the market. There is no minimum or maximum price imposed on the QE. The price depends strongly on the complexity of the building, the travel time for the QE, etc. Typical costs range between 500 € and 1,000 €.

Assessor corps

There are 1,299 registered QEs for public buildings and 886 internal experts. The internal experts are employees of the public organisation with two years of experience with energy efficiency. No exam is needed for internal experts.

Since September 2012, candidate QEs must, besides following a recognised training course, also pass a centralised exam. In 2013, in relation to the number of candidate QEs for public buildings following the training (49), rather few (29) took the exam. Ninety-three per cent (93%) of those passed the exam.

Quality Assurance (QA) of EPCs

Up to now, the VEA performed only a limited number of checks on the quality of EPCs for display in public buildings. EPCs with an unrealistic consumption or unrealistic usable floor areas were retrieved from the database. Supporting documents were requested and checked by the VEA for a number of EPCs. Up to now, no administrative fines were imposed. In 2013, no quality checks on the EPCs for public buildings were executed.

III.iii. Implementation of mandatory advertising requirement

Since January 2012, it is mandatory to publish the energy score and the address or the unique certificate reference number in all commercial advertisements. From 2012 until the end of December 2013, 5,224 controls have been executed regarding the advertising requirements. Of those, 735 advertisements (14%) were incorrect. In 2013, 83% of the controlled advertisements had the correct advertisement requirements (89% in 2012). Both private persons and broker agencies can receive a fine of between 500 € and 5,000 € for not publishing the required data regarding the EPCs. Since the start of 2012 until the end of December 2013, 68 fines were imposed (42 in 2012).

III.iv. Information campaigns

After the initial campaign in 2008, there were no major information campaigns concerning the EPC. A brochure listing the obligations related to the EPC is available on the website (Figure 23). Energy experts and other stakeholders are informed through a newsletter, the website, specific mailings, and other means. Additionally, public organisations are informed through newsletters, brochures, etc. (Figure 24).

Based on the results of the surveys, the VEA will try to communicate the benefits of EPCs in other information campaigns concerning rational energy use, zero-energy buildings, etc. Having an EPC is not the final aim, but an EPC can be a tool for inspiring energy saving in buildings.

A brochure listing all the subsidies and fiscal advantages for energy-saving investments (for residential buildings) is published every year (Figure 25). All brochures can be downloaded from the website[6].

III.v. Coverage of the national building stock

There are 2,626,744 buildings in the Flemish Region, of which 417,637 are non-residential buildings (including industrial and public buildings), and within these buildings, there are 3,069,975 residential units. At the end of 2014, 29% of the residential building units in the Flemish Region had an EPC (887,496 units out of a total stock of 3,069,975 residential units).

The public sector, as defined in the EPBD, is much larger than the stricter definition when applying the EED, Article 5 (only 150 buildings would be included in the strict EED definition). It is therefore not possible to estimate the coverage since there are yet no central data or statistics available regarding the number of public buildings subject to Article 12 of the EPBD.

III.vi. Other relevant plans

In 2013, the VEA started with the evaluation of the EPC regulation and therefore used input from different surveys:

- *"RUE-enquête"*: 1,004 Flemish households;
- 6 interviews with sector representatives of real estate agencies and notaries;
- interviews with real estate agents (103);
- online interviews with QEs (864).

The first draft of the evaluation report was published on the website of the VEA on 6 June 2014. Stakeholders were asked to give feedback on this report. The final report was send to the Flemish Minister of Energy in September 2014. Based on this report, changes on the procedures and the regulations will be made.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

The Flemish Region has adopted the inspection option for heating and air-conditioning (AC) systems. The Department of Environment, Nature and Energy is in charge of the implementation of these requirements, which are independent of the EED implementation.

[6] *www.energieprestatiedatabank.be*

Table 4: Summary of types of inspections on central heating systems powered by a boiler with gaseous, liquid or solid fuel.

Type of inspection	Fuel	Nominal power	When?	What?	By whom?*
Inspection before first utilisation	Gaseous	All	Before using a new or modified boiler (e.g., replaced burner, modified chimney)	Thorough inspection of several safety aspects and proper functioning of the boiler as defined by law, including adjustment of the boiler when deemed necessary.	RTG
	Liquid				RTL
	Solid				SC
Maintenance	Gaseous	≥ 20 kW	At least every two years		RTG
	Liquid		At least each year		RTL
	Solid	All			SC
Heating audit	Gaseous	≥ 20 kW and ≤ 100 kW	At least every five years	Inspection of the entire heating system by means of specialised software provided by the government, in order to determine energy-saving methods. By using this software, the energy efficiency of the entire heating installation is estimated.	RTG
		> 100 kW	At least every four years		RTH
	Liquid	≥ 20 kW and ≤ 100 kW	At least every five years		RTL
		> 100 kW	At least every five years		RTH
	Solid	All	At least every five years		RTH

* Abbreviations: RTG (recognised technician – gaseous fuel), RTL (recognised technician – liquid fuel), RTH (recognised technician – heating audit), SC (skilled craftsman).

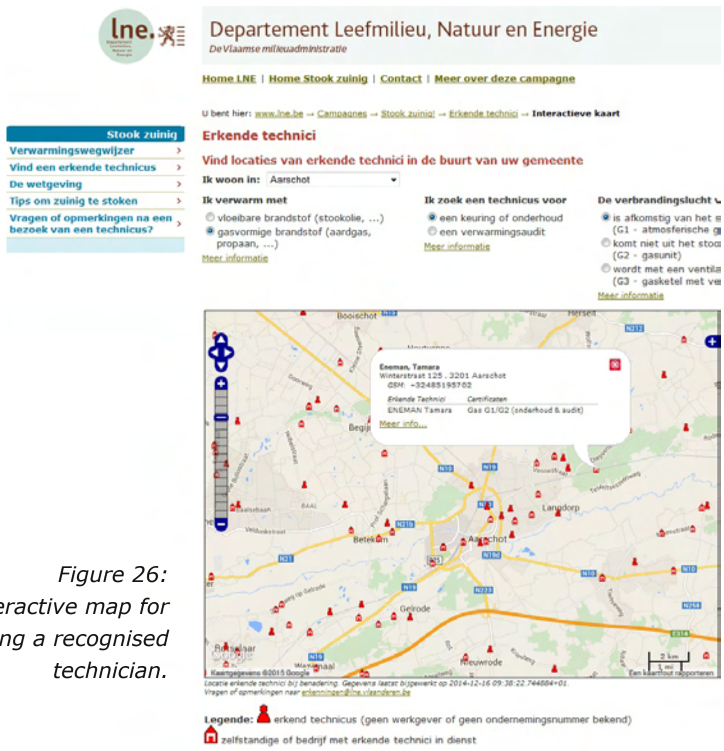


Figure 26: Interactive map for locating a recognised technician.

Table 5: Frequency of inspection of AC systems.

Nominal cooling capacity	Frequency of inspection
> 12 and < 50kW	every 5 years
≥ 50 kW and <250 kW	every 3 years
≥ 250 kW	every 2 years

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

In the Flemish region, central heating systems must be inspected by a recognised technician before they are used for the first time. Once in use, these systems must be inspected periodically, checking the proper operation as well as several safety aspects. Since May 2013, an audit of the entire heating system must be performed regularly, during which possible energy-saving methods are determined. The results of each inspection are documented in a report. There are only numbers of performed heating audits for boilers with an output greater than 100 kW. There is yet no database available for inspections of heating systems with boilers with less than 100 kW, but a new online software is being developed. A detailed summary of inspections is given in Table 4.

Arrangements for assurance, registration and promotion of competent persons

All types of inspections must be performed by a recognised technician. Technicians must complete a specific initial training and attend in-service training at least every five years. An interactive map and a list of recognised technicians are available online.

Promotional activities

In the autumn of 2013, the government of the Flemish Region launched a campaign to promote the aforementioned inspections and published a campaign website, www.stookzuinig.be, offering information concerning central heating systems, an interactive map to locate a nearby recognised technician (Figure 26), as well as a web application to determine user responsibilities. Regularly, at the start of the heating season, municipalities are reminded of this legislation and are requested to locally publish this information.

Enforcement and penalties

The quality control of recognised technicians is run by several supervisors of the Department of Environment, Nature and Energy who check whether a recognised technician meets the requirements when performing inspections and drawing up inspection reports (see below). If the latter is not the case, the technician will be warned, fined or prosecuted and/or their recognition can be suspended or withdrawn. Non-recognised technicians performing any of the aforementioned mandatory inspections that have been reported to the government are prosecuted.

Municipal supervisors and supervisors of the police zones may sanction the owner or user of a central heating system when a mandatory inspection has not been carried out. The supervisors can carry out a random selection of inspections or act when they receive complaints. A list of possible sanctions is included in the decree of 5 April 1995 concerning general provisions relating to environmental policy (e.g., a fine dependent on the kind of infraction).

Quality control of inspection reports

To implement the independent control system, a statistically significant percentage of the executed inspections are examined annually by an accredited inspection body appointed by the government. In 2013, 374 inspections were verified. As of 2014, around 600 randomly selected recognised technicians, as well as technicians against whom complaints have been made, are subjected to quality control annually.

Inspection activity figures

As of 2014, the number of recognised technicians for the inspection of systems using boilers with liquid or gaseous fuels exceeds 5,000 and 8,000, respectively. Currently, there are no figures of the total amount of inspected installations.

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

AC systems with a cooling capacity above 12 kW need regular inspection by a recognised expert. New AC systems should be inspected within 12 months of commissioning. The frequency of inspection of AC systems in use is dependent on the nominal cooling capacity, as shown in Table 5.

Inspection is conducted with software to evaluate energy efficiency and dimensioning of AC systems, specifically prepared for meeting EPBD requirements, and supplied freely by the Flemish government. The result of these inspections is a report that includes recommendations for the cost-effective improvement of the energy performance of the AC system. In 2015, the current software spreadsheet will be replaced by a more user-friendly online application.

Arrangements for assurance, registration and promotion of competent persons

In order to become a recognised expert, one has to meet certain requirements regarding training qualifications, or possess relevant experience of at least three years, attend a specific training course and pass a specific exam. Additional training every five years is required as well. The training courses started in the autumn of 2014. Until 1 January 2015, individuals with minimum training or experience (specified in the Flemish legislation on recognised experts: VLAREL) were temporarily accepted as recognised experts[7].

Promotional activities

All information relevant to the inspection of AC systems is supplied on the website of the Flemish Department of Environment, Nature and Energy[8].

Enforcement and penalties

Recognised experts must upon request provide information on all inspections conducted in the last three years to the supervising government. The Flemish government can suspend or withdraw the recognition in specific cases. No penalties have been levied yet.

Municipal supervisors and supervisors of the police zones may sanction the owner or user of an AC system when a mandatory inspection has not been carried out. The supervisors can carry out a random selection of inspections, or act when they receive complaints. A list of possible sanctions is included in the decree of 5 April 1995 concerning general provisions relating to environmental policy (e.g., a fine that depends on the kind of infraction).

Quality control of inspection reports

Once the new inspection software is introduced (in 2015), all inspection reports will be stored in a central database. This database will be used for quality control on a statistically significant number of issued reports by an independent accredited inspection body, as stated in the VLAREL. Until the end of 2014, no inspection reports have been controlled.

Inspection activity figures

The new software will be used to monitor inspection activity as well. No inspection activity figures are available yet.

[7], [8] www.lne.be/themas/erkenningen/airco-energiedeskundige

3. A success story in EPBD implementation

The governmental decision on gradually tightening the energy performance requirements for new buildings towards 2021, and the communication about this, garnered a strong response from the building sector. A transition is taking place whereby NZEBs are gaining interest not just from innovators but also from a rapidly growing group of builders. On the supply side, more and more architects, EPB experts, construction companies, installers, etc. are levelling up their knowledge, expertise and services to the NZEB market segment. All these building professionals are visible through governmental and non-profit web portals. Surveys show that one in two future homeowners considers building a NZEB.

To stimulate NZEBs in the Flemish Region, focus is put on the frontrunners (early adopters) paving the way. The VEA developed a NZEB-label and provided this as communication material to frontrunners, who are engaged in promoting NZEBs and putting their development into practice. Since the start of February 2014, a large number (300) of companies and organisations have become involved.

Thanks to a successful campaign, NZEBs are becoming more and more mainstream; it is a prominent theme at housing and building fairs, the media converse regularly about it, NZEB buildings are considered stable investments, private companies are positioning themselves as 'NZEB providers' and are developing demonstration projects, and so forth.

Another key to success is aligning with support mechanisms (property tax reductions and subsidies). As shown in Figure 7, in 2011, subsidies for E60 and E40 contributed to the improvement of the E-levels of new residential buildings (see spikes at levels E60 and E40). Parallel to the tightening path, a parallel path is fixed until 2021 concerning the evolution (and phasing out) of the different support mechanisms.

The EPB-software for new buildings was adapted and determines which NZEB requirements are fulfilled and which are not. When NZEB requirements are fulfilled, the label *'Ik BEN hier'* ('I'm NZEB here') appears. This instrument might inspire energy experts and future homeowners to take the necessary measures to achieve the NZEB-level and receive the associated subsidy.

4. Conclusions, future plans

Directive 2010/31/EU was a strong catalyst to get EPBD implementation on a higher level.

Requirements for new buildings were sharpened and the path towards 2021 was developed. New requirements for TBS and for thorough renovations were introduced on 1 January 2015. The average energy performance of new buildings decreases every year, and a well-functioning enforcement strategy is one of the keys to this success. A close follow-up of cost-optimisation of the path leading up to 2021 can be actualised with biannual cost-optimal studies. The roll-out of the NZEB action plan delivered a successful introduction of the NZEB level. A lot of frontrunner companies support the NZEB message.

At the end of 2014, almost one quarter of existing residential buildings will have an EPC. Ninety-three per cent (93%) of existing buildings have an EPC when rented or sold. Eighty-six per cent (86%) of a sample of controlled advertisements in 2012 and 2013 contain the correct information on the EPC. The VEA continually strives to ameliorate the quality of the EPCs.

Tools and accreditation schemes on inspections have been improved in the past years to achieve a larger impact.

Implementation of the EPBD in Belgium

STATUS IN DECEMBER **2015**

Walloon Region

1. Introduction

In Belgium, the responsibility for implementing the Energy Performance of Buildings Directive (EPBD) resides with the three regions: the Walloon Region, the Flemish Region and the Brussels Capital Region. This reports focuses on the implementation of the EPBD in the Walloon Region, where the relevant overall responsibility (except for the inspection of boilers and Air-Conditioning (AC) systems, which are the responsibility of the Walloon Agency for Air and Climate) rests with the Public Service of the Walloon Region, Department of Energy and Sustainable Buildings (hereinafter referred to as 'administration').

The Walloon Region of Belgium implemented the EPBD on 19 April 2007. The region has had a thermal regulation for new residential buildings in place since 1985, and for existing residential buildings, new and existing schools, as well as offices since 1996. For existing buildings, there are requirements in place for the building envelope (U-values) and for ventilation. These requirements are applicable to every renovation, but an administrative procedure is only organised in renovation cases where a building permit is required. For new buildings, the requirements depend on the building type, and may cover the building envelope (U-values, global insulation level), the global energy performance rating (E_w, E_{spec}), ventilation, and an overheating rating. A certification scheme is in place for existing residential buildings since June 2010, and for existing non-residential buildings since October 2011.

The EPBD is implemented by a decree, for which its execution orders were adopted on 28 November 2013 and 15 May 2014, and fully entered into force in May 2015. These rules incorporate existing regulations and include changes required by the EPBD Directive 2010/31/EU, such as display of energy performance indicators in sale and rental advertisements, extension of the concept of major renovations to buildings under 250 m² and, among others, the addition of system requirements for renovations.

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2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

In Belgium, regulations on buildings' energy performance are a regional competence. However, there are cooperation agreements between the three regions, in the interest of establishing an almost common methodology[1], leaving each region to define its own requirements. Also, the three regions use a single, jointly

NATIONAL WEBSITE energie.wallonie.be

[1] *The major difference between the Flemish Region and the Walloon Region is the reference building to which the project is compared when calculating the requirement E.*
The major difference between the Brussels Capital Region and the other two regions lies in the indicators used for the requirements, in production performance of hot water generators and the conversion factor in primary energy of wood.

developed, software tool (Figure 1). The aim is to make it easier for professionals to apply the tool.

I.i. Progress and current status

The calculation procedures and the minimum requirements for new and existing buildings have been included in an Executive Order of 22 June 2012 (p. 34014). After a transition phase that began in 2008, the Walloon Energy Performance Regulation (EPB) came fully into force in its current form in May 2010.

Since May 2010, the demand levels of the requirements have been tightened three times, i.e., in September 2011, June 2012 and January 2014, as illustrated in Table 1. The calculation procedure will continue to evolve, and technical studies are constantly being conducted to continue these developments. Priorities are established through consultation with the stakeholders. The next update is planned for January 2017.

After May 2015, further changes in administrative procedures and agreements were introduced. The administrative procedure anticipates that an initial EPB statement[2] would be submitted along with the request for planning permission (instead of fifteen days before work would start, as in the past). This initial EPB statement requires a complete energy performance calculation when the request for planning permission is submitted. The administrative procedure for new buildings subject to an overall energy performance level requirement is as follows:

> At the time of the request for planning permission:
  - Initial EPB statement. This is a document by which the applicant shows the measures taken to meet the requirements. Compliance with the requirements is mandatory to obtain a building permit. This document is submitted to the administration and uploaded to a central EPB database.

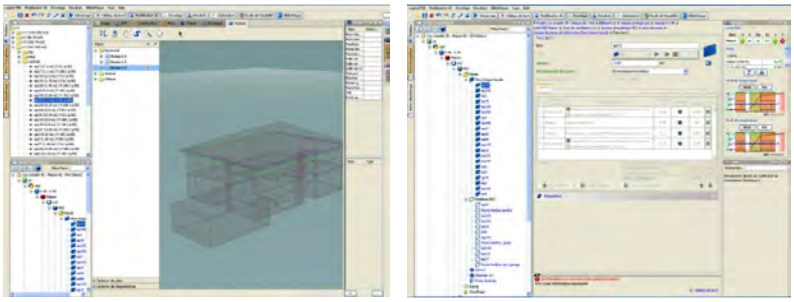


Figure 1: Software tool for the calculation of a building's energy performance.

> At the end of works:
  - Final EPB statement. This is a document by which the applicant demonstrates compliance with the energy performance requirements. This document is also submitted to the administration and uploaded to the central EPB database.
  - The Energy Performance Certificate (EPC) is then established by the expert, based on the information provided in the final EPB statement.

The amendments to the regulation also set requirements for the accreditation of Qualified Experts (QEs), which include the requirement to undergo training and to pass an examination. With a certain professional background, it is possible to directly attempt the exam without going through training.

Meanwhile, the administration put the necessary elements in place to prepare the sector for the arrival of the 2021 building regulation, which includes the Nearly Zero-Energy Building (NZEB) requirements.

Figure 2 shows the impact of the changes in the regulations on the primary energy consumption among new building projects registered in the EPB database.

I.ii. Format of national transposition and implementation of existing regulations

Regulations

The type and level of requirements for new buildings are determined by the function and type of the building (residential and schools, or offices, industry and other, non-residential, buildings), as shown in Table 1, and cover the following areas:

> the maximum E_{spec} value, which expresses the primary energy demand per m^2 of heated and/or conditioned floor area;

> the maximum E_w value, which expresses the primary energy consumption of the building compared to the primary energy demand of a reference building (different from the reference building in the Flemish Region);

> the maximum K-value, as in the Flemish Region and the Brussels Capital Region, which depends on the average U-value and the compactness (ratio between the volume of the conditioned space and the external area of the envelope) of the building;

[2] *EPB statement is an official declaration from the person who assumes the responsibility to tell the authorities that the building, as designed or built, meets the requirements of the EPB regulation.*

Requirements	Before EPBD		EPBD		
	Old requirements (2)	Requirements sept '08 - apr '10	Requirements may '10 - aug '11	Requirements sept '11 - dec '13	Requirements jan '14 - ...
A - U_{max} values ($W/m^2.K$) - New and existing (1) houses, collective housing, hospitals, offices and schools - New and existing shops, catering buildings, sports facilities, business and industry					
1. Walls defining the protected volume, excluding dividing walls with an adjacent protected volume					
1.1. Windows and other translucent walls, excluding doors, garage doors, curtain walls and glass brick walls	$U_{w,max}$ = 3.5	$U_{w,max}$ = 2.5 and $U_{g,max}$ = 1.6	$U_{w,max}$ = 2.5 and $U_{g,max}$ = 1.6	$U_{w,max}$ = 2.2 and $U_{g,max}$ = 1.3	$U_{w,max}$ = 1.8 and $U_{g,max}$ = 1.1
1.2. Opaque walls					
1.2.1. Ceilings and roofs	0.4	0.3	0.3	0.27	0.24
1.2.2. Walls without any contact with the ground, with the exception of walls covered in 1.2.4	0.6	0.5	0.4	0.32	0.24
1.2.3. Walls in contact with the ground	0.9	0.9	R_{min} = 1.0	R_{min} = 1.3	R_{min} = 1.5
1.2.4. Vertical walls and sloping walls in contact:			R_{min} = 1.0	R_{min} = 1.2	R_{min} = 1.4
- with underfloor spaces	0.6	0.6			
- with cellars outside the protected volume	0.9	0.9			
1.2.5. Floor in contact with the outside environment or above an underfloor space	0.6	0.6	0.6	0.35	0.3
1.2.6. Other floors:		0.9	U_{max} = 0.4 or R_{min} = 1.0	U_{max} = 0.35 or R_{min} = 1.3	U_{max} = 0.3 or R_{min} = 1.75
- above a crawl space - above a cellar outside the protected volume - basement floors underground	0.9				
- above the ground	1.2				
1.3. Doors and garage doors	$U_{D,max}$ = 3.5	$U_{D,max}$ = 2.9	$U_{D,max}$ = 2.9	$U_{D,max}$ = 2.2	$U_{D,max}$ = 2.0
1.4. Curtain walls	3.5	$U_{CW,max}$ = 2.9 and $U_{g,max}$ = 1.6	$U_{CW,max}$ = 2.9 and $U_{g,max}$ = 1.6	$U_{CW,max}$ = 2.2 and $U_{g,max}$ = 1.3	$U_{CW,max}$ = 2.0 and $U_{g,max}$ = 1.1
1.5. Glass brick walls	3.5	3.5	3.5	2.2	2.0
2. Walls between 2 protected volumes located on adjacent properties	1.0	1.0	1.0	1.0	1.0
3. Opaque walls inside a same protected volume or adjacent to another protected volume on the same property, except for doors and garage doors:					
3.1. between distinct residential units	1.0	1.0	1.0	1.0	1.0
3.2. between residential units and common spaces (staircase, entrance hall, passage)	-				
3.3. between residential units and non-residential occupancy spaces	1.0				
3.4. between industrial occupancy spaces and non-industrial occupancy spaces	1.0				

(1) Renovated buildings where a building permit is mandatory, and unheated buildings changing their occupancy
(2) These U-value requirements do not apply to shops, catering buildings, sports facilities, business and industry

Requirements	Before EPBD		EPBD		
	Old requirements (2)	Requirements sept '08 - apr '10	Requirements may '10 - aug '11	Requirements sept '11 - dec '13	Requirements jan '14 - ...
B - K values (-) – Global insulation level (function of average U-value and compactness)					
New buildings:					
Houses	K55	K45	K45	K45	K40
Offices and schools	K65				
Collective housing, hospitals, shops, catering buildings, sports facilities and business	-				
Industry	-	K55	K55	K55	K55
Existing unheated buildings changing their occupancy to:					
Houses	K65	K65	K65	K65	K65
Offices and schools	K70				
Other uses (heated)	-				
Existing heated buildings (except industry) changing their occupancy to:					
Houses	K65	-	-	-	-
Offices and schools	K70				
Other uses (heated)	-				
Existing industry (heated or unheated) changing their occupancy to:					
Houses	K65	K65	K65	K65	K65
Offices and schools	K70				
Other uses (heated)	-				
Others	-	-	-	-	-

Requirements	Before EPBD		EPBD		
	Old requirements (2)	Requirements sept '08 - apr '10	Requirements may '10 - aug '11	Requirements sept '11 - dec '13	Requirements jan '14 - ...
C - E_w (-) – Global energy performance level (calculated primary energy consumption divided by calculated primary energy consumption of a reference building) **D - E_{spec} ($kWh/m^2.year$) – Specific energy consumption** (calculated primary energy consumption per m^2 of heating floor area) **E - Overheating rating (K.h)**					
New buildings:					
Houses	-	-	$E_w \leq 100$ $E_{spec} \leq 170$ $I_{overh} \leq 17,500$	$E_w \leq 80$ $E_{spec} \leq 130$ $I_{overh} \leq 17,500$	$E_w \leq 80$ $E_{spec} \leq 130$ $I_{overh} \leq 17,500$
Offices and schools	-	-	$E_w \leq 100$	$E_w \leq 80$	$E_w \leq 80$
Other destinations	-	-	-	-	-
Existing buildings:	-	-	-	-	-

Requirements	Before EPBD		EPBD		
	Old requirements (2)	Requirements sept '08 - apr '10	Requirements may '10 - aug '11	Requirements sept '11 - dec '13	Requirements jan '14 - ...
F - Ventilation					
New houses and buildings changing their occupancy to houses	Requirements are set in the annex V of the execution order of 17 April 2008 (based on NBN D50-001)				
New offices, schools and buildings changing their occupancy to offices or schools	Requirements on air outputs are function of premises use	Requirements are set in the annex VI of the execution order of 17 April 2008 (based on NBN EN 13779)			
New collective housing, hospitals, shops, catering buildings, sports facilities, businesses and buildings changing their occupancy to these uses	-				
Renovated houses with a mandatory building permit	Partial system (only for supply air if windows are replaced)				
Renovated offices and schools with a mandatory building permit	Partial system (only for supply air if windows are replaced)				
Renovated collective housing, hospitals, shops, catering buildings, sports facilities and businesses with a mandatory building permit	-	Partial system (only for supply air if windows are replaced)			
New and existing industry	-	-	-	-	-

Table 1: Evolution of energy requirements.

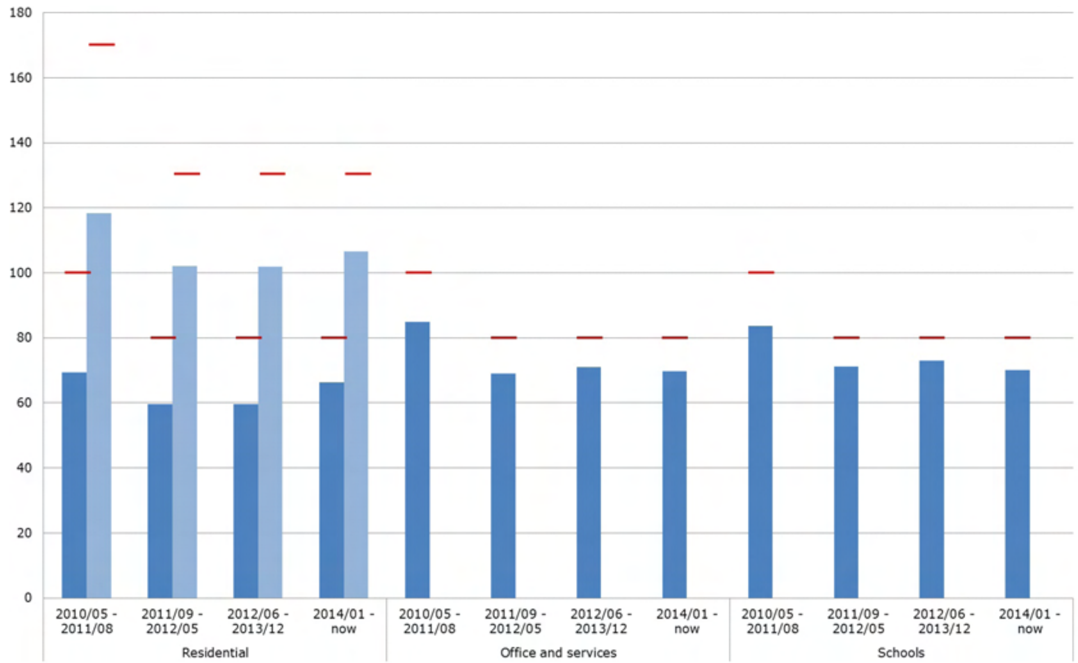


Figure 2: Average results for buildings registered in the EPB database, in terms of E_w (primary energy consumption), compared to the legal requirements.
- Dark blue: E_w value average
- Light blue: E_{spec} value average
- Red lines: maximum allowed consumption

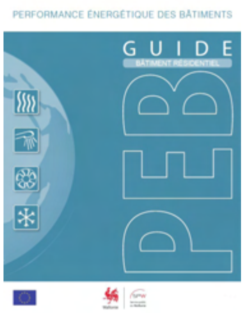


Figure 3: Guide to energy performance for residential buildings.

> the maximum U-values for each element of the building envelope;
> the requirements concerning ventilation (minimum ventilation rates to ensure indoor air quality);
> the maximum rating value for overheating.

Technical guidance document

A practical guide (Figure 3), designed for professionals, helps them to understand the new regulation. This guide is available on the website[3] of the Department of Energy and Sustainable Buildings.

A specific support service called "*Facilitateurs PEB*" is also available. This service is accessible by e-mail or phone.

Table 2: Elements included in the energy performance calculations for residential and non-residential buildings.

	Residential buildings	Non-residential buildings
For the envelope:		
o Transmission losses, including thermal bridges	X	X
o Ventilation losses, including evaluation of infiltration	X	X
o Internal and solar gains	X	X
o Heat capacity	X	X
For systems:		
o Heating installation	X	X
o Air-conditioning installations, including free cooling systems	X	X
o Hygienic ventilation	X	X
o Hot water supply (currently only for residential buildings)	X	-
o Lighting installation (only for non-residential buildings)	-	X
o Consumption of auxiliary equipment	X	X
o Thermal and photovoltaic solar system	X	X
For internal comfort:		
o Type of ventilation (natural, mechanical, mixed) and air flow rates	X	X
o Assessing the risk of overheating	X	-

The energy performance calculation methodology is almost identical for the three regions. There are two variations of the calculation methodology, one for residential, and another for non-residential buildings. The main elements included in each version are listed in Table 2.

The following factors (f_P) are used to express the final results in terms of primary energy:

> natural gas, oil, propane, butane, LPG, wood, pellets: f_P = 1.0;
> electricity (consumed or self-produced): f_P = 2.5.

The three regions are working together to adapt the energy performance calculation method (to develop a simplified method and to propose an alternative to fixed values, allowing the inclusion of product data and consideration of the EcoDesign Directive, etc.). The three regions, together with the Belgian Building Research Institute, the main universities of the country and design offices, have established a common platform, the so-called 'EPB consortium', with the objective to bring together a variety of actors capable of conducting studies on the evolution of the energy performance calculation method. In those technical studies, the existing standards (including CEN standards) are always considered.

Quality Assurance (QA) / Compliance checking process

A free, commonly used software tool for QEs has been developed to calculate the primary energy consumption of the

[3] www.leguidepeb.be

building, to check compliance with regulation requirements, and to deliver proper documentation to the administration. The software tool integrates validation rules to avoid encoding errors and to facilitate control. In addition to the adaptations necessary for the implementation of requirements that are regularly increased, the Walloon Region ensures constant improvements in the usability of the tool, in response to user expectations and feedback.

QEs must save all their files on the central EPB web database (Figure 4). Local and regional administrations (920 civil servants in total) have access to this database in order to ensure compliance with the regulation. Until now, 40,315 construction projects have been registered in the database (these consist of new buildings and major renovations since May 2010), of which 6,814 have been completed (building construction completed) (Figure 5).

Qualified Experts (QEs)

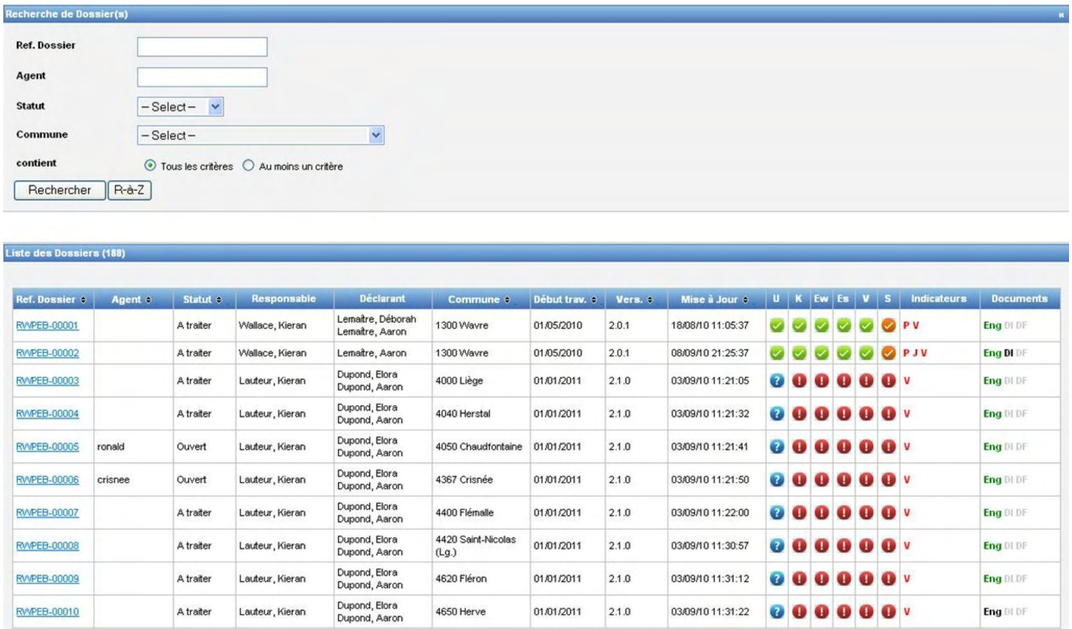
Professionals in charge of implementing the regulation are called "*EPB responsibles*", and they are required to hold a degree in either architecture, or engineering. For a person to become accredited, he/she must hold one of the required degrees, and prove that they have insurance coverage. Training courses are not mandatory, but are organised continuously. Their aim is to:

> explain the basic principles of the calculation method and the energy requirements to new QEs;

> explore the technical aspects in more detail with the accredited QEs.

Names and addresses of QEs are listed on the website[4] of the Department of Energy and Sustainable Buildings.

From May 2015, QEs will need to undergo training and must pass an examination to become accredited.



Ref. Dossier	Agent	Statut	Responsable	Déclarant	Commune	Début trav.	Vers.	Mise à Jour	U	K	Ew	Es	V	S	Indicateurs	Documents
RWPEB-00001		A traiter	Wallace, Kieran	Lemaitre, Déborah Lemaitre, Aaron	1300 Wavre	01/05/2010	2.0.1	18/08/10 11:05:37							P V	Eng DI DF
RWPEB-00002		A traiter	Wallace, Kieran	Lemaitre, Aaron	1300 Wavre	01/05/2010	2.0.1	08/09/10 21:25:37							P J V	Eng DI DF
RWPEB-00003		A traiter	Lauteur, Kieran	Dupond, Elora Dupond, Aaron	4000 Liège	01/01/2011	2.1.0	03/09/10 11:21:05							V	Eng DI DF
RWPEB-00004		A traiter	Lauteur, Kieran	Dupond, Elora Dupond, Aaron	4040 Herstal	01/01/2011	2.1.0	03/09/10 11:21:32							V	Eng DI DF
RWPEB-00005	ronald	Ouvert	Lauteur, Kieran	Dupond, Elora Dupond, Aaron	4050 Chaudfontaine	01/01/2011	2.1.0	03/09/10 11:21:41							V	Eng DI DF
RWPEB-00006	crisnee	Ouvert	Lauteur, Kieran	Dupond, Elora Dupond, Aaron	4367 Crisnée	01/01/2011	2.1.0	03/09/10 11:21:50							V	Eng DI DF
RWPEB-00007		A traiter	Lauteur, Kieran	Dupond, Elora Dupond, Aaron	4400 Flémalle	01/01/2011	2.1.0	03/09/10 11:22:00							V	Eng DI DF
RWPEB-00008		A traiter	Lauteur, Kieran	Dupond, Elora Dupond, Aaron	4420 Saint-Nicolas (Lg.)	01/01/2011	2.1.0	03/09/10 11:30:57							V	Eng DI DF
RWPEB-00009		A traiter	Lauteur, Kieran	Dupond, Elora Dupond, Aaron	4620 Fléron	01/01/2011	2.1.0	03/09/10 11:31:12							V	Eng DI DF
RWPEB-00010		A traiter	Lauteur, Kieran	Dupond, Elora Dupond, Aaron	4650 Herve	01/01/2011	2.1.0	03/09/10 11:31:22							V	Eng DI DF

Figure 4: Preview of the central EPB database.

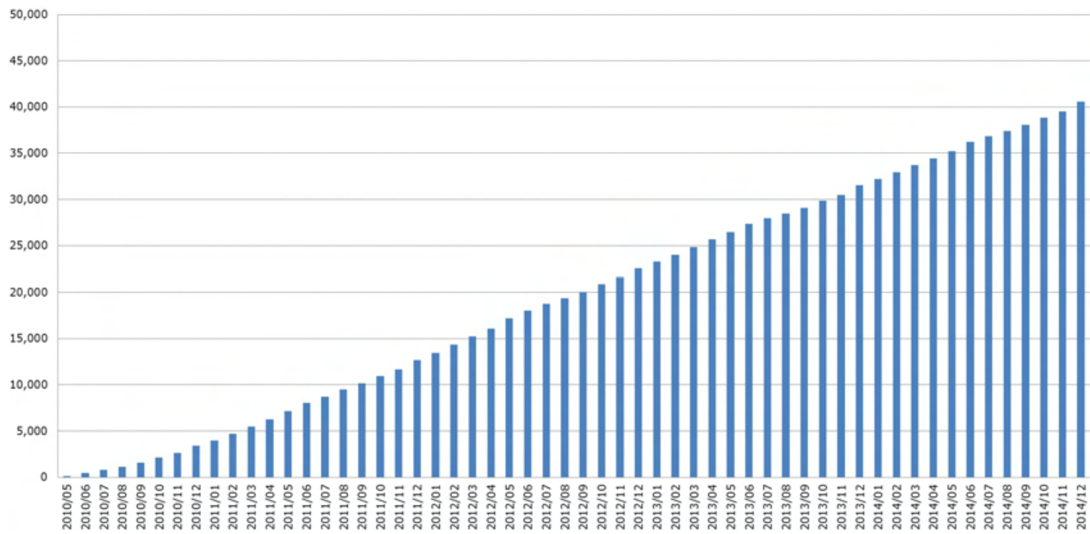


Figure 5: Central EPB database – number of registered EPB statements.

[4] *http://energie.wallonie.be/fr/liste-des-responsables-peb-agrees.html?IDC=7264*

I.iii. Cost-optimal procedure for setting energy performance requirements

In order to determine optimal energy performance levels in relation to costs, a study (called 'Co-ZEB' and available on the website[5] of the Department of Energy and Sustainable Buildings) was launched at the end of 2011 and published in June 2013. The economic parameters included are as follows:

> macro-economic calculation scenario;
> a discount rate of 4%, as suggested in the guidelines;
> medium scenario trend for energy cost increases (1.75%).

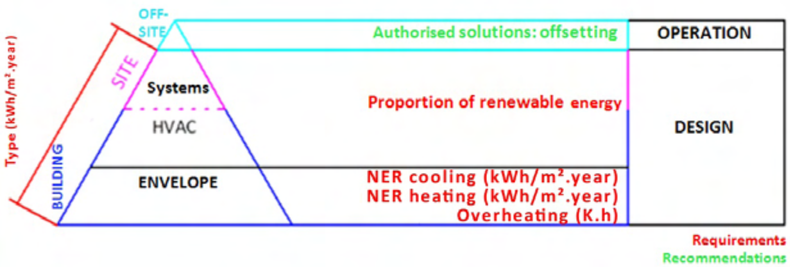
Table 3: Comparison between cost-optimal levels and 2014 requirements.

Elements	Optimum
Window insulation	Requirement 2014 : $U_{w,max}$ = 1.8 W/m².K and $U_{g,max}$ = 1.1 W/m².K
Ceiling and roof insulation	No clear optimum
Wall insulation	Requirement 2014 : U_{max} = 0.24 W/m².K
Floor insulation	Requirement 2014 : U_{max} = 0.3 W/m².K
Global insulation	**2014 Requirements (see table below)**

Destination	Cost-optimal K level	Required K level since January 2014	Gap (%) with 2014 requirements
Houses	-	K35	-
Offices (without AC system)	K33	K35	-5,7%
Offices (with AC system)	K37	K35	+5,7%
Schools	K36	K35	+2,8%

Destination	Cost-optimal E_w level	Required E_w level since January 2014	Gap (%) with 2014 requirements	Cost-optimal building setup
Houses	65,55	80	-18%	- 2014 U values - gas condensing boiler - ventilation C+ - airtightness 4 m³/h.m²
	E_{spec} : 112,6 kWh/m².year	E_{spec} : 130 kWh/m².year	E_{spec}: -13%	
Offices (without AC system)	50	80	-37%	- 2014 U values (glass with solar factor g=0.38) - gas condensing boiler - ventilation D - lighting diming - indoor manual solar protections
Offices (with AC system)	63	80	-21%	- 2014 U values (without solar glass) - gas condensing boiler - ventilation D - lighting diming - indoor manual solar protections - AC system
Schools	32	80	-60%	- 2014 U values (without solar glass) - air/water heat pump - ventilation C - efficient lighting - indoor mobile solar protections - PV panels

Figure 6: NZEB definition.



The main conclusions in relation to the requirements foreseen for 2014 are:

> in terms of U values and global insulation levels, requirements were found to be cost-optimal;
> concerning system E_w level for new buildings (global energy consumption level expressed in primary energy), requirements were found to be only slightly different from cost-optimal solutions, depending on building typology (Table 3).

Thus, the requirements included in the new 2014 regulation are, so far, found to be cost-optimal.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

In 2012, the Co-ZEB study laid out the national definition of NZEB as a building with the energy performance level of the building envelope close or equivalent to the '*Passive House*' standard. In this study, NZEBs were characterised by a high thermal performance of the building envelope, as well as by covering a part of the residual consumption for heating/cooling and electricity using Renewable Energy Sources (RES), as illustrated in Figure 6.

However, it is not necessary for a NZEB to comply with all of the criteria set by the '*Passive House*' standard, given the highly constraining nature of these criteria for certain building types and/or for certain locations (in particular the criterion on the airtightness of the building envelope, which imposes a specific level of performance that is often difficult to achieve, in construction terms). The quantification of the energy performance level is based on the development zones and the building type, as well as on whether the building is new, or renovated.

To be certified as a NZEB, the building must meet a series of strict requirements or alternative criteria, which are a series of non-restrictive recommendations aimed at facilitating compliance with the requirements set. A list of recommended equipment solutions encourages the occupants of NZEBs to align their actual energy consumption with the projected or reference consumption estimated for

[5] energie.wallonie.be/fr/etudecozebcoutoptimum.html?IDC=8729&IDD=97766

elements not considered in the characterisation of a NZEB at the design stage.

Application of NZEB requirements to the cost-optimal calculation, based on the assumptions included in the study, has shown that:

> New NZEB residential buildings are relatively close to cost-optimal under the assumptions that were chosen for the study and they are very close to cost-optimal in case a high trend of energy cost increase had been chosen.
> New NZEB offices are about 10% above cost-optimal.
> New NZEB schools are not cost-optimal but they would approach cost-optimal in case a high trend of energy cost increase had been chosen.

In early 2014, these requirements were presented to the regional stakeholders of the building sector as part of a 2014 - 2020 roadmap, but they did not garner consensus. Therefore, a new proposal has been developed which is based on the results of calculations on model geometry, statistical data and subsidies databases. These new requirements were approved by the regional stakeholders of the building sector and will be adopted by the Government in January 2016. They are presented in Table 4.

Figures and statistics on existing NZEBs

Based on NZEBs requirements (Table 3), 2,856 of the buildings included in the EPB database meet the definition of NZEB, representing 12% of the total final EPB statements.

The renewable solutions for heating most commonly proposed by the designers to meet the NZEB requirements are shown in Table 3, and include the use of a heat pump (26%), a combination of heat pump with photovoltaic solar panels (20%), photovoltaic solar panels alone (11%), or a combination of a biomass boiler with photovoltaic solar panels (4%). It is interesting to observe that, in 26% of the cases, the net energy needs for heating and overheating set out in the NZEB requirements for primary energy consumption are met without the use of RES (Figure 7).

Table 4: NZEB requirements and recommendations.

Individual residential units			**2021**
E_W			45
E_{spec}			95 kWh/m²
K			35
U_{max} roof/wall/ceiling			0.24 kWh/m²
U_{max} floor			0.24 kWh/m²
U_{max} window			1.5 kWh/m²
U_{max} glazing			1.1 kWh/m²
U_{max} door			2.0 kWh/m²
Ventilation			*
Overheating index			< 6,500 K.h
% RES			-
non-residential units			**2021 (2019 public buildings)**
FUNCTIONS	Overall requirement E_W		
	Lodging		90
	Offices		45
	Schools		45
	Health care	With nocturnal occupation	90
		Without nocturnal occupation	90
		Operating room	90
	Group	High occupancy	90
		Low occupancy	90
		Cafeterias/ large dining rooms	90
	Kitchen		90
	Commerce		90
	Sports facilities	Sport hall/gymnasium	90
		Fitness Dance	90
		Sauna Pool	90
	Technical local		45/90
	Common		45/90
	Other		90
	Unknown		90
E_{spec}			
Other requirements			
K			35
U_{max} roof/wall/ceiling			0.24 kWh/m²
U_{max} floor			0.24 kWh/m²
U_{max} window			1.5 kWh/m²
U_{max} glazing			1.1 kWh/m²
U_{max} door			2.0 kWh/m²
Ventilation			*
Overheating index			
% RES			-

* Specified in an annex

Figure 7: Number of NZEBs and use of RES.

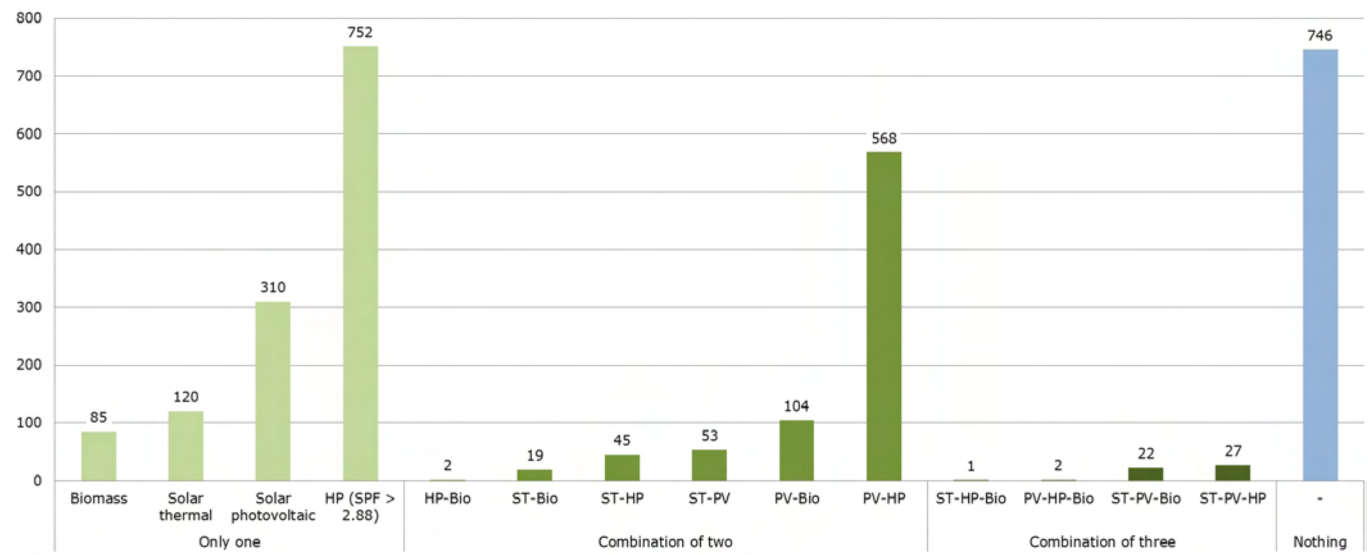


Figure 8: Reference apartment buildings for Article 4 of the EED.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Concerning Article 4 of the EED, a first draft of a renovation action plan for the Walloon Region was included in the third National Energy Efficiency Action Plan (NEEAP3). A study was conducted by the University of Mons, the University of Liège and the 3E consultant group, with the aim to present the residential and commercial building stock, and to identify cost-effective approaches for renovation linked to building type. The study will be published at the end of 2015. Already, a summary overview of the residential and commercial building stock has been put together (Figure 8). The Walloon Region has already implemented a number of regulatory and non-regulatory measures, including subsidies for energy audits, subsidies for energy-efficient renovation of houses, zero interest rate credit for energy renovation of houses and tax reductions, as policies and instruments to stimulate major, cost-effective renovation, including gradual major renovations. The government and major stakeholders have also established an employment-environment alliance (EEA) through the “Plan Marshall 2.Vert”, which aims at improving the environment, while promoting economic opportunities and job creation, ensuring the transition of the entire construction industry to a more sustainable construction/renovation model. Three areas for improvement were identified:

> stimulating the demand for renovation and for sustainable construction of private and public buildings;

> increasing the construction sector’s capacity and the number of new and renovated buildings on offer in the market;

> developing skills through a comprehensive training program.

The EEA is a multi-year plan with a budget of 879 M€.

In addition to the above-mentioned measures, which represent an initial strategy of building renovation, the Department of Energy and Sustainable Building has begun to consider supporting the establishment of a refurbishing strategy for buildings in the Walloon Region, by organising workshops aimed at inspiring the vision and proposing concrete actions.

In parallel, in October 2013, a consultation on the requirements and the methodology of energy performance calculation was held at the request of the building sector. Eleven organisations participated. The objective of the consultation was to establish a roadmap for energy performance requirements applicable in the Walloon Region for the period 2014-2020, for both new construction and renovation of all types of buildings. The roadmap should be acceptable to all, on the basis of European objectives, while meeting the specific conditions of the Walloon Region and of its key stakeholders, the economic and energy context, the expected achievements, as well as the affordability of housing. For the more specific cases of renovation, a strategic consultation on the long-term renovation of buildings was also proposed. A preliminary report was produced in June 2014, in which the following main needs were identified:

> to know better all possible means of communication to pass the message to every citizen in the Walloon Region;

> to conduct an energy audit prior to any works and/or subsidies;

> to give clear instructions to QEs regarding long term energy requirements for renovations;

> to develop EPCs as a support tool for decision-making, and to work towards complementarity between EPCs and energy audits suitable for investment decisions;

> to establish criteria for evaluating whether large-scale refurbishment is preferable to demolition/ reconstruction;

> to distinguish regulation requirements for new construction versus renovated buildings that are nearly as energy efficient as new buildings.

At the end of 2015, the government in place since June 2014 has been working on a EEA in the frame of the “Plan Marshall 4.0”, that will include some specific actions related to a long-term strategy for mobilising investment in the renovation of the national building stock. Concrete actions are planned for 2016 to deepen stakeholder involvement and develop tools.

Concerning Article 5 of the EED, the Walloon Region has chosen to adopt an alternative approach to the required annual renovation of 3% of existing public buildings. Article 5.6 allows for the adoption of other effective measures, such as major renovations, as well as measures to modify the behaviour of occupants in buildings owned and occupied by the central government, in order to achieve, by 2020, energy savings that would be equivalent to those that would result from the obligatory renovation rate defined in paragraph 1 of Article 5.

The Walloon Region decided to determine its target based on the pre-existing register of buildings' energy performance, with data collected by the different institutions of central government. This register lists technical data on the buildings, e.g., heated area, occupancy and annual actual consumption data (corrected according to heating degree days), and enables the characterisation of a building's individual energy performance in kWh/m².year, which can then be compared to the cost-optimal energy performance of the region in which the building is located. This sets the goal of primary energy savings, corresponding to the required 3% of annual savings that must be achieved by each official institution that must comply with this EED requirement. At this stage, the Walloon Region has calculated its renovation target based on an economical primary energy consumption of 15 kWh/m².year.

The measures which the Walloon Region plans to take in order to achieve its energy savings objective, are those recommended by the Walloon energy audits, as defined in the UREBA programme *("Utilisation Rationnelle de l'Energie dans les Bâtiments Publics - Rational Use of Energy in Public Buildings")*.

I.vi. Other relevant plans

There are a number of voluntary programmes related to new and existing residential and non-residential buildings. The most significant of these are:

> The Energy Advice Procedure ('PAE1') for existing residential buildings, in force since 2006. A new procedure called 'PAE2', which is accompanied by a new report layout and includes a strong link with EPCs, has been developed and applied since late 2013. This is an audit that provides an evaluation of the building's energy performance, taking into account the real energy consumption, as well as detailed recommendations to improve this performance. The energy audit also shows how the EPC would improve if works recommended by the audit were implemented (Figure 9). At the moment, more than 483 assessors are accredited on the basis of PAE2 to perform energy audits, and all audits are centralised in a database. Currently, more than 38,900 PAE1 audits are registered in this database, as are more than 5,800 PAE2 audits, together representing more than 2.9% of the existing building stock in the Walloon Region.

> The call for projects "Exemplary buildings in Wallonia"[6] was an action aimed to develop the construction and refurbishment of buildings with strict energy and environmental criteria applied to architectural quality, cost-effectiveness and reproducibility. A technical annex lists criteria and minimum requirement levels that must be met to submit a project. The projects selected by the jury receive a grant and technical guidance to ensure compliance with their commitments. This action aims to prepare the building sector for NZEB requirements, beyond the legal minimum requirements. The first call ended in December 2012. Seventy (70) projects for residential buildings were submitted, and 23 projects, representing a built area of 7,415 m², were declared

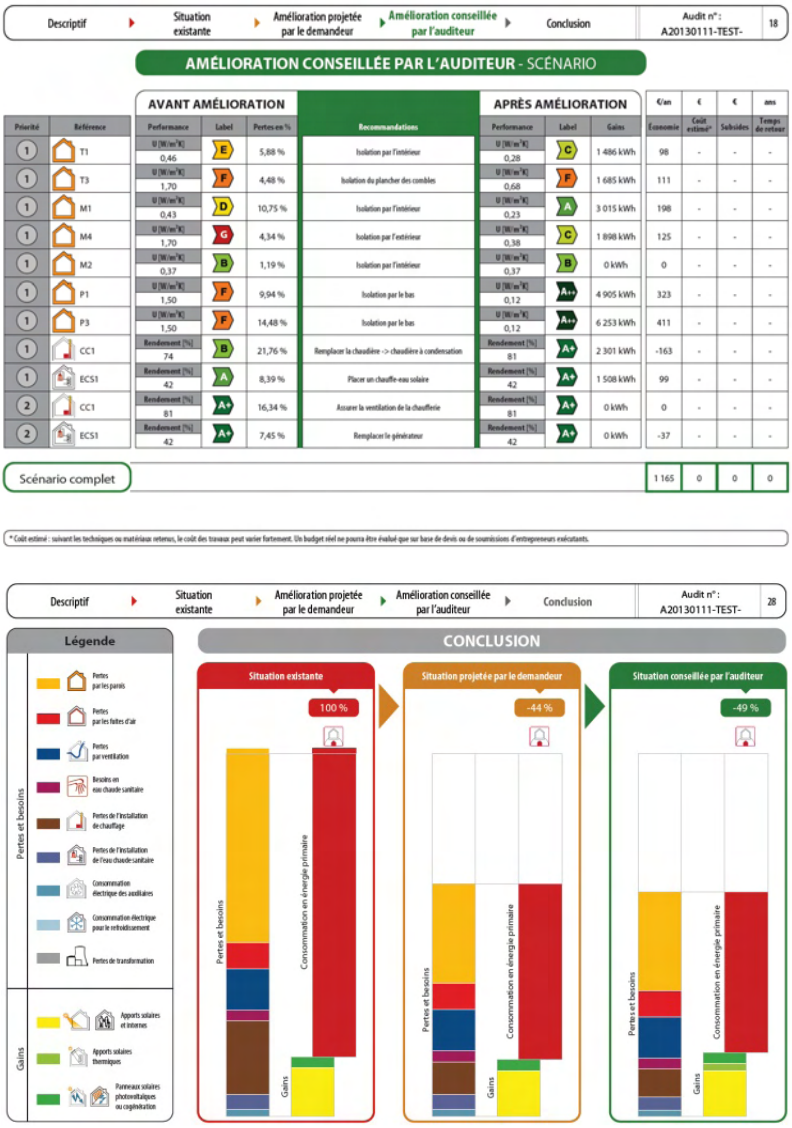


Figure 9: Layout of the new energy audit.

[6] *energie.wallonie.be/fr/l-action-batiments-exemplaires-wallonie.html?IDC=8614*

winners by the jury. At this time, construction works are ongoing and 8 projects are being finalised. A second call closed in December 2013. Fourteen (14) non-residential projects were submitted, and 7 projects, representing 24,159 m² of buildings, were declared winners. After construction, projects that comply with their commitments shall receive confirmation showing their exemplary performance.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

The Walloon Region is working on the inclusion of requirements on Technical Building Systems (TBS) into its legislation. The requirements will enter into force on 1 May 2016 and are partially inspired by the Flemish Regions TBS requirements, with some additional specifications, or modifications, inspired by the Brussels Capital Region's 'heating' and 'air-conditioning' decrees.

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The bill establishes minimal requirements for heating systems with gas, liquid, or solid fuel boilers, or with heat pumps. For instance, the requirements on the Coefficient of Performance (COP) for two types of heat pumps are presented in Table 5. The other types of heat pumps are already subject to sufficient performance requirements, laid out in Commission Regulation 813/2013.

In new direct electrical heating systems installed after 1 May 2016, the power of the direct electrical heating system will be limited to 15 W/m² of the building's heated floor area. Similar restrictions are set on the power of electrical Domestic Hot Warer (DHW) boilers.

A minimal efficiency is also foreseen (Table 6) for compression cooling devices, with respect to the cooling vector (water or air).

Requirements will be set for the heat recuperation of central ventilation systems. The Walloon Region will implement some general requirements for all ventilation systems (not just large ones).

Table 5: Coefficient of Performance (COP) as function of the type of heat pump.

Heat Pump Type	Coefficient of Performance
Soil / Water	4.3
Water/ Water	5.1

Table 6: Minimal efficiency for compression cooling devices.

Type of cooling machine	$\eta_{inst,min}$
Cold water cooling machine (air cooled)	2.0
Cold water cooling machine (water cooled)	3.1
Cold water cooling machine (water cooled and with remote condenser)	2.5

II.ii. Regulation of system performance, distinct from product or whole building performance

The general philosophy of the bill is to set requirements for whole systems, instead of parts of the system. In general, parameters to be taken into account include among others pipe insulation and the initial setting of the various system components.

For instance, in the case of the heat recuperation in a serially produced central ventilation system, the requirement is set to:

$$\eta_{hr,vent} = \eta_{test} \cdot f_{at\ AHU} \cdot f_{at,\ duct} \cdot f_{insul,duct} \cdot f_{ae} \cdot f_{reg,vent} \geq 75\%$$

Where η_{test} is the efficiency of the heat recuperator measured in laboratory conditions, but where the other parameters are linked to the global system:

> $f_{at,\ AHU}$ is representative of the airtightness of the air handling unit;

> $f_{at,\ duct}$ is representative of the airtightness of the air ducts;

> $f_{insul,\ duct}$ is linked to the insulation of the ventilation air ducts;

> f_{ae} is representative of the system settings;

> $f_{reg,\ vent}$ is representative of the speed of the fans.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

The bill applies to the installation of new equipment, as well as to the renovation of existing systems in existing buildings. The requirements must be fulfilled upon new installation, or replacement of one of the main parts of the system. For a fuel boiler, these 'main parts' are the burner, or the whole boiler. For a ventilation system, these are the air-handling unit, or the heat recuperator.

The same calculation method applies for both cases (new and renovated buildings).

II.iv. Provisions for installation, dimensioning, adjustment and control

TBS requirements are often linked to parameters which reinforce efficient design and good installation of the various system components.

In the case of a boiler, for example, the requirement takes into account the location of the boiler, or the setting of its temperature by the use of different corrective coefficients.

There is no global building performance calculation involved in the TBS requirements. Better TBS have had a positive impact on the E-level, but this impact has not been calculated.

II.v. Encouragement of intelligent metering

The bill also sets requirements on the meters to be installed, depending on the TBS. In the case of a boiler, installing a fuel meter will be required when the power is greater than 100 kW. In the case of one or more heat pumps, a power meter will be required when the total power is greater than 12 kW. If the combined power is greater than 100 kW, a meter for the measurement of the energy delivered by the heat pump(s) shall also be installed. Similar requirements also apply to cooling systems.

The bill also prescribes the metering characteristics and the national or European standards they must meet. However, no requirements for intelligent metering are included.

II.vi. Encouragement of active energy-saving control (automation, control and monitoring)

The requirement to install meters in certain configurations, and the inclusion of parameters that could enhance more efficient use of a system, are some of the factors that contribute to a more rational use of energy. For instance, the air-conditioning requirements take into account a correction factor linked to the use of an automatic control system that prevents simultaneous heating and cooling in the same room.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

The regulations on energy performance certification can be divided into two phases: before and after 30 April 2015[7].

Since May 2015, a new EPB decree[8] and a new enforcement order[9] related to this decree have entered into force, addressing the certification of all buildings. Some aspects of this enforcement order, mainly in relation to advertising requirements, only entered into force in January 2015. Nevertheless, except in specific aspects, this new regulation will not fundamentally change the rules of previous regulations. All EPCs are valid for 10 years, except those for public buildings which are valid for 5 years. Each certificate is identified by a unique number.

Since 1 May 2010, an EPC is mandatory for new buildings when the building permit is requested. A QE is identified at the beginning of the construction works and is responsible for the building's compliance with requirements. At the end of the process, the EPC is issued by the administration on the basis of the information contained in the building's final EPB statement. According to the new regulation, from 1 May 2015, the EPC will be issued by the QE, on the basis of this final EPB statement. The EPC layout and indicators are the same as those for existing buildings, except for recommendations that are linked to behaviour.

Certification of existing non-residential buildings has not yet been implemented in practice. The calculation method and the software tool are still under preparation. Certification of existing non-residential buildings is expected to begin in 2018. The EPCs issued by a QE, will be based on an asset rating system and will be registered in a database.

Certification of existing residential buildings applies to buildings whose building permit was requested before 1 May 2010. An EPC has to be available, at the latest, when a preliminary sales agreement is signed, in case of sale, or at the time of contract signature, at the latest, in case of rental. If the EPC is missing, an administrative fine of 2 €/m^2 with a minimum of 250 € and a maximum of 25,000 € is legally prescribed. Because of the difficulty of measuring the building on-site, a fixed penalty will now apply. From 1 January 2015, the energy performance indicator must be stated in the sale or rental advertisements, otherwise, there will be a fine of 500 €. Moreover, if

[7] *Regulations applicable until May 2015:*
- *Certification of new buildings: the enforcement order was approved by the government on 25 August 2011 (M.B. du 05/09/2011, p. 56370).*
- *Certification of existing residential buildings: the enforcement order was approved by the government on 3 December 2009 (M.B. du 22/12/2009, p. 80379), and was modified on 27 May 2010 (M.B. du 07/06/2010, p. 35958).*
- *Certification of existing non-residential buildings: the enforcement order was approved by the government on 20 October 2011 (M.B. du 03/11/2011, p. 65830).*
- *Certification of public buildings: the enforcement order was approved by the government on 24 November 2011 (M.B. du 12/12/2011, p. 72952).*

[8] *Approved by the parliament on 28 November 2013 (M.B. 27/12/2013, p. 102985).*

[9] *Approved by government on 15 May 2014 (M.B. du 30/07/2014, p. 56172 – add. 21/08/2014, p. 61244).*

the EPC is absent at the time of the proposed sale or lease, the fine will be 1,000 €. The regional administration is responsible for monitoring compliance with this requirement. However, no fines were issued until 2015.

For existing residential buildings, the development of the calculation method (asset rating), the content of the EPC, the software tools, the handbook for QEs, and the training material are finalised. They are being continuously adapted based on input received from the certification support service, to clarify questions posed by assessors.

Figure 10: EPC generation process.

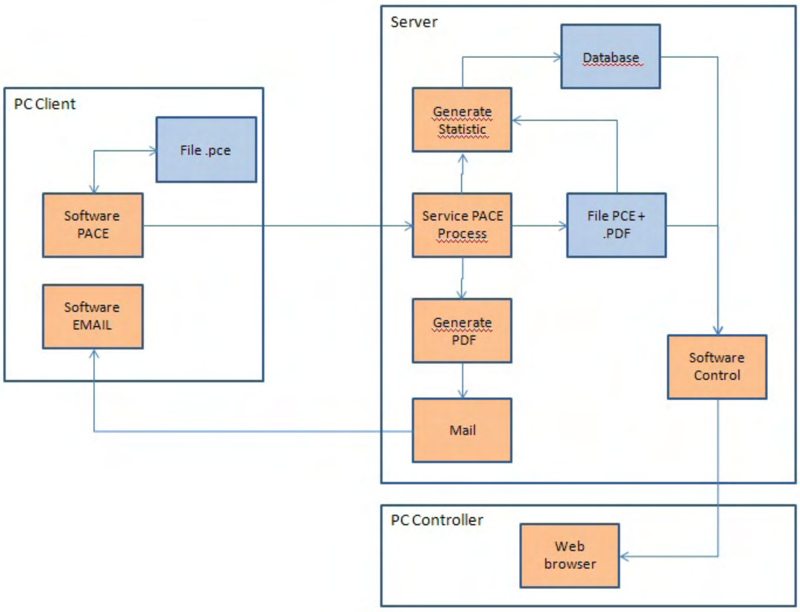
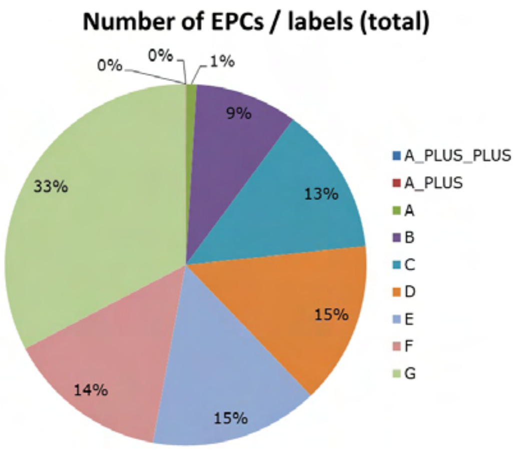
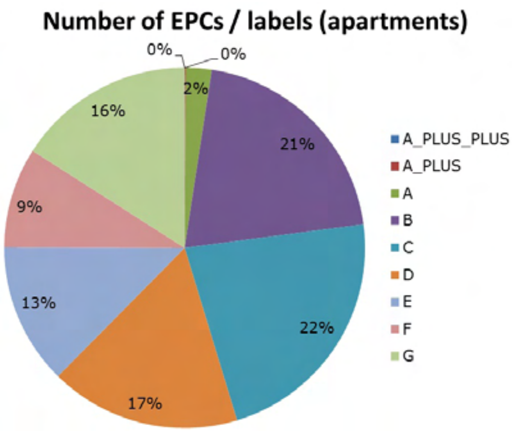
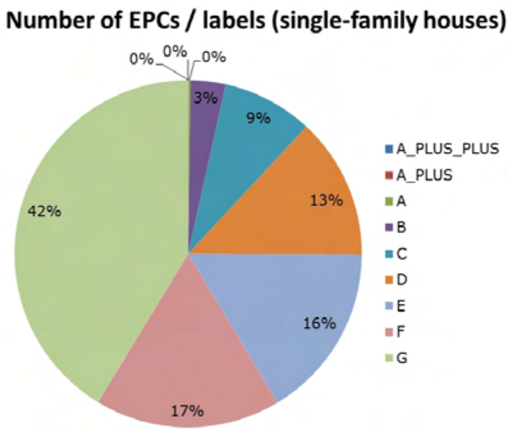


Figure 11: Distribution of EPCs per label for apartment buildings and single-family houses.







III.i. Progress and current status on sale or rental of buildings

Overview and administration system

For existing residential buildings, a dedicated, stand-alone software, called PACE, is used by assessors to input the building data collected, and then the server generates the EPC (Figure 10). This PACE software includes built-in validation rules, in order to avoid sending incomplete EPCs to the database (which also includes new buildings). It also contains validation rules for input data to prevent mistakes (rules to prohibit or flag certain values). The file with the building data and the EPC are recorded in a database before the certificate is sent to the assessors by e-mail in PDF format.

From the analysis of the data available in the central database, it is possible to extract quite interesting information. For example, the average building label is E, but this depends on the use of the building: the average label for single-family houses is F, whereas for apartments it is D (Figure 11). The average E_{spec} (Figure 12) has evolved since certification began in 2010 in the following way:

> During the first two semesters of operation of the database (in 2010), certification was only mandatory at the time of sale for single-family houses with building permits requested after 1 December 1996, and so the collected E_{spec} data cannot be considered representative.

> Data collected after the second semester of operation of the database show that the average E_{spec} improved over time, independent from the year of construction of the building. One possible explanation for this finding could be that the obligation was not well-known to the wider public and, as a consequence, few people presented additional proof to demonstrate good energy performance of their house at the time, whereas, as they gained more

knowledge on how to use the information in the EPC, they started providing more relevant documentation. A second possible explanation could be that the improvement in energy performance is achieved through the refurbishment of houses.

However, it is important for the general public to understand that old houses do not necessarily have poor energy performance, as much as recently built houses do not necessarily have good energy performance. The only way to know the actual energy performance of a building is through obtaining an EPC. Figure 13 shows the distribution of EPC labels in relation to the age of the building (for cases where the building age is known).

By the end of 2014, EPCs for new residential buildings were being delivered by the administration on the basis of data entered by QEs into the software (PEB-software). After 1 May 2015, EPCs are delivered by the QEs.

How flats are certified in apartment buildings

In multi-family residential buildings, the EPC is issued per apartment. In case there is a collective system for heating, DHW, ventilation, etc., an audit of the collective system must be completed at the time of first rental or sale of an apartment. The data from the audit are saved in a database, and are used as input for the certification of the other apartments in the building.

Figure 12:
Evolution of the average E_{spec} on single-family house certificates.

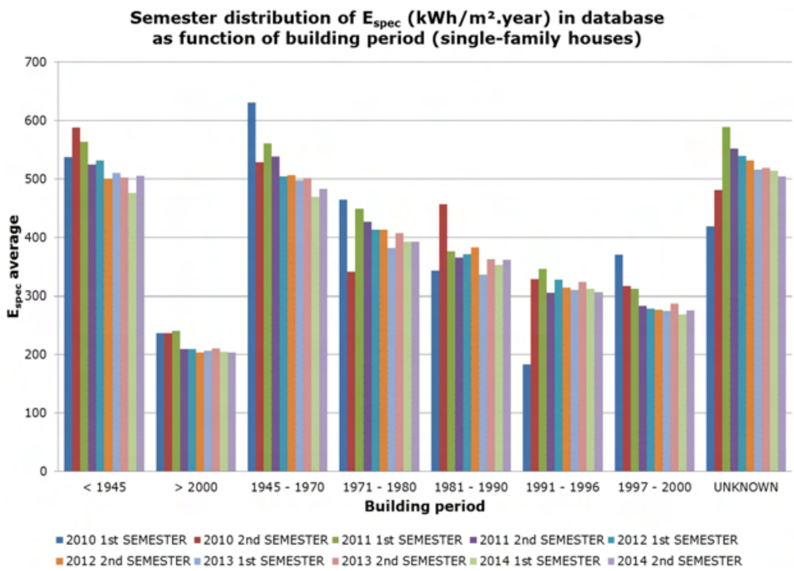
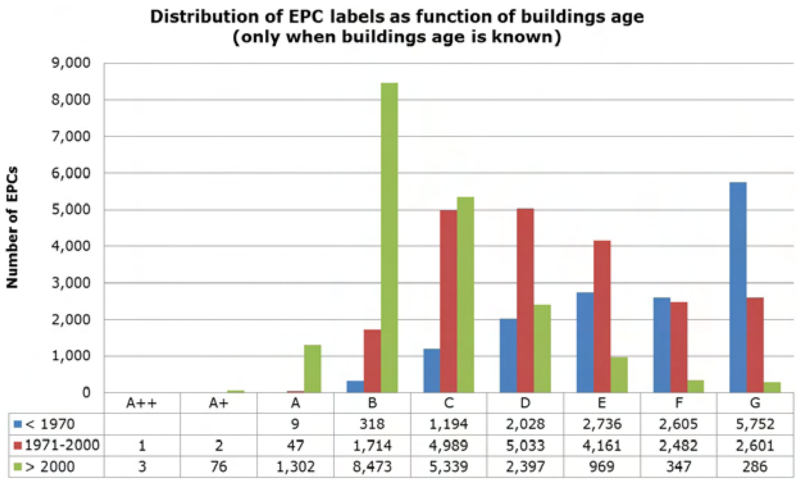
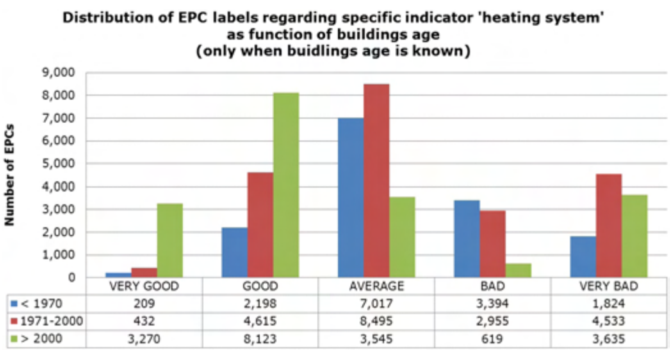


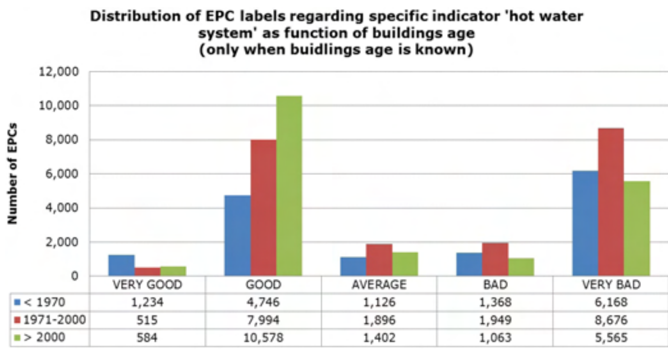
Figure 13: Main image, EPC label distribution in relation to building age. Additional images show specific indicators.



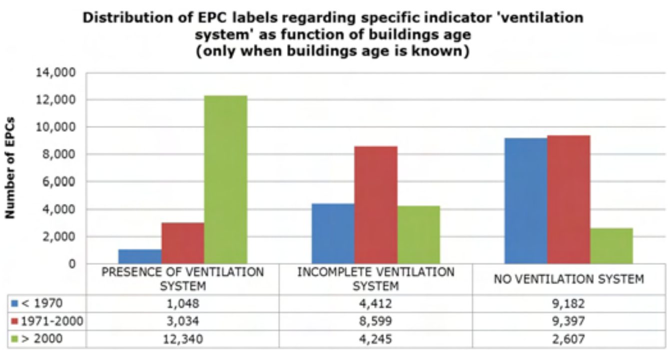
	A++	A+	A	B	C	D	E	F	G
< 1970			9	318	1,194	2,028	2,736	2,605	5,752
1971-2000	1	2	47	1,714	4,989	5,033	4,161	2,482	2,601
> 2000	3	76	1,302	8,473	5,339	2,397	969	347	286



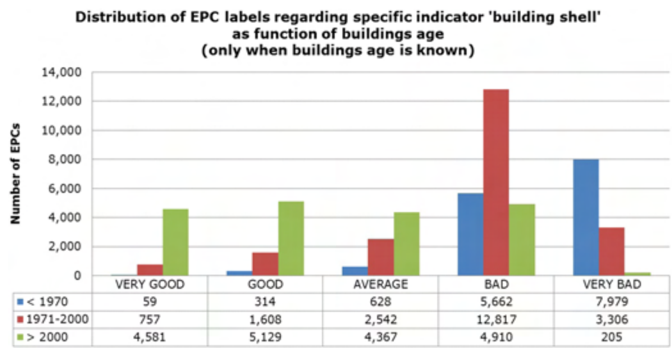
	VERY GOOD	GOOD	AVERAGE	BAD	VERY BAD
< 1970	209	2,198	7,017	3,394	1,824
1971-2000	432	4,615	8,495	2,955	4,533
> 2000	3,270	8,123	3,545	619	3,635



	VERY GOOD	GOOD	AVERAGE	BAD	VERY BAD
< 1970	1,234	4,746	1,126	1,368	6,168
1971-2000	515	7,994	1,896	1,949	8,676
> 2000	584	10,578	1,402	1,063	5,565



	PRESENCE OF VENTILATION SYSTEM	INCOMPLETE VENTILATION SYSTEM	NO VENTILATION SYSTEM
< 1970	1,048	4,412	9,182
1971-2000	3,034	8,599	9,397
> 2000	12,340	4,245	2,607



	VERY GOOD	GOOD	AVERAGE	BAD	VERY BAD
< 1970	59	314	628	5,662	7,979
1971-2000	757	1,608	2,542	12,817	3,306
> 2000	4,581	5,129	4,367	4,910	205

Format and content of the EPC

For residential buildings, the format and content of the EPC was adapted in November 2014 (Figure 14) in order to:

> obtain more information on input data (transparency), while maintaining comprehensibility for the general public, with a focus on the structure of results;
> include graphics on the global evaluation of energy performance;
> improve the recommendations section;
> inform on the importance and type of documentation that may be considered sufficient proof;
> include more space for illustrations and comments.

The EPC contains improvement measures without detailed facts and figures. These measures are automatically delivered by the software tool, however they are related to the result of the calculation. For example, a classification of a wall is given by the software depending of the U-value calculated by the software.

The EPC contains a recommendation that, in case the landlord intends to carry out a renovation, he/she should go beyond the EPC and conduct an energy audit of the building (this audit takes about a day and a half). The outcome of the audit is linked to incentives to improve the energy performance of the house. The experts authorised to conduct audits are the same who are also authorised to issue EPCs. The energy audit includes a simulated EPC after the renovation works are carried out (Figure 15).

EPC activity levels

By late 2015, more than 318,000 certificates for existing residential buildings have already been registered in the database, since June 2010. More than 200 certificates are sent per day to the database. This represents about 21% of the building stock. It is not possible to know how many EPCs are issued for renovated buildings, since it is not an input data necessary to complete an EPC.

For new residential buildings, 12,506 certificates were delivered by the administration and included in the database between May 2010 and May 2015. Since May 2015, 1,812 certificates have already been delivered by QEs and included in the database.

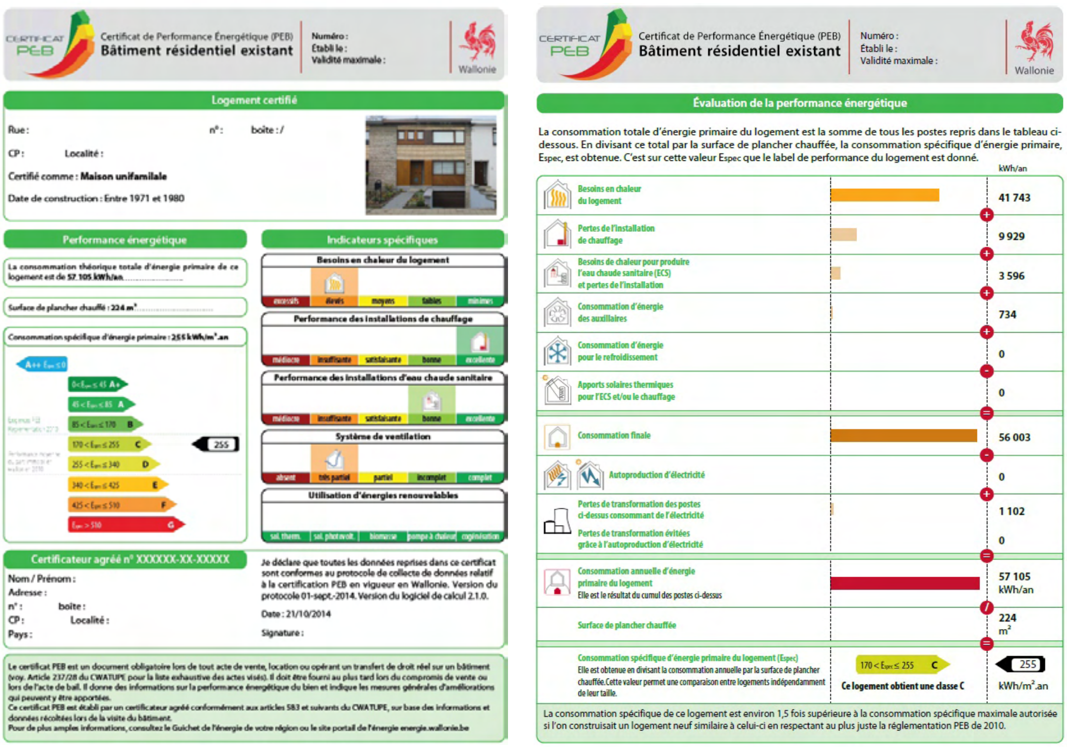
Typical EPC costs

For existing residential buildings, the certification process is quick (it takes about four hours), in order to keep the price – which is displayed on the certificate – low. In the early stages of certification, the average price (Figure 16) was 480 € (VAT included) for single-family houses. Currently, it is about 300 € (VAT included). The average price for an apartment was initially 250 - 350 €, and it is currently about 150 - 200 €. The total turnover generated since the beginning of the certification of existing residential buildings in June 2010 is about 100 M€ (VAT included).

Assessor corps

To issue EPCs for existing residential or non-residential buildings, either a degree in architecture or engineering is

Figure 14: New EPC layout for residential buildings.



necessary, or a degree in another field concerning the energy performance of buildings, or at least two years of professional experience in the field of building energy performance calculation. In order to issue certificates, QEs must attend a training course of five and a half days, and then pass an exam. So far, the administration has received 3,798 applications, of which, 3,476 were accepted. At the end of 2014, more than 2,000 assessors were accredited. Among them, more than 88% are engineers or architects. The names and addresses of the assessors are listed on the official website of DGO4 Energie[10].

In order for a firm to be accredited, there must be at least one accredited natural person working in the company.

Support for QEs is available by e-mail and phone. Another aim of this support service is to provide tools for QEs: a semestrial newsletter, a list of frequently asked questions, help on workflow (documents in a 'tree' structure to help accredited experts make decisions on how to treat a residential building, e.g., number of certificates needed, certification as 'apartment building', 'single-family house' or 'collective housing', etc.), workshops, improvements on the calculation procedure, handbooks, software, training material, etc.

Compliance levels by sector

The level of compliance is difficult to assess. Notaries require an EPC to be available before any sales agreement can be made/concluded. In case of rental,

Figure 15: Projected certificate results after renovation works presented in an energy audit.

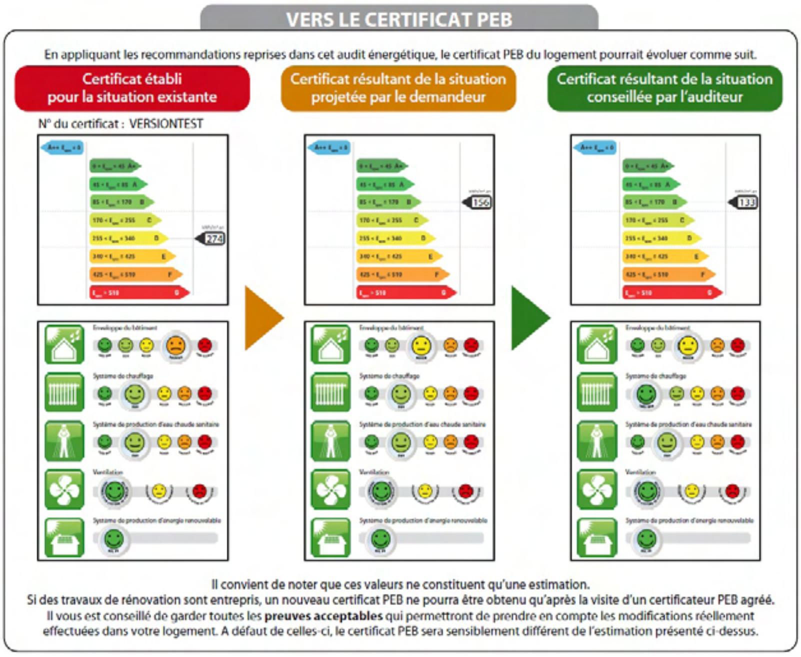
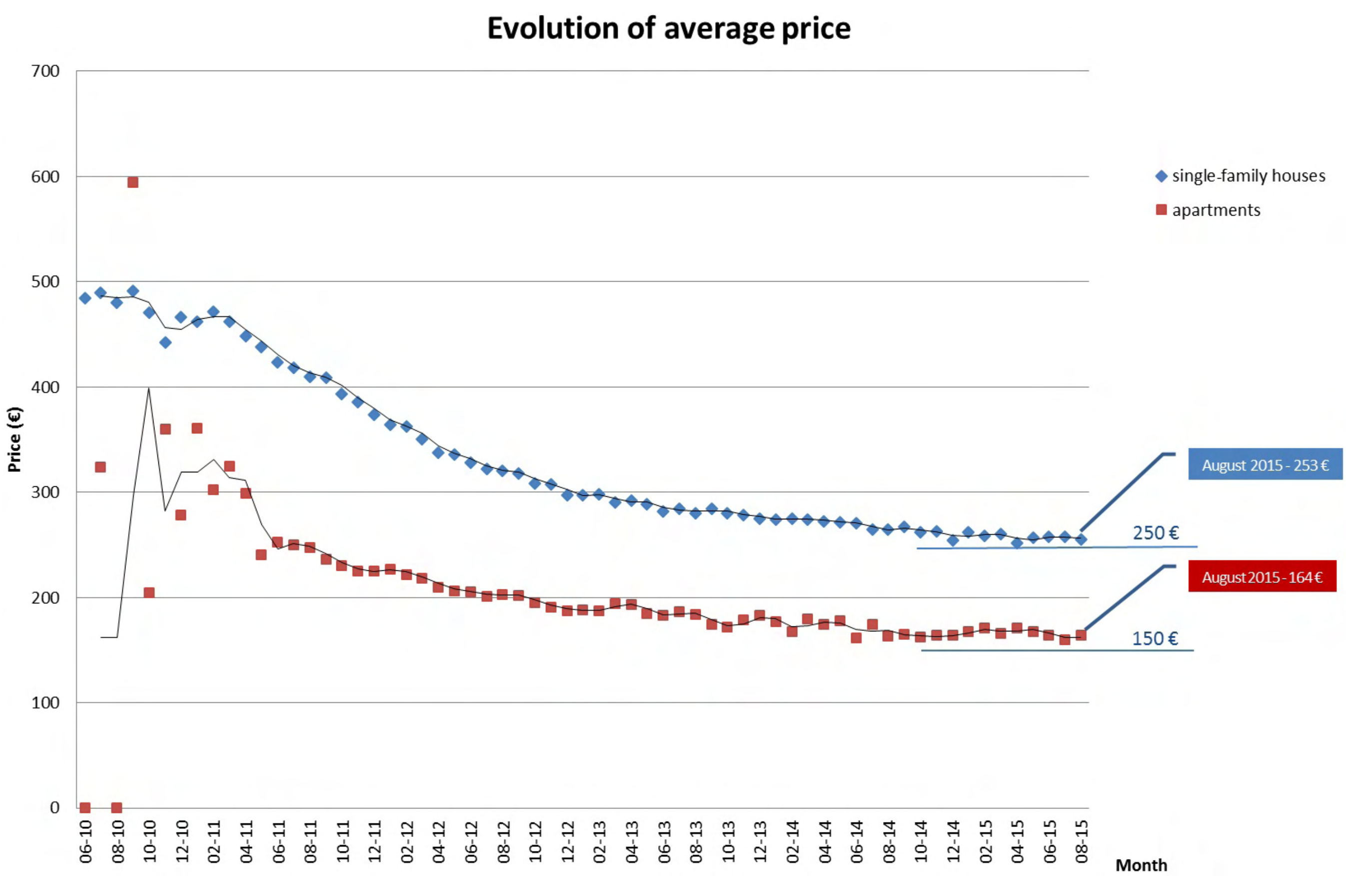


Figure 16: EPC for residential buildings – evolution of average price.



[10] energie.wallonie.be >> Particuliers >> Acheter, vendre, louer: le certificat PEB >> Liste des certificateurs PEB agréés or energie.wallonie.be/fr/acheter-vendre-louer-le-certificat-peb.html?IDC=8789

lease agreements must be registered with the Federal Administration. Although statistical information is not available, this obligation is now well-known among the general public, and is well followed.

So far, if the EPC is missing, an administrative fine of 2 €/m² with a minimum of 250 € and a maximum of 25,000 € is legally prescribed. The administration has not applied this rule yet, because of the difficulty in determining the specific amount of the fine, since it requires access to the building.

From May 2015, an administrative fine of 1,000 € will be imposed in case of absence of the EPC at the time of transaction. The fine will be doubled in the case of recidivism within three years.

Quality Assurance (QA) of EPCs

The public administration is the competent authority which has the responsibility to independently control a statistically significant percentage of the certificates issued annually. Quality controls of existing residential buildings began in 2012 by manually checking the EPCs of the QEs, through data mining the certificate database. As a result, the first procedures concerning infringement were issued.

In 2012, the administration requested 15 control actions, with the result that one assessor had to undergo a new training, and another saw his accreditation revoked.

This first Quality Assurance (QA) procedure was not applied, because it required a high degree of knowledge about certification, the structure of the database and how to extract data from it, etc. Furthermore, this method was found to be inefficient in rapidly detecting inconsistent data, or problems with the QE's work.

Therefore, it was decided to develop an automatic tool that would increase efficiency and systematise quality checks, with respect to the objectives of the EPBD requirements (checking a statistically representative number of EPCs). This tool is based on a web application (called Web control) and it was finalised at the end of 2013.

Its main functionalities are:

> screening of suspicious EPC data (based on improved data analysis during the first control) and identifying the certificates concerned;

> randomly selecting certificates from each QE for a post control;

> providing an interface for exchange between QEs and controllers;

> archiving control documents related to assessors.

The process first verifies the validity of the data of each certificate stored in the database by screening any abnormal records. Then, EPCs are identified by whether or not they contain invalid or abnormal data or values. That means that EPCs which include errors or inconsistent values are pinpointed for further action (Table 7).

The controller views a summary panel where s/he finds information on each QE, e.g., the total number of EPCs prepared, the number of EPCs with inconsistencies, and the EPCs selected randomly for control. The controller also has access to the EPC details through another panel that indicates the type of inconsistencies. In all cases, the controller has the possibility to make a more accurate check of the input data, by directly launching the certification software, or looking at the EPCs themselves.

If the investigation concludes that a control procedure should be launched, for example due to frequently occurring errors, the controller notifies the QE of his errors and requests that he checks and sends documentation that prove the data measured and the results indicated on the EPC.

If necessary, wrong EPCs are corrected before the controller approves them and ends the control procedure. Whether the QE is penalised or not depends on the frequency, quantity and type of errors, as well as their impact on the EPC outcome, particularly on the label of the building.

Table 7: Number of EPCs selected for control by the web application relative to the total EPCs in the database. • AI means certificates with inconsistent data or values • AI means randomly selected certificates with inconsistent data or values • SI means without inconsistent data or values • SI* means randomly selected without inconsistent data or values*

		certificates with SI status			certificates with AI status		
Year	**Number of certificates**	**SI**	**SI***	**% (SI+SI*)**	**AI**	**AI***	**% (AI+AI*)**
2011	**65,011**	34,089	1,766	55%	27,722	1,434	45%
2012	**74,991**	45,454	2,355	64%	25,813	1,369	36%
2013	**65,037**	46,640	2,483	76%	15,114	800	24%
2014	**67,157**	32,000	2,095	51%	30,897	2,165	49%

The first control cases were undertaken through the Web control application in December 2013. During that month, 6 requests for explanation were sent to QEs concerning 71 EPCs. Of those, 70 EPCs needed to be modified due to errors in collected data. Only 1 EPC had no errors.

In 2014, 71 requests for explanation were sent to QEs. Of the 1,075 certificates checked, 201 certificates needed to be modified, 334 certificates had no errors, 279 certificates were approved with only minor errors, and 540 included suspicious data and were designated for further control (Table 8).

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The Executive Order of 24 November 2011 regulated the certification of public buildings. This executive order was abrogated on 1 May 2015 and replaced by the Decree of 2013 and the Order of the Government of 2014.

Statistics to determine the number of public buildings will be obtained later on.

Format and content of the EPC

The EPC indicates the energy class of the building according to its type. This figure is based on operational rating converted into primary energy per m^2. The EPC also contains a graph showing the real consumption of electricity and fuels in the last 3 years, and other specific indicators. An EPC model was not yet available at the end of 2014, so no EPCs have been issued for display yet.

Frequency of updating

The EPC of public buildings is valid for 5 years. The Walloon Region adopted a simplified calculation method based on an operational rating. The energy consumption indicators must be updated every year and subsequently registered in the database.

Costs

The cost of the EPC is indicated on the EPC itself if it is produced by a QE. The cost will depend on the size and complexity of the building and is expected to be between 300 € and 1,500 €. The price to establish the first EPC of a building will be higher than the subsequent certificates, which will simply update the first.

Assessor corps

For external private citizens to become accredited to certify public buildings, these persons must meet the same conditions described earlier for the other types of experts.

In order for a firm to become accredited, there must be at least one accredited individual working at the company.

Natural persons who work for a public authority can also become accredited. However, such experts only have the competence to issue EPCs for the public authority they work for. These internal experts must also meet the same conditions described earlier for the other types of experts related to training and exams.

Quality Assurance (QA) of EPCs

After the control system is implemented, an administrative fine of 1,000 € shall be imposed in case of failure to display a valid EPC.

III.iii. Implementation of mandatory advertising requirement

The execution order adopted on 15 May 2014 and modified by the execution order adopted on 18 December 2014, was launched in January 2015 and sets the requirement to include the EPC indicator(s) in advertisements. Requirements for the display of indicators are set out in the Ministerial Order of 23 December 2014.

The indicators and identification numbers to display vary depending on the type of media being used. At most, the indicators that must be included in advertisements are:

> the energy label (Figure 17);
> E_{spec} expressed in kWh/m^2.year;
> E_{total} expressed in kWh/year.

Additionally, the EPC identification number can also be required.

Year	Control folder	Certificates checked	Certificates with error	Certificates without error	Certificates with suspicion of error (under checking)
2013	6	71	70	1	0
2014	71	1,075	201	334	540

Table 8: Number of EPCs checked by the administration.

Inclusion of indicators is initially the responsibility of the owner (seller, or lessor), but also of the professional representative (lawyer, or real estate agent). Publishers, who have no role in the sales process, do not bear any responsibility.

Leaving out energy performance indicators in advertising is a punishable offence. The legal provision should be interpreted broadly, so that poor communication of the indicators (i.e., too small to be legible) and thus failure to achieve the objectives of the regulation is also punishable.

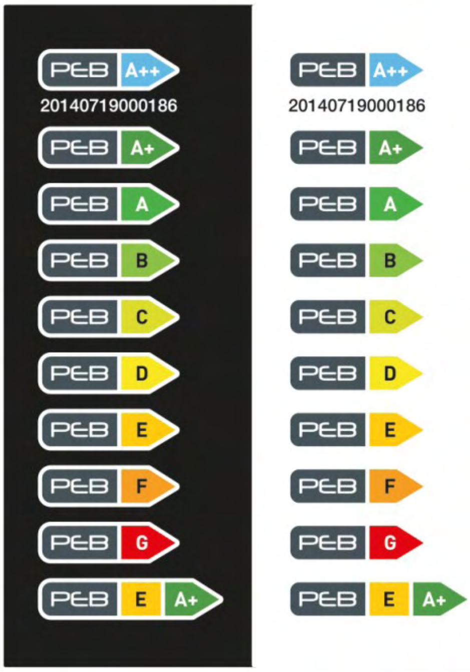


Figure 17: Prescribed format for the energy label included in advertisements.

Figure 18: Banner on immoweb website to promote the EPC.

Figure 19: EPC information campaign for indicators in advertisements.

The decree foresees a fixed administrative fine of 500 € when the energy performance indicator(s) on the EPCs are not mentioned in the advertisement. The fine is doubled in case of recidivism within 3 years. Controls are performed by the regional energy administration. More than 170 real estate agencies have been controlled since the obligation was introduced.

III.iv. Information campaigns

In the Walloon Region, there is continuous information about EPCs, requirements, energy efficiency, etc., available, targeting the general public.

Various publications are regularly updated and reprinted by the Walloon Region. They can be downloaded from the website energie.wallonie.be.

The Department of Energy and Sustainable Buildings publishes a quarterly magazine *'Energie4'*. The EPBD is regularly discussed there (e.g., a brief overview of requirements was included in December 2013, an article on the EPC indicators included in advertising was included in December 2014, etc.).

An advertisement was published on the most significant property sale/rental website (immoweb.be) to promote the EPC (Figure 18).

In December 2014, there was an advertising campaign on the EPC indicators using various media including the internet, the daily press and magazines (Figure 19).

The Walloon Region also developed partnerships with different media, as a way to inform the public regularly. These include e.g.:

> *'Architrave' – magazine* for architects: two articles about requirements and energy efficiency in 2013, two articles about the EPC and one article about requirements in 2014.

> *'SudPresse'* - daily press: two features about requirements and energy efficiency in 2013, two others in 2014, and one more about the EPC.

> Video clips (1'30") about energy, sometimes concerning the energy performance of buildings, are regularly broadcast in the news on the Belgian public television and are also available on YouTube (Figure 20).

The energy performance of buildings is also regularly addressed in the Belgian broadcasts *"Une Brique dans le Ventre"* (RTBF) and *"Clé sur Porte"* (RTL).

III.v. Coverage of the national building stock

At the end of 2015, more than 23% of the residential building stock has been included in the database since June 2010 (Figure 21). No information is yet available for non-residential buildings.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

The Walloon Region has adopted the inspection option for heating and Air-Conditioning (AC) systems.

IV.i. Progress and current status on heating systems

The inspection of heating systems was included in an Executive Order of 29 January 2009 and adapted by the Executive Order of 15 May 2014. The Government of the Walloon Region approved this order to prevent the atmospheric pollution produced by central systems for heating, and to reduce their energy consumption. This order replaced the royal order in force since 1978 for the inspection of liquid or solid fuel boilers.

According to the *"Décret du 05 juin 2008 relatif à la recherche, la constatation, la poursuite et la répression des infractions et les mesures de réparation en matière d'environnement"*, control of compliance with the Executive Order of 29 January 2009 is the responsibility of the Department of Environmental Police and Controls of the Walloon Region. This decree also defines the penalties that may be imposed on persons violating these regulations.

The order also requires that a post-control of certified technicians is carried out by accredited control bodies.

After the inspections, the reports include recommendations for cost-effective improvements to the heating system.

Overview, technical method and administration system

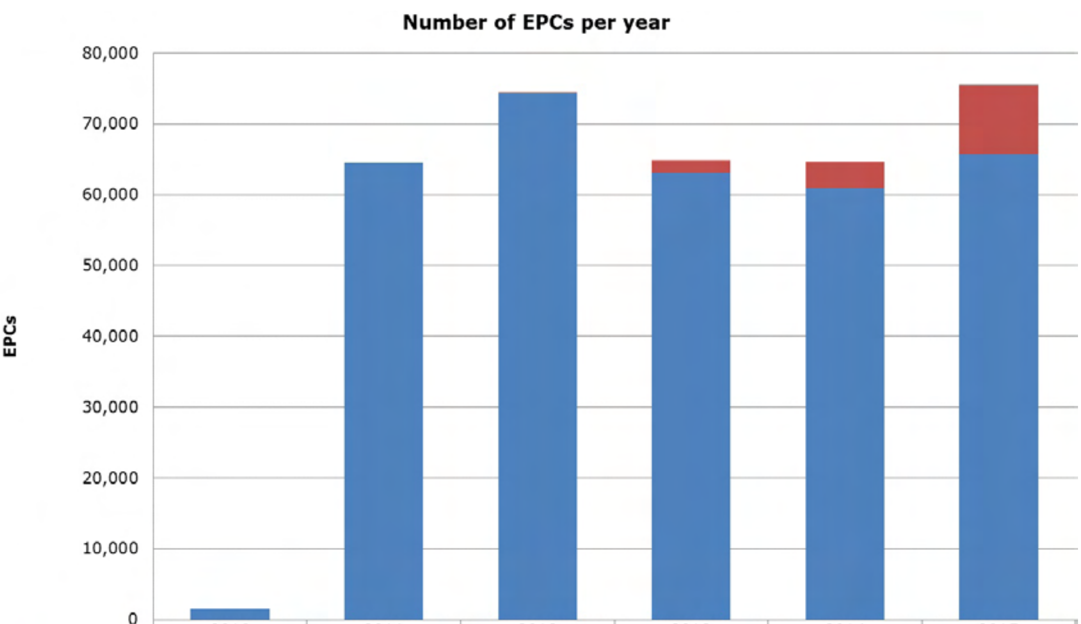
Inspections include two parts: a boiler efficiency assessment and a boiler sizing assessment. Inspections are mandatory at least every year for oil and solid fuel boilers, every two years for gas boilers with a rated power higher than 100 kW, and every three years for gas boilers with a rated power less than or equal to 100 kW.

The assessment of the boiler sizing is not repeated, as long as no changes were made to the heating system, or as regards the heating requirements of the building.

The Executive Order of 15 May 2014 mandates that inspections are carried out with a calculation tool or software provided by the administration.

Figure 20: Video information campaigns about the EPBD.

Figure 21: Number of EPCs issued per year.



	2010	2011	2012	2013	2014	2015
New houses			12	1,720	3,620	9,752
Existing houses	1,476	64,540	74,351	63,177	60,990	65,732

Arrangements for assurance, registration and promotion of competent persons

Inspections are carried out by accredited technicians, who must complete training and pass an exam. Training is differentiated by type of boiler (liquid, or gas). Accreditation of the training courses is managed by the Air Climate Agency (AWAC), both during the application process, and later during controls of the recognised technicians who pass the exam.

At the end of October 2014, approximately 2,600 technicians are certified to inspect gas fuel boilers, and roughly the same number for liquid fuel boilers.

Currently, 13 training centres are recognised for providing training to technicians inspecting liquid fuel boilers, and 9 for inspecting gas fuel boilers.

All useful information is available at the site of the Air Climate Agency[11].

Enforcement and penalties

In order to facilitate the control of certified technicians, the inspection reports they are required to provide to the administration are recorded in a register.

Penalties may lead to suspension or revocation of technicians' accreditation. However, the penalties for inspectors were not implemented as of the end of 2014.

Furthermore, the owner of a boiler is punishable for not performing inspections. Sanctions are provided for in the Environmental Code (Decree of 27 May 2004 and Executive Order of 17 March 2005). The issuance of a statement for infringement is rare (about 2 to 3 statements per year). Controls are operated by the pollution repression unit of the Walloon Region, up to now mainly in response to complaints.

Quality control of inspection reports

The Executive Order of 29 January 2009, as amended by the Executive Order of 15 May 2014, provides that each year, a statistically significant proportion of reports must be controlled by the inspection body accredited, on the basis of a random selection.

In 2013, 486 certificates were checked. No checks were performed in 2014.

Inspection activity figures

In 2013, about 747,000 inspection certificates, including reports, were issued. In 2014, this figure is about 756,000.

IV.ii. Progress and current status on AC systems

The Government of the Walloon Region approved two executive orders, one on 12 July 2007 and another on 18 October 2012, respectively, to prevent pollution at the time of installation and entering into service of fixed air-conditioning (AC) systems using fluoride cooling, as well as in case of maintenance, repair or upgrade on those systems. These legal texts have however yet to be completed to take into account energy aspects.

Once the system is implemented, accredited AC experts must complete specific training at an accredited training centre in order to be able to carry out energy inspections on AC systems. Controls of accredited AC experts are mandated to be performed by an accredited control body. Energy-related trainings should complement this scheme.

Overview, technical method and administration system

Those executive orders mandate energy inspections and evaluation of the energy performance of the AC unit by accredited experts, in order to ensure its proper functioning and sizing, in relation to the cooling needs of the building.

Inspections must be undertaken by accredited technicians who have undergone training and passed an exam. Training accreditations are managed by the Air Climate Agency (AWAC).

Currently, 9 training centres are accredited to provide training for certified technicians.

The Air Climate Agency website also contains all the useful information for AC system inspections.

Enforcement and penalties

In order to facilitate inspection of certified technicians, inspection reports must be recorded in a register that certified technicians have to provide to the administration. As far as inspections on specific energy aspects are concerned, they have not yet begun and no report has yet been filed. The frequency of inspections will depend on the power of the device.

Penalties may lead to suspension, or revocation of technicians' accreditation.

Quality control of inspection reports

Article 58/2 of the Executive Order of 12 July 2007 allows the president of the

[11] www.awac.be

Air and Climate Agency to, at any time, order an inspection to any accredited inspection body, to check if the AC inspections are in compliance with the existing legislation. This check may also include a verification whether the AC inspectors meet the legal requirements in terms of training and recognition.

QA for AC inspections is the same as for heating systems, but it has not yet begun. A review of regulations is currently underway, and is being conducted by the three regions together.

3. A success story in EPBD implementation

In September 2003, a voluntary action called *"Construire avec l'Energie (CALE)"* was initiated by the Walloon Region to prepare for the transposition of the EPBD. The aim of this action was to build houses which are more energy efficient than required by the regulation. The first phase of this action, called CALE 1, was based on a charter describing five energy performance criteria, including two of a qualitative nature, related to heating and hot water. The document also contained the procedure to become a CALE expert, and the procedure to be used to submit a project. The action also provided training and business support measures to move towards more energy-efficient buildings. At the end of the process, houses that match the technical criteria of the CALE action receive a certificate ("Building with energy") that states their achieved performances.

Open to all owners and professionals in the building sector, this action granted a subsidy of up to 2,000 € for all projects that met the criteria.

In 2007 and again in 2010, the technical criteria of the CALE action were strengthened twice, in order to raise the bar for performance beyond the requirements of the regulation (Table 9).

The CALE action can be summarised in figures as follows:

> 51 information sessions and 68 technical training modules;
> 1,198 business partners (768 architecture firms - or 914 architects - 62 offices and 222 companies);
> 1,412 dossiers (houses or apartment buildings - or 1,661 units) submitted for analysis to CALE experts: 367 houses in CALE 1, 836 in CALE 2 and 489 in CALE 3;
> 860 "Building with energy" certificates issued through November 2014.

The team in charge of setting requirements and procedures, and for analysing projects related to CALE was composed of the Belgian Building Research Institute (coordinator), with partners from the *"Institut wallon de Formation en Alternance et des Indépendants et Petites et Moyennes Entreprises"*, *"Université Catholique de Louvain-la-Neuve"*, *"Université de Liège"* and "*Université de Mons*" and the *"Confédération de la Construction Wallonne"* and *"Union Wallone des Architectes"*, that represent construction contractors and architects.

Action phases	CALE 1 (feb. 2004 - sept. 2007)	CALE 2 (oct. 2007 - dec. 2009)	CALE 3 (jan. 2010 - dec. 2011)
BUILDING SHELL	Wall insulation ($U \leq U_{max}$ regulatory) and $U_{windows} \leq 2.0$ W/m².K	Wall insulation ($U \leq U_{max}$ regulatory) and $U_{windows} \leq 2.0$ W/m².K	Wall insulation ($U \leq U_{max}$ regulatory) and $U_{windows} \leq 2.0$ W/m².K
	Global insulation level $K \leq 45$	Global insulation level $K \leq 45$	Global insulation level $K \leq 35$
	No requirement relating to airtightness	No requirement relating to airtightness but possible to take into account in the EPB calculation	airtightness : $v_{50} \leq 6$ m³/h.m²
VENTILATION	Compliance with regulation (NBN D50-001)	Compliance with regulation (NBN then AGW 17.04.2008)	Compliance with regulation (AGW 17.04.2008)
SYSTEMS	Heating/SHW : with label (HR+, Optimaz, ...)	-	-
GLOBAL ENERGY PERFORMANCE INDICATOR	-	$E_w \leq 100$ $E_{spec} \leq 170$ kWh/m².year	$E_w \leq 70$ $E_{spec} \leq 120$ kWh/m².year
OVERHEATING	-	Compliance with future regulation (index I ≤ 17,500 K.h)	Compliance with regulation (index I ≤ 17,500 K.h)

Table 9: Phases of CALE action.

A book titled “Building with energy, the happiness of living” presents a selection of 20 buildings, from hundreds that have received the “Building with energy” certificate (Figure 22).

Figure 22: Cover of the book "Building with energy, the happiness of living".

4. Conclusions, future plans

In the Walloon Region, regulations in compliance with the Energy Performance of Buildings Directive (EPBD) have been in place since 2007, and are currently well-known among architects and engineers, as well as building contractors. As an example, several years ago, practical solutions to construct thermal bridges were known to only a few architects and engineers, whereas today they are often used by building contractors. This is also the case for airtightness and other quality issues. Also, awareness among the general public concerning the importance of a well-insulated building with efficient energy systems has increased. Energy certificates and energy audits also contribute significantly to the increase in awareness, as do the voluntary actions led by the region in the field of energy performance of buildings, and the financial incentives (energy investment tax credits, allowances, 0% interest loans for energy investments, etc.).

However, despite this gradual increase in awareness during the first phase of the enforcement of the regulation, the region has to intensify controls, by finalising the software tools, and by dedicating more human resources to this end. This is also in line with the requirements of Directive 2010/31/EU. The Government adopted the EPBD Decree at the end of 2013 and a new set of executive orders in order to comply with the new directive.

The Walloon Region has worked on an extension of the study on cost-optimality. This new study, available in January 2015, aims at providing an overview of the residential and commercial building stock and the identification of cost-effective approaches for renovation in line with Article 4 of the Energy Efficiency Directive (EED).

The Walloon Region is also developing a new tool for the integration of Renewable Energy Sources (RES) in relation to EPBD requirements (feasibility study tool) to be available in 2015. A new set of training sessions for Qualified Experts (QEs) is also under development, to delve deeper into technical details related to systems, airtightness, RES integration, and thermal bridges. The Walloon Region is also pursuing consultation with the building sector to finalise a roadmap to Nearly Zero-Energy Buildings (NZEBs) and to discuss solutions to improve the quality of works, and to secure further funding.

Implementation of the EPBD in Bulgaria

STATUS IN DECEMBER **2015**

1. Introduction

Actions for increasing energy efficiency have already been applied for a few decades in Bulgaria. This report outlines the development of the legal and technical measures to improve energy efficiency in buildings.

The report presents an overview of the application of the principles of the Energy Performance of Buildings Directive (EPBD), Directives 2002/91/EC and 2010/31/EC. It outlines the development of regulatory measures set up to ensure mechanisms for reducing energy consumption in buildings in Bulgaria. In addition, an attempt is made to identify guidelines for future mechanisms to continue to improve buildings' energy efficiency.

The Minister of Energy is responsible for the implementation of all directives on energy efficiency (including Directive 2010/31/EC). All plans and programmes, including those in the building sector, are covered by the National Action Plan for Energy Efficiency (NEEAP). The Minister of Energy coordinates implementation in all sectors and produces reports on the execution of the NEEAP.

The Ministry of Energy is in charge of implementing state policy to increase energy efficiency in final energy consumption and the provision of energy services in Bulgaria. The Ministry of Regional Development and Public Works is responsible for the development and implementation of technical rules and regulations in the field of energy performance of new and existing buildings, the implementation of projects related to the renovation of residential buildings and the improvement of energy efficiency in residential buildings. The Sustainable Energy Development Agency (SEDA) implements the national policy on improving energy efficiency of both end-use energy and energy services.

Bulgarian legislation had by 2005 already introduced some principles of Directive 2002/91/EC. The next steps to build on this were:

- *The Energy Efficiency Act, promulgated in State Gazette No. 98/14.11.2008, with further amendments to the Act promulgated in State Gazettes No. 35/03.05.2011 and No. 38/18.05.2012.*
- *The next Energy Efficiency Act was promulgated in State Gazette No. 24/12/03/2013. The latest amendments to this act are State Gazettes No. 59/05.07.2013, No. 66/26.07.2013, No. 22/03.11.2014 and No. 33/11.04.2014.*
- *The Law on Energy Efficiency transposed the Directive 2010/31/EC into national legislation and also entered into force on 11 April 2014.*
- *The most recent Energy Efficiency Act is promulgated in State Gazette No. 35/05.15.2015, and it transposed both directives: Directive 2010/31/EC and Directive 2012/27/EC. An interdepartmental working group was established to develop the regulations under the new law, with a November 2015 deadline for drafts.*

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2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Bulgarian legislation differentiates between two main categories of buildings: new and existing buildings, and imposes specific requirements according to their use as residential, non-residential and public. This section of the report summarises the energy performance requirements, including Nearly Zero-Energy Buildings (NZEBs), energy performance certificate (EPC) requirements for residential, non-residential, and governmental and municipality owned public buildings, as well as inspection requirements for heating and air conditioning (AC) systems. Future plans will also be outlined in this section.

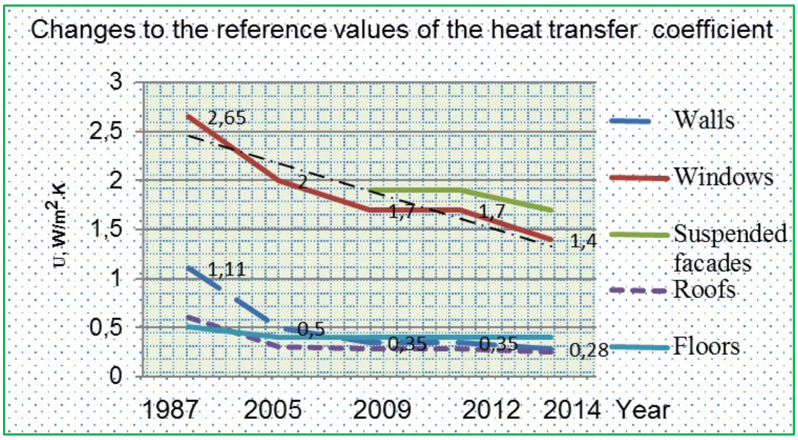
Table 1: Reference values of the heat transfer coefficient, effective from 15 July 2015.

Type of Envelope Structures and Elements	U, $W/m^2.K$	
	Internal T^0 $\theta i \geq 15\ ^0C$	Internal T^0 $\theta i < 15\ ^0C$
External walls in contact with the external air	0.28	0.35
Walls adjacent to unheated spaces, when the difference of average temperatures between heated and unheated spaces are equal or more than 5^0 C	0.50	0.63
External walls of heated basement adjacent to the ground	0.6	0.75
Floor slab over an unheated basement	0.50	0.63
Heated floor area directly bordering the ground in a building without basement	0.40	0.50
Floor of a heated basement	0.45	0.56
Floor of a heated space in contact with external air	0.25	0.32
Wall, ceiling or floor in contact with the external air or the ground with in-built area	0.40	0.50
Flat or sloped roof with heated underroof space designed for habitation	0.25	0.32
Ceiling slab of an unheated flat roof with an air layer with thickness $\delta > 0.30$ m	0.30	0.38
External door, solid, adjacent to the external air	2.2	2.75
External door, solid, adjacent to an unheated space	3.5	4.38

Table 2: Requirements (U-values - $W/m^2.K$) over time.

Year	1987	1999	2005	2009	2012	2014
Walls	1.11	0.5	0.5	0.35	0.35	0.35
Windows	2.65	2.65	2	1.7	1.7	1.4
Suspended facades				1.9	1.9	1.7
Roofs	0.603	0.3	0.3	0.28	0.28	0.28
Floors	0.503	0.5	0.4	0.4	0.4	0.4

Figure 1: Trends.



The Energy Efficiency Act and the relevant regulations that will follow set out the legislative and technical measures that should, by law, be applied to buildings. The Energy Efficiency Act sets out the type of buildings which should be certified within a certain period. All public buildings in operation with a total built-up area of 500 m^2, and from 9 July 2015 with a total built-up area of over 250 m^2, are subject to mandatory certification. Owners of such buildings are obliged to implement the measures prescribed by the energy audit, within three years for existing buildings, and within six years for new buildings, from the date the audit results are accepted.

Energy performance of buildings, implementation of audits and certification, the methodology for energy estimations (by calculation), inspection of building systems, experts to be recognised, and the rules for issuing reports, are set out in detail in the relevant ordinances to the Energy Efficiency Act and the Law on Spatial Planning. These regulations propose methods for assessing the technical measures for energy saving, and methodologies for assessing savings from replacement of the energy source, both in terms of building elements, as well as building systems.

I.ii. Format of national transposition and implementation of existing regulations

Minimum requirements for the energy performance of buildings or parts thereof are specified in the Law on Spatial Planning (see Table 1). These requirements have been gradually tightened since the EPBD was first implemented, as shown in Table 2 and Figure 1. There is no unambiguously stated optimum of global energy consumption for any of the categories of buildings required by the EPBD. Instead, the law defines certain ranges of energy consumption in kWh/m^2.year for ten categories of buildings, related to energy consumption classes. From 2005, assessment of compliance with the energy efficiency requirements is undertaken for each individual building by audit companies that are registered with the SEDA.

According to the Energy Efficiency Act and the Law on Spatial Planning, any investment project must meet the energy efficiency requirements. Contracting entities are obliged to obtain an EPC of the building. This applies to new building projects, and to cases of reconstruction, major renovation, overhaul and refurbishment of existing buildings. Compliance with prescribed measures is assessed through energy audits performed by companies registered with the SEDA. The SEDA is the authority that imposes penalties for non-compliance. Through the end of 2014, no penalties had yet been imposed.

Ordinance No. 7 for energy efficiency in buildings, promulgated in State Gazette No. 5/14.01.2005, with recent changes implemented State Gazette No. 35/15.05.2015, amended and supplemented State Gazette No. 90/20.11.2015, defines the methodology for calculating the indicators of energy consumption and the energy performance of buildings. When designing new buildings and reconstructing existing buildings, the investments in energy efficiency are eligible provided the materials and the systems are in compliance with legal standards and technical specifications.

The main indicators for the energy performance of buildings are:

> $EP_{max,r}$ is the energy performance characteristic (kWh/m².year) of the building calculated with the last issued U-values norms (i.e., the existing norms in accordance with the current legislation at the moment of the estimations);
> $EP_{max,s}$ is the energy performance characteristic (kWh/m².year) of the building calculated with the U-values norms active in the moment of building commissioning.

The calculation methodology takes into consideration:

> the climatic zone the building is located in;
> the average volume of indoor air temperature;
> the size and characteristics of the envelope structures and elements;
> the availability of different thermal zones;
> the net volume of conditioned space;
> quality indicators of indoor air;
> thermal bridges;
> shading devices.

[1] www.ensi.no

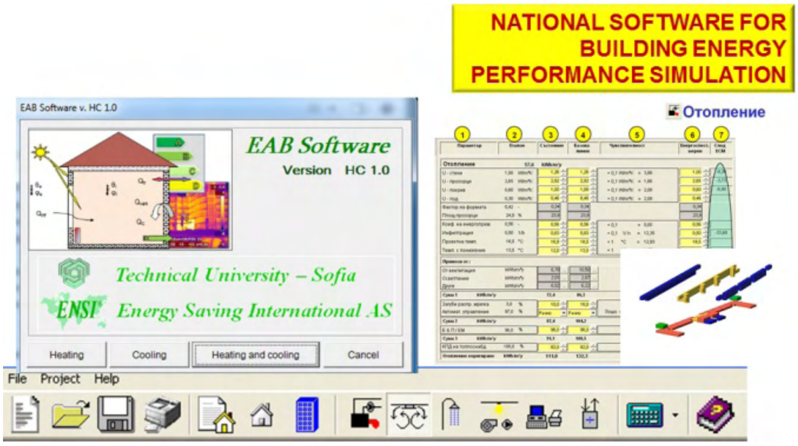


Figure 2: Software for modelling and simulation of the annual energy consumption in buildings, using EAB Software HC -v.1.

National software for modelling and simulation of the annual energy consumption in buildings was first developed in 2005 by the Technical University of Sofia, together with Norwegian ENSI[1]. It is regularly upgraded. The latest version used by registered audit firms and consultants was released in 2010 (see Figure 2). The calculation methodology includes the following aspects:

> specific annual consumption of primary energy, taking into account the orientation, size and shape of the building, and characteristics of the envelope structures and elements;
> thermal and optical features, including internal components: heat capacity, insulation, passive heating, cooling components and thermal bridges;
> air permeability, moisture resistance and water impermeability;
> heating systems and Domestic Hot Water (DHW);
> air-conditioning (AC) and natural and mechanical ventilation systems;
> natural lighting and lighting installations, passive solar systems and solar protection;
> systems for utilisation of renewable energy sources (RES);
> indoor climate conditions and internal energy loads;
> technical characteristics of the defined sources of heat and/or cold, and seasonal efficiency.

Table 3: Conversion factors.

Type of resource/energy	Coefficient, accounting the losses of energy resources end energy ei	Coefficient of ecological equivalent fi g_{CO_2}/KWh
Industrial diesel fuel	1.1	267
Heavy oil	1.1	279
Natural gas	1.1	202
LPG	1.1	227
Black coal	1.2	341
Lignite/brown coal	1.2	364
Hard coal	1.2	354
Briquettes	1.25	351
Wood pellets	1.05	43
District heating	1.3	290
Electricity	3	819

Ordinance No. RD-16-869/02.08.2011 for calculating the overall share of energy from renewable sources in gross final consumption of energy and the consumption of biofuels and renewable energy in transport lays down guidelines for the calculation of the renewable energy produced by heat pumps using various heat sources (e.g., air, water, geothermal, etc.), in accordance with Article 5 of Directive 2009/28/EC.

I.iii. Cost-optimal procedure for setting energy performance requirements

The cost-effective range is based on the achievable values of the integrated characteristics $EP_{max,r}$ and $EP_{max,s}$ according to EN 15217, for ten categories of buildings.

Figure 3: Energy consumption classes.

Class	EPmin, kWh/m2	EPmax, kWh/m2	RESIDENTIAL BUILDINGS
A+	<	48	A+
A	48	95	A
B	96	190	B
C	191	240	C
D	241	290	D
E	291	363	E
F	364	435	F
G	>	435	G

Class	EPmin, kWh/m2	EPmax, kWh/m2	HOSPITAL BUILDINGS
A+	<	70	A+
A	70	140	A
B	141	280	B
C	281	365	C
D	366	450	D
E	451	563	E
F	564	675	F
G	>	675	G

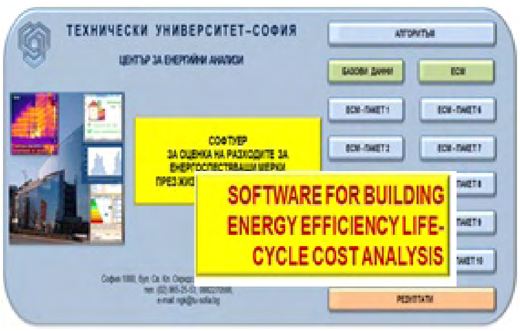


Figure 4: Software for Life-Cycle Cost Analysis.

Figure 3 indicates the cost-optimal energy consumption classes for residential and hospital buildings. The structure of the certificates for other types of non-residential buildings is the same, but the values of EP_{min}[2] and EP_{max} are different.

For the calculation using the methodology laid out in the Commission Delegated Regulation (EU) No 244/2012, a specialised software for life-cycle cost analysis of single measures as well as packages of energy conservation measures in buildings has been developed (Figure 4). It allows for comparison of the economic feasibility of the various alternative packages of energy saving measures. The calculations are made based on the sequential implementation of the following steps:

> structuring of packages of combinations of single measures;

> developing a matrix of energy saving measures;

> simulation study of energy consumption;

> analyses.

The cost-optimal calculations are carried out in a way that makes it possible to investigate the best combination of measures.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

The definition for Nearly Zero-Energy Buildings (NZEBs) is given in the Energy Efficiency Act of 15 May 2015. Point 28 from the additional provisions states that *"a Nearly Zero-Energy Building is a building that meets both of the following conditions:*

a) energy consumption of the building, defined as primary energy, corresponds to class A of the scale of energy classes for the type of building;

b) not less than 55% of the consumed (delivered) energy for heating, cooling, ventilation, domestic hot water and lighting is energy from renewable sources produced on-site at the level of a building or near the building."

The Minister of Regional Development and Public Works has established an interdepartmental working group to draft a national plan for NZEB by 15 November 2015. The national plan to increase the number of buildings with near-zero energy has been developed. The plan is being processed for adoption and publication.

[2] *EP_{min} is a notional value used to define the range for energy consumption classes.*

Building system	Nº	Indication	Single energy conservation measure (SECM)	Minimum requirement for the SECM	
				Parameter	Value
Building envelope	1	B1	Replacement of windows and external doors	U, W/m².K	1.40
	2	B2	Thermal insulation of walls	U, W/m².K	0.28
	3	B3	Thermal insulation of roofs	U, W/m².K	0.20
Heating	4	C1	District heating (substation)	η, %	100
	5	C2	Installing of biomass firing boiler (pellets)	η, %	103
	6	C3	Installing of gas firing boiler	η, %	103
	7	C4	Installing of light oil firing boiler	η, %	89
	8	C5	Installing of direct evaporation heat pump	SPF, -	3.5
	9	C6	Installing of air to water heat pump	SPF, -	3.5
	10	C7	Installing of ground source heat pump	SPF, -	3.5
Ventilation	11	C8	District heating	η, %	100
	12	C9	Installing of air to air heat pump	SPF, -	3.5
	13	C10	Installing of air to water heat pump	SPF, -	3.5
	14	C11	Installing of ground source to air heat pump	SPF, -	3.5
	15	C12	Heat recovery	η, %	70
Domestic hot water	16	C13	District heating (substation)	η, %	100
	17	C14	Installing of biomass firing boiler (pellets)	η, %	103
	18	C15	Installing of gas firing boiler	η, %	103
	19	C16	Installing of air to water heat pump	SPF, -	3.5
	20	C17	Installing of solar water heater	η, %	60
Cooling	21	C18	Installing of water chiller	SEER, -	2.5
	22	C19	Installing of direct evaporation heat pump	SPF, -	3.5
Lighting	23	C20	Energy efficiency lighting	η, %	70

Table 4: Single energy conservation measures to meet NZEB requirements.

The first building with close-to-zero-energy consumption was built in 2012 (Figure 5). The total primary energy use is 47.94 KWh/m².year. Many experts propose to formulate the concept of NZEB through linking specific values for primary energy consumption in kWh/m².year. The proposals include the formation of an acceptable level of CO_2 emissions. On the other hand, the Community of Architects in Bulgaria seeks to impose the concept of *"Passive House"*. There are already several buildings with an energy consumption below 15 KWh/m².year. *"Sun"* Kindergarten in Gabrovo is the first passive public building in Bulgaria and one of the first buildings officially certified by the Passive House Institute (Figure 6). In recent years, other such projects have been implemented in private buildings as well (e.g., in Dobrich and Samokov; Figures 7a and 7b).

Figure 5: The first NZEB in Bulgaria – The research centre of the Technical University, Sofia.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The Regulations under the Energy Efficiency Act are due to be changed. The Minister of Energy has established an interdepartmental working group to develop drafts of ordinances stipulated by the Energy Efficiency Act until 15 November 2015, some of which are directly relevant to energy efficiency in buildings. These include:

> an ordinance on indicators for energy consumption and buildings' energy performance, and on the parameters of the scale for energy use classes for different categories of buildings;

> an ordinance on conditions and procedures for efficient energy audits and certification of buildings, parts of buildings, and the conditions for an assessment of energy savings.

An ordinance titled "Minimum energy performance requirements for buildings or parts thereof in order to achieve optimal levels of costs, technical requirements and indicators for EE and methods/ standards for determining the annual energy consumption in buildings, including NZEBs" is forthcoming from the Ministry of Regional Development and Public Works.

An inventory list of the 8,162 heated and/or cooled governmental and municipal buildings with a total useful floor area over 250 m² was published on the Ministry of Economy and Energy's website in 2013. Bulgaria has introduced a plan to renovate 5% of the governmental and municipality buildings each year. The respective regional and municipal authorities are free to choose which buildings will undergo renovation each year, with the requirement that after renovation the building must obtain an EPC of at least class B.

Figure 6: Examples of "Passive houses" in Bulgaria.

Figure 7a: House in Dobrich.

Figure 7b: House in Samokov.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

Technical Building System (TBS) requirements apply to new buildings and refurbishments and/or major renovations of existing buildings, when major renovation includes all technical systems. TBS requirements are specified in Ordinance 7, as amended in 2015 (State Gazette No. 27/14.04. 2015, corrected State Gazette No. 31/28.04.2015. 2015, supplemented State Gazette No. 35/15.05.2015). The special requirements relate to:

> parameters of systems for solar energy utilisation for DHW (Annex No. 11);
> seasonal efficiency of heat pumps with electrically driven compressors in heating mode with SPF_{min} not less than 3.5 and driven thermal energy not less than 1.15 SPF_{min};
> calculating the integrated energy efficiency indicator for boilers (including steam boilers and boilers burning biomass at nominal and partial load): minimum requirements are given depending on the type and capacity of the boilers and the average temperature of the heated water;
> reference values for heat transfer through transparent enclosing structures (Table 5);
> use of products in the buildings must provide a high degree of environmental and health safety.

The Public Procurement Law, promulgated in State Gazette No. 28/06.04.2004, last amended and supplemented State Gazette No. 79/13.10.2015 stipulates benchmarks for state and municipal buildings, when replacing or purchasing new equipment that must meet energy efficiency requirements. For private buildings, the owner freely chooses the energy efficiency parameters of the equipment.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

A new Ordinance No. 16-1594, promulgated in State Gazette No. 101/22.11.2013, repealed the first version of the EPC, named as *"Energy Passport of Building"* that had been published in Ordinance No. 16-1057 State Gazette 103 (2009) to transpose the Directive 2002/91/EC. The new documents are entitled *"Certificate of design energy performance requirements" and "Energy Performance Certificate" (EPC)*.
The *"Certificate of design energy performance requirements"* is issued for buildings under construction. The *EPC* is issued for buildings in use, after and depending on the results of an energy audit. An Annex to the Ordinance No. 16-1594 indicates a detailed template for EPCs and a synopsis template for energy performance audits. The ordinance sets out the conditions and procedures for:

> certification for energy performance of buildings at the design stage;
> certification for energy performance of buildings in operation;
> assessment of energy savings;
> rules for submission and acceptance of documents for the assessment of energy efficiency and subsequent certification of buildings.

EPCs are issued by auditing companies, registered by the SEDA in a database. This database is freely accessible to the public.

EPCs are issued after the construction of a new building is completed but before it is put into use. The total number of all EPCs issued in 2013 and 2014 was 694 and 783, respectively, and an independent random control was carried out by the SEDA on 438 of these in 2013 and all 783 in 2014. The total number of all certified buildings through the end of 2014 is 3,674.

Table 5: Reference values of heat transfer coefficient for transparent enclosing structures

№	Type of precast element - completed window system	U_w, W/m².K
1	Exterior windows, glazed doors and windows, with vertical and horizontal axes of rotation, with a frame of PVC with three or more hollow chambers, roof windows of any type frame of PVC	1.4
2	Exterior windows, glazed doors and windows, with vertical and horizontal axes of rotation, wood frames, roof windows for each type of opening, by a frame from a tree	1.6/1.8
3	Exterior windows, glazed doors and windows, with vertical and horizontal axes of rotation, with aluminium frame with a discontinuous thermal bridge	1.7
4	Suspended facades/facades with increased requirements	1.75/1.9

According to the Energy Efficiency Act, energy performance of new buildings prior to operation shall be certified by a *"Certificate of design energy performance requirements"* for the building project. The certificate shall be issued by the energy efficiency consultants working for auditing companies and registered with the SEDA. This document replaces the former building energy passport. Terms and conditions for issue of certificates are determined by Ordinance No. 16-1594/13.11.2013. Under the same ordinance, the contracting authority/owner must provide the SEDA with a certified copy of the certificate within thirty days of the beginning of the building's operation. The Energy Efficiency Act requires that the contracting authority or owner of the new building acquires the building's EPC prior to its operation. Owners of the individual units in a building are entitled to receive a notarised copy of the original certificate. The original is kept by the owner, empowered by the building's community. The EPC for new buildings must be issued between three and six years after the building becomes operational. The EPC is valid for up to ten years.

At present, the SEDA does not carry out any controls to check if an EPC is not delivered, and the ordinance does not set any penalties if an owner does not deliver an EPC to the SEDA.

EPCs are issued for multi-family buildings with a common heating system and they are valid for all the building units. There are no provisions for selling or renting just one unit in a building without an EPC, i.e., an EPC is not yet required in this case.

EPCs for buildings at the design stage consist of three pages, and they are valid for up to six years. Figure 8 shows the cover page.

Each privately-owned building already operational may be voluntarily certified by its owner. The Energy Efficiency Act identifies buildings that are subject to mandatory certification, as well as exceptions, in compliance with EPBD provisions. EPCs for buildings in use shall be issued following an energy efficiency audit and are valid for up to ten years. These EPCs consist of five pages. Figure 9 shows the cover page. The energy audits over the last three years are shown in Table 6.

Figure 8: Cover page of the EPC issued for a building at the design stage.

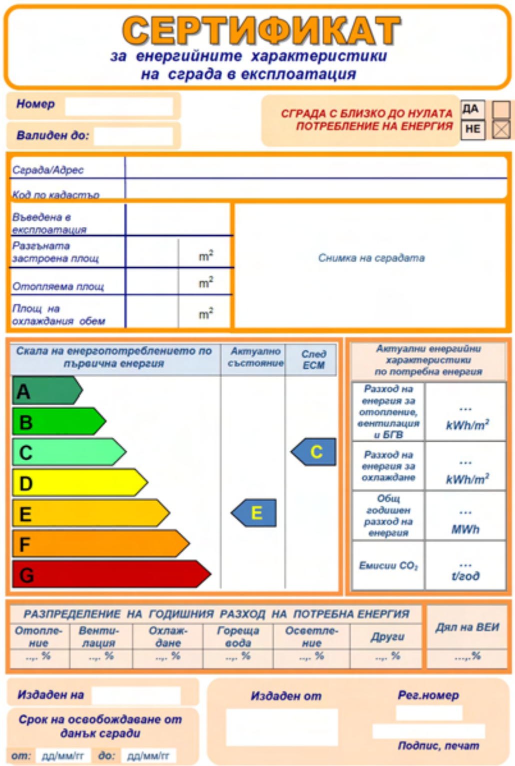


Figure 9: Cover page of the EPC issued for a building in use.

Table 6: Audits 2011 – 2014.

	2011 year		2012 year		2013 year		2014 year	
	Number	Total area m²	Number	Total area m²	Number	Total area m²	Number	Total area m²
Municipality owned buildings	188	535,780	386	1,146,318	280	807,088	422	1,264,263
Government owned buildings	26	308,260	97	507,296	60	624,700	119	650,269
Public buildings, privately owned	85	560,803	69	430,736	92	555, 720	198	1,350 ,414
Total	301	1,404,843	553	2,084,350	432	1,987,508	739	3,264,946

In all heated and/or cooled buildings that are state property used by the state administration, measures are taken annually to improve the energy performance of at least 5% of the total floor area (in accordance with Article 23 of the Energy Efficiency Act).

Advertisement

When selling a building or building unit, according to the Energy Efficiency Act, vendors must provide the purchaser with the building's EPC, and a notarised copy of the EPC in the case of a sale of a building or an individual building unit in a building with a common heating and/or cooling system.

When selling or renting a building, the landlord must hand over to the buyer or the tenant a copy of the building's EPC.

When a building in operation for which an EPC has been issued is advertised for sale or for rent, the specific annual consumption of primary energy in kWh/m^2, referred to in the EPC, must appear in all advertisements. There are, however, still no controls and no penalties for non-compliance with the advertisement requirement.

Penalties

The law specifies different penalties towards persons who perform energy audits and inspections. The most substantial penalties are towards the audit companies and experts, if the EPC has been issued without a prior energy efficiency audit. The fine is then between 50,000 and 100,000 Levs (25,000 to 50,000 €) or a pecuniary penalty of 200,000 to 300,000 Levs (100,000 to 150,000 €) (confiscated property corresponding to this value).

Up to the end of 2014, no penalties had been imposed.

The law does not include any penalties for building owners who fail to have inspections carried out at the prescribed intervals.

Assessors

The Minister of Economy and Energy along with the Minister of Regional Development issued a new Ordinance No. RD-16-301/10.03.2014, promulgated in State Gazette No. 27/ 25.03.2014. The new ordinance repeals the previous Ordinance No RD-16-348 for the circumstances liable for entry in the register of persons performing certification of buildings and energy efficiency audits, procedures for obtaining information from the register, conditions and procedures for qualification and the necessary technical means for carrying out activities in auditing and certification promulgated in the State Gazette No. 28/14.04.2009. The new ordinance specifies the circumstances for acquisition of skills and the technical means to carry out audit investigations and certifications, as well as for certification of an engineer or an architect who has received specific training, passed an examination, received a certificate and registered in SEDA. The procedures for obtaining information from the SEDA's database are also outlined in this ordinance.

The SEDA created and maintains a register of companies and consultants for energy audits of buildings and of energy consultants, freely accessible by the public. By the end of 2014 the register contained data on 321 building audit companies and 8 consultants. The consultants can be included in only up to two audit companies. The SEDA maintains lists of persons who have qualified to issue EPCs.

The SEDA carried out the following controls of energy auditors and consultants:

> validity checks of the input data used to issue EPCs, as well as checks of the results stated on certificates;
> detailed checks on the input data and results inscribed on EPCs, including the prescribed measures to increase energy efficiency;
> full inspection of the data and results of the prescribed measures to improve energy efficiency through on-site visits to verify compliance between those data in the EPCs and the certified building.

Methodologies for calculating energy savings to meet EPC recommendations

Methodologies for calculating the energy savings of single measures are legislatively defined by Ordinance No. 7 on energy efficiency of buildings. Annex 3 to the ordinance is a *"Methodology for calculating the indicators for energy consumption and the energy performance of buildings"*.

The indicator values for new buildings and the reference value must be calculated based on data for buildings during the design stage. The indicator values for existing buildings and the reference value are calculated based on data on the state of the building when performing energy efficiency audits under the requirements of the Energy Efficiency Act, i.e., no default values can be used.

The methodology for calculating the energy performance of buildings in Bulgaria is based on the European method EN ISO 13790, introduced as Bulgarian standard BDS EN ISO 13790. The calculations of energy consumption take into consideration the characteristics of the building envelope, equipment and appliances (see Table 1). In determining the annual energy consumption for heating, ventilation, cooling and hot water, best European practices and standards are used and adopted in the national standardisation (for example: BDS EN ISO 13790:2008; BDS EN 15217:2007; BDS EN 15232:2012; BDS EN 15316; BDS EN 15239:2007; BDS EN 15378:2008; BDS EN ISO 6946; BDS EN ISO 14683; BDS EN 1027; BDS EN 1220, etc.). Reference values of the co-efficient of heat transfer for major envelope elements of heated buildings through design, reconstruction, major renovation and major repair phases are defined in Table 1.

The total annual energy consumption for heating, cooling, ventilation, hot water, lighting and appliances per square meter of the building conditioned area are defined as primary energy - for both existing and new buildings.

The data necessary to calculate the duration of the heating period and degree days in urban areas are based on the climatic factors in the zone in which the building is situated (see Figure 10). The data for the heating period and degree days of 108 settlements in all climatic zones are listed in Table 1 of Ordinance No. 7. Table 7 lists the climatic data for the largest cities of the nine zones.

Decree No. 36 of 15 February 2013, establishes specialised methods for assessment of energy savings. In the section on buildings, methodologies are suggested in order to demonstrate the energy savings achieved through the implementation of a single measure or group of measures in buildings that do not have an EPC. These methodologies cannot be used for producing an EPC in buildings subject to mandatory certification. The methodologies generally cover the following categories:

> replacement of existing equipment with new, more energy efficient ones;
> upgrading of existing equipment or major upgrade, repair and reconstruction of the building;
> acquisition of new energy efficient equipment or construction of new energy-efficient buildings.

Table 7: Data for the duration of the heating period and degree days (DD).

Zone	City	The number of heating days(t_{HP}) at:	DD at:	The number of heating days(t_{HP}) at:	DD at:
		$q_e \geq 12\ ^0C$		$q_e \geq 12\ ^0C$	
		$q_{iH} = 19\ ^0C$		$q_{iH} = 17\ ^0C$	
1	Varna	180	2,400	180	2,040
2	Shumen	190	2,800	190	2,420
3	Ruse	175	2,600	175	2,250
4	Pleven	180	2,700	180	2,340
5	Burgas	170	2,300	170	1,960
6	Plovdiv	175	2,500	175	2,150
7	Sofia	190	2,900	190	2,520
8	Haskovo	175	2,300	175	1,950
9	Blagoevgrad	170	2,400	170	2,060

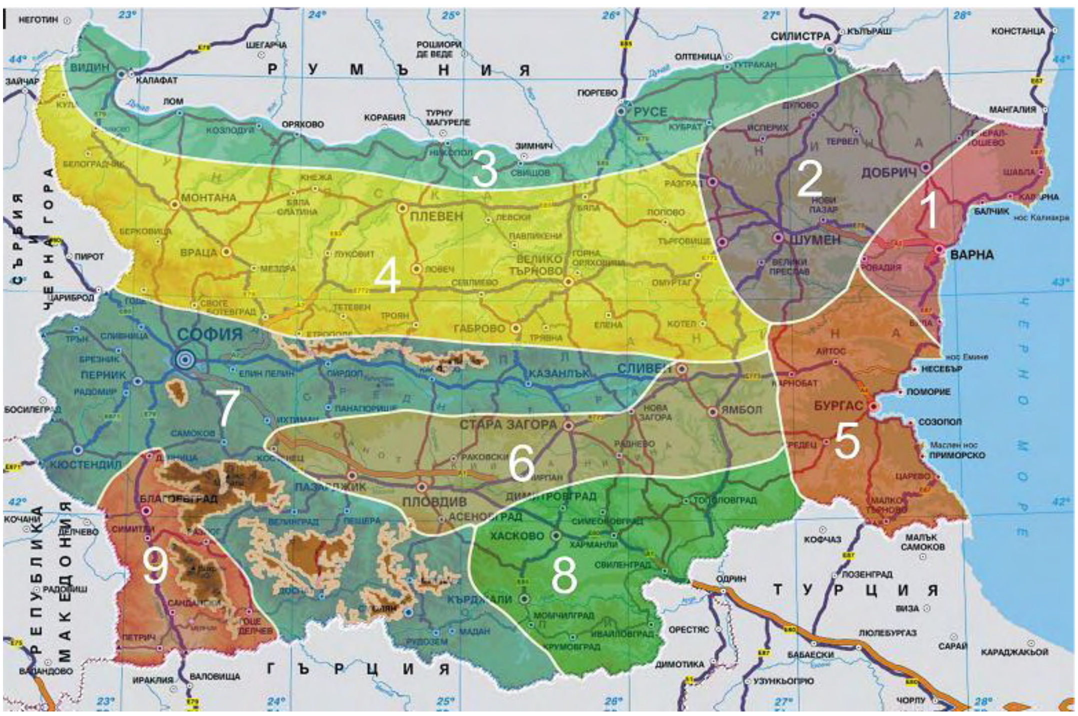


Figure 10: Map of climatic zones in Bulgaria.

Information campaigns

There has never been any targeted and specialised information campaign on the implementation of the EPBD. Regulations and procedures, as well as information on the conditions of certification, auditing companies and experts are freely accessible on the SEDA's website and database. Most of the databases developed and maintained by the SEDA are also freely available, although some of them require online registration. Nevertheless, the SEDA's regional offices currently provide information to various interested parties on the possibilities of energy efficiency measures.

Bulgaria intends to continue working on the national project titled *"Energy Renovation of Bulgarian Homes"*. Decree No. 13/07.05.2013 provides for additional financial support through the budget of the Ministry of Regional Development to ensure the participation of owners of private residential units in multi-family residential buildings, promulgated in State Gazette No. 43/14.05.2013[3]. Its purpose is to support owners' associations or owners of individual units in multi-family residential buildings. For each approved building, owners receive a financial contribution of 75% of the budget for the renovation of the building/block/section. An EPC must be issued at the end of the works. As of 28 October 2013, the conditions for participation in the project were amended as follows:

> owners of individual units who implement energy efficiency improvements receive a 75% subsidy for the renovation of their share of the common areas and 100% of the cost of replacing the windows in the house;

> the requirement to contribute a portion of the amount required for the renovation to the owners' association was decreased from 30% to 15%.

Conclusions, future plans

A project for the application of the *"White Certificates Trading Scheme"* financial mechanism is under development, and expected to be finalised in September 2015.

The specific objectives of the project are:

> to assist and optimise both the SEDA and users in the performance of their duties under the Energy Efficiency Act, in order to increase the quality of energy services and the overview capabilities of the SEDA;

> to increase the volume of investments attracted towards the implementation of energy efficiency policies;

> to increase the volume, quality and cost-effectiveness of energy efficiency measures implemented through the introduction of a market for energy savings based on tradable white certificates;

> to increase the scope of the implemented energy saving measures and incentives and the capabilities of audit and Energy Service COmpanies (ESCOs);

> to allow free access for all stakeholders to methods for evaluation of investment intentions and energy efficiency projects: anyone interested will be able to freely use software to help with decision-making on planning projects for energy saving.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Bulgaria has a full system of inspections in place. The SEDA is the body responsible for independent control of inspection reports on heating and AC. SEDA controls all reports. Inspection reports are kept in a database that is not freely accessible to the public.

The Energy Efficiency Act stipulates a regular inspection for heating installations with boilers of an effective rated output for space heating higher than 20 kW in all buildings, public and private, and AC systems with nominal power above 12 kW (See Table 8).

Energy efficiency inspections, audits of buildings and industrial enterprises, certification of buildings, evaluations of compliance of development-project designs and preparation of energy savings

Table 8: Registered boilers and air-conditioning systems in buildings, 2011-2014.

	2011 year		2012 year		2013 year		2014 year	
	Number	Installed MW	Number	Installed MW	Number	Installed MW	Number	Installed MW
Boilers	707	394.2	335	246.7	128	42.7	61	16.8
Air conditioning systems	228	16.8	84	7.0	264	8.6	36	2.9
Total	935	411.1	419	253.7	392	51.4	97	19.7

[3] *Operational Programme Regional Development 2007-2013*

	2011 year		2012 year		2013 year		2014 year	
	Number	Installed MW	Number	Installed MW	Number	Installed MW	Number	Installed MW
Boilers	219	88.6	530	340.8	189	98.4	212	104
Air conditioning systems	39	4.6	96	8.9	112	10.5	71	10.9
Total	258	93.2	626	349.7	301	108.9	283	114.9

Table 9: Inspections of boilers and air-conditioning systems in buildings, 2011-2014, carried out in accordance with Article 50 and Article 51 of the Energy Efficiency Act of 15 May 2015.

evaluations are carried out by energy auditors (engineers, who have received specific training for inspections, passed an examination, received a certificate and registered with SEDA) listed in a special public register. The register is maintained and administrated by the SEDA. The SEDA is also responsible for the documentary control of auditors, and of their qualifications and the quality of audits.

The SEDA created and maintains databases on the condition of these heating and AC systems. According to Article 50 of the Energy Efficiency Act, the inspections of heating systems with hot water boilers are periodic, as follows:

> every 8 years for heating systems with hot water boilers using liquid or solid fuel and units with rated power from 20 to 50 kW, as well as natural gas boilers with a rated output of 100 kW and above;

> every 4 years for heating systems with hot water boilers using liquid or solid fuel and units with rated power from 50 to 100 kW inclusive;

> every 3 years for heating systems with hot water boilers using liquid or solid fuel and units with nominal power of 100 kW and above.

In 2013, 189 boilers were inspected and in 2014, the SEDA collected information on 212 inspected boilers (see Table 9).

According to Article 50 of the Energy Efficiency Act, AC systems are subject to mandatory periodic inspection of energy efficiency every 4 years, which includes evaluation of the condition and functioning of the accessible parts of the AC unit, and assessment of the efficiency and dimensioning of the AC unit, according to the cooling requirements of the building.

Inspection bodies annually submit, no later than 31 January of the current calendar year, to the SEDA a list of hot water boilers and AC systems which were inspected the previous year. The reports should describe clearly and in detail the current state of the systems, and prescribe entirely understandable measures to improve energy efficiency.

The reports are checked for conformity and there are no penalties for any errors found.

For AC systems subject to inspection, the information in the SEDA databases indicates that 112 AC systems were inspected in 2013, and 71 in 2014 (see Table 9).

The SEDA simply receives inspection reports that are submitted voluntarily by inspectors, but it does not seek to identify buildings with systems required to have an inspection where no inspection report is submitted. There are no penalties laid out for not performing a required inspection.

3. A success story in implementing the EPBD

The Bulgarian Demonstration Project for the Renovation of Multi-family Buildings[4], a joint initiative of the United Nations Development Programme and the Ministry of Regional Development and Public Works, began in 2007. Under the Demo Project, a model for an integrated energy audit of buildings in which the use of Renewable Energy Sources (RES) had been introduced was tested. The project aimed to renovate 50 pilot multi-family residential buildings in 13 cities in Bulgaria. The energy audits carried out in 27 renovated buildings after the first two heating seasons confirmed the planned savings of 40-60%.

Besides energy savings, the model of voluntary association of condominium owners and the new mechanism for technical and financial support were also tested. The project was awarded first prize by the European Union *"Sustainable Energy for Europe"* in 2011.[5]

Following the completion of the pilot project, the Bulgarian Ministry of Regional Development launched a programme to improve the energy efficiency of multi-family residential buildings by developing financial mechanisms for the implementation of the "National Programme for Renovation of Bulgarian Homes". All the buildings

[4] *http://open.undp.org/#project/00046967*
[5] *Operational Programme "Regional Development 2007-2013"*

involved in this programme must have an EPC issued after renovation.

4. Conclusions, future plans

A significant proportion of buildings' energy demands shall be met by Renewable Energy Sources (RES) systems installed on or around the buildings. Increasing the energy efficiency through the funding and implementation of appropriate legal and technical measures also leads to a reduction in carbon emissions.

The National Programme for Energy Efficiency of Multi-family Buildings (Decree No. 18 of the Council of Ministers, promulgated in State Gazette No. 10/06.02.2015, corrected by State Gazette No. 18/10.03.2015) is in the process of being implemented. At present, the implementation of the programme for building renovation has received some 600 requests for contracts, with approximately 400 contracts for targeted buildings signed between municipalities, regional governors and Bulgarian banks.

Implementation of the EPBD in Croatia

STATUS IN DECEMBER **2014**

AUTHOR

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1. Introduction

The first requirements for the energy efficiency of buildings in Croatia were established by regulation in 1970. This regulation defined the requirements for the building envelope (maximum specific thermal losses and permitted thermal transmittance values). Improvements to the requirements continued until 1987. Certain transposition activities of the Energy Performance of Buildings Directive (EPBD) started in 2005 under the Ministry of Construction and Physical Planning (MCPP). The Technical regulation on energy economy and heat retention in buildings established the maximum permitted annual energy needs for heating (QH,nd)[1], as well as a new, higher restriction on thermal transmittance values (U-values) for building elements. In 2007, the Physical Planning and Building Act transposed the provisions of the EPBD related to the energy certification of buildings and requirements for the energy performance of buildings.

Official implementation of the EPBD within Croatian regulations started in 2008 under the MCPP, and involved improving the technical regulation and amending the Physical Planning and Building Act. As a result of the latter, certain parts of the transposition became the responsibility of the Ministry of Economy (Act of Energy End-use Efficiency), in particular energy certification, regular inspection of heating and air-conditioning (AC) systems in buildings, and establishment of an independent control system. In this way, the EPBD transposition and implementation was divided under the competence of two ministries. The Act on Energy End-use Efficiency (in part related to energy efficiency in buildings) and the Physical Planning and Building Act were overridden by the new Building Act published in 2013. With this new regulation, the transposition and implementation of the EPBD passed under the sole competence of the MCPP.

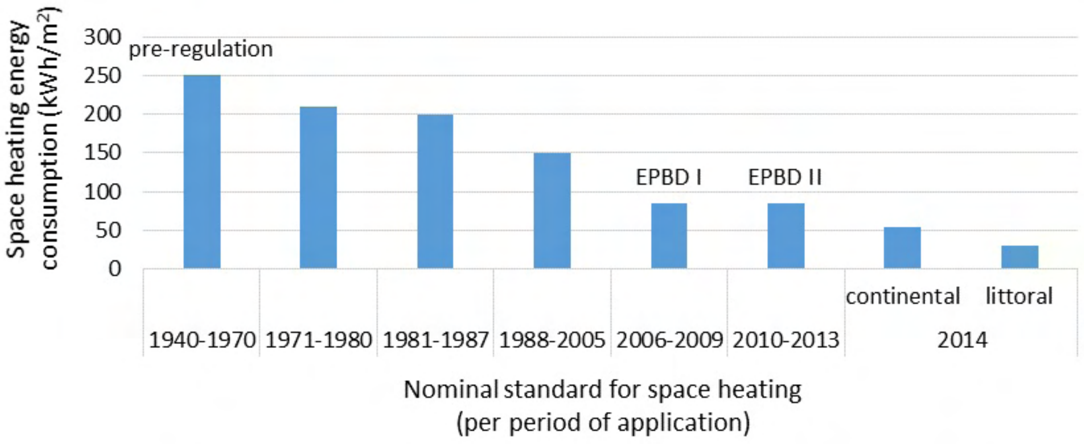
The Building Act (Official Gazette 153/2013) has set the legislative basis for applying minimum technical requirements for the energy performance of buildings and their components, as well as for setting requirements for existing buildings and their components that are undergoing renovation. It also requires the drafting of studies containing technical, environmental and economic analyses of alternative energy supply systems, to be developed prior to building permit issuance for all buildings with a total useful surface area exceeding 50 m2, the issuance of Energy Performance Certificates (EPCs), as well as carrying out regular inspections of heating and AC systems in buildings, and the establishment of an independent control system.

From 2012 to November 2014, new subordinate regulations were adopted, or existing ones were amended. The most important one is the new Technical regulation on rational use of energy and heat retention in buildings (OG 97/2014 and 130/2014), in which calculations were carried out for cost-optimal levels of minimum energy performance requirements using the comparative methodology framework for all types of buildings. Furthermore, definitions were proposed for Nearly Zero-Energy Buildings (NZEBs) for all types of buildings.

NATIONAL WEBSITE www.mgipu.hr

[1] *According to ISO 13790:2008 Energy performance of buildings - Calculation of energy use for space heating and cooling, and also according to EU Regulation 244/2012.*

Figure 1:
Energy consumption in Croatia for the heating of residential buildings per periods of application of the regulation[2] (expressed as $Q_{H,nd}$).



2. Current status of implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

The requirements for energy consumption and heat retention in buildings that were set and have been implemented since 2005, related in particular to prescribing the maximum specific thermal energy needs for heating ($Q_{H,nd}$) for residential and non-residential buildings, and the maximum allowed heat transmission coefficients (U-values) for single parts of the building envelope. There are additional requirements related to energy savings in case of building reconstruction: the necessary minimum heat retention, maximum thermal losses, reduction of the effects of thermal bridges and prevention of water vapour condensation.

Based on the cost-optimal analyses that were carried out in 2013 and 2014, requirements were set on individual types of buildings regarding energy needs for heating ($Q_{H,nd}$). The requirement regarding the primary energy consumption (E_{prim}) is included in the Technical regulation on rational use of energy and heat retention in buildings (OG 97/2014 and 130/2014) and the remaining requirements for delivered (final) energy consumption (E_{del}) are specified in the new technical regulation, published in November 2015 (OG 128/15).

The technical regulation (OG 97/2014 and 130/2014) prescribes the requirements of the energy performance of new buildings and, in case of major refurbishment, of existing buildings. Requirements are prescribed for maximum primary energy consumptions, maximum annual energy needs for heating, maximum heat transmission coefficients, reduction of the effects of thermal bridges (for this purpose, a catalogue of good solutions has been developed), the efficiency of technical systems, the efficiency class of the building automation and control system, the airtightness of buildings, and the share of Renewable Energy Sources (RES). Provisions for indoor environmental quality (including air quality, thermal comfort, lighting and acoustics) are also ensured, for which the values recommended in HRN EN 15251:2008 are used.

Compliance with the requirements of airtightness is proven by testing the new or renovated existing building according to HRN EN 13829:2002[3], method A, before the technical inspection of the building. For a pressure difference between inside and outside of 50 Pa, measured airflow, reduced to a volume of indoor air, should not exceed $n_{50} = 3.0\ h^{-1}$ in buildings without mechanical ventilation devices, or $n_{50} = 1.5\ h^{-1}$ in a building with a mechanical ventilation device. For multi-family residential buildings, airtightness requirements must be fulfilled for each apartment. For non-residential buildings, airtightness requirements must be fulfilled by the

[2] *The first regulation was in 1970. Before that, construction was according to the prevailing common practices.*
[3] *Thermal performance of buildings - Determination of air permeability of buildings - Fan pressurisation method.*

building envelope. The minimum airtightness of windows, balcony doors and roof windows is determined according to EN 12207: 2001[4], and must be class 2 for buildings of up to two floors, or class 3 for higher buildings.

Annual energy needs for heating, $Q_{H,nd}$ (kWh/year), is calculated according to the standard ISO 13790:2008 monthly method, including requirement for calculating the solar heat gains Q_{sol}, necessary to consider the opacity of movable shading in glazings.

Pursuant to the technical regulation, the reference climate is the climate observed at characteristic meteorological stations in continental and littoral Croatia. Continental Croatia includes all places where the mean monthly outdoor temperature of the coldest month is equal to or less than 3 °C as observed by the closest to the building's location meteorological station. Littoral Croatia includes all places where the mean monthly outdoor temperature of the coldest month is higher than 3 °C as observed by the closest to the building's location meteorological station.

The requirements for residential and non-residential buildings heated to a temperature of 18 °C or more, include prescribed maximum values of energy needs for heating (depending on the building shape and climate) and maximum primary energy consumption depending on the climate (see Tables 1 and 2).

With regard to RES, the building must meet one of the following three requirements:

1. at least 20% of the total energy needs for the operation of the systems in the building is covered by energy from RES;
2. a share of the total delivered energy supply for heating and cooling of the building, as well as for Domestic Hot Water (DHW), preparation is obtained in one of the following ways:
   - > at least 25% from solar radiation;
   - > at least 30% from gaseous biomass;
   - > at least 50% from solid biomass;
   - > at least 70% from geothermal energy;
   - > at least 50% from heat from the environment;
   - > at least 50% from cogeneration installations with a high efficiency, in compliance with a special regulation;
3. 50% of the energy needs of a building is covered from district heating that meets the requirements from item 2.

Table 1:
Maximum allowed annual thermal energy needs for heating ($Q_{H,nd}$) of residential and non-residential buildings heated to a temperature of 18 °C or more (past and present status).

Building type	Climate	Shape factor f_0 (m^{-1}) = Area / Volume		
		$f_0 \leq 0.20$	$0.20 < f_0 < 1.05$	$f_0 \geq 1.05$
Maximum $Q_{H,nd}$ Technical regulation 2008				
residential kWh/m².year	continental & littoral	51.31	$41.03 + 51.41 \cdot f_0$	95.01
non-residential kWh/m³.year	continental & littoral	16.42	$13.13 + 16.45 \cdot f_0$	30.40
Maximum $Q_{H,nd}$ Technical regulation 2014				
building* ≤ 80 m² kWh/m².year	continental & littoral	51.31	$41.03 + 51.41 \cdot f_0$	95.01
Single-family house kWh/m².year	continental	40.50	$33.62 + 34.4 \cdot f_0$	69.74
	littoral	21.60	$17.73 + 19.33 \cdot f_0$	38.03
other residential & non-residential kWh/m².year	continental	40.50	$32.39 + 40.58 \cdot f_0$	75.00
	littoral	21.60	$17.27 + 21.65 \cdot f_0$	40.00

*surface area of the gross floor area of a building equal or below 80 m² regardless of type (residential and non-residential)

Table 2:
Optimal value of primary energy consumption (E_{prim}) by building types according to cost-optimal analyses (Technical regulation 2014 current status).

	E_{prim} for new buildings [kWh/m².year]		E_{prim} for renovated old buildings [kWh/m².year]	
	Continental climate	Littoral climate	Continental climate	Littoral climate
Single-family house	100	60	135	70
Apartment blocks	120	90	180	130
Offices	65	65	65	65
Educational buildings	60	55	90	75
Hospitals	280	280	330	300
Hotels and restaurants	120	70	135	115
Sports facilities	400	170	400	215
Wholesale and retail trade services buildings	450	280	475	300

[4] *Windows and doors - Air permeability - Classification*

Table 3: Maximum allowed heat transmission coefficient, U [W/m².K], for elements of new buildings and after reconstruction of existing buildings heated to a temperature of 18 °C or more, and heated between 12 °C and 18 °C (previous and current status).

Building element	Maximum U-values [W/m².K]							
	Technical regulation 2008				Technical regulation 2014			
	heated ≥ 18°C		12°C < heated < 18°C		heated ≥ 18°C		12°C < heated < 18°C	
	Cont.	Littoral	Cont.	Littoral	Cont.	Littoral	Cont.	Littoral
External walls	0.45	0.60	0.75	0.75	0.30	0.45	0.50	0.60
Transparent facade elements (frame)	1.80	1.80	3.00	3.00	1.40	1.80	2.50	2.80
Glazing only	/	/	/	/	1.10	1.10	1.40	1.40
Roofs	0.30	0.40	0.40	0.50	0.25	0.30	0.40	0.50
Ceilings above external air	0.30	0.40	0.40	0.50	0.25	0.30	0.40	0.50
Walls and ceilings of non-heated rooms	0.50	0.65	2.00	2.00	0.40	0.60	0.90	1.20
Floor	0.50	0.50	0.65	0.80	0.30	0.50	0.65	0.80
External doors	2.90	2.90	2.90	2.90	2.00	2.40	2.90	2.90
Ceilings and floors between apartments	1.40	1.40	1.40	1.40	0.60	0.80	1.20	1.20

The maximum allowed heat transmission coefficient values for single parts of the building were tightened by approximately 20% as compared to those prescribed in 2008.

I.ii. Format of national transposition and implementation of existing regulations

The Building Act (Official Gazette 153/2013) has overridden two previous acts in which the transposition and implementation of the EPBD had been divided (the Act on Energy End-use Efficiency, in part related to energy efficiency in buildings, and the Physical Planning and Building Act). It has also amended subordinate regulations that were adopted earlier. Finally, the Building Act has provided a unique basis for full transposition of the EPBD. The subordinate regulations are:

> the Technical regulation on rational use of energy and heat retention in buildings (OG 97/2014 and 130/2014);
> the Ordinance on energy audits of buildings and energy certification (OG 48/2014);
> the Ordinance on requirements and criteria for persons performing energy audits of construction works and energy certification of buildings (OG 81/2012 and 64/2013);
> the Ordinance on the control of Energy Performance Certificates (EPCs) of buildings and of reports on energy audits of construction works (OG 81/2012 and 79/2013);
> the methodology for carrying out energy audits of construction works with the algorithm for calculating the energy performance of buildings (June 2014).

The national methodology includes the algorithm for calculating the energy performance of buildings. The algorithm is based on CEN standards, except in individual cases where CEN standards were not appropriate, in which case other solutions were used (e.g., the application of the roof standard, ventilation and AC). The algorithm includes five parts according to the following calculation fields:

> energy needs for space heating and cooling in buildings according to HRN EN ISO 13790;
> energy requirements and efficiency of thermal technical systems in buildings (systems for space heating and DHW);
> energy requirements and efficiency of thermal technical systems in buildings (cogeneration systems, district heating systems, photovoltaic systems);
> energy requirements and efficiency of lighting systems in buildings;
> energy requirements for the application of ventilation and AC systems for space heating and cooling in buildings.

For the purposes of primary energy calculation, a set of primary energy conversion factors were determined (Table 4). Their calculation used three-year average data from actual annual energy balances of Croatia in 2009-2011 (determined according to EUROSTAT’s Methodology for Energy Balances).

Energy source	Primary energy factor				Emission t_{CO_2}/TJ (kg_{CO_2}/GJ)
	Total	Renewable component	Non-renewable component	Imported component	
Lignite	1.082	0.0001	1.081	0.0001	105.13
Fuelwood	1.111	1.0001	0.111	0.0001	8.08
Wood pellets	1.191	1.0364	0.123	0.0322	9.56
Wood chips	1.211	1.0303	0.154	0.0268	11.76
Solar energy	1.048	1.0130	0.024	0.0115	1.96
Geothermal energy	1.211	1.0933	0.080	0.0383	6.52
Natural gas	1.097	0.001	1.095	0.001	61.17
Fuel oil	1.132	0.001	1.130	0.001	86.20
Electric energy	1.614	0.433	0.798	0.383	65.22
District heating Croatia - average	1.523	0.022	1.494	0.008	100.69

Table 4: Primary energy factors.*

*Only the non-renewable component is used for calculating the energy performance of buildings. These factors are applied as of 1 October 2014.

I.iii. Cost-optimal procedure for setting energy performance requirements

A cost-optimal analysis was carried out for the following building types: single-family houses, apartment blocks, offices, educational buildings, hospitals, hotels and restaurants, sports facilities and wholesale and retail trade buildings. When carrying out cost-optimal analyses, the global cost has been calculated for every building type variant. The sensitivity analysis has been carried out with regard to changes of discount rate, inflation rate, market interest rate, cost of CO_2 emissions and growth rate of energy costs.

Data on the lifecycle of components and technical systems were determined pursuant to Standard EN 15459:2007, Energy performance of buildings - Economic evaluation procedure for energy systems in buildings. For those systems and components not covered by the standard, data from good engineering practices in Croatia were used. The microeconomic and macroeconomic cost-optimal analysis has been carried out pursuant to the EU Regulation 244/2012, fully pursuant to Standard EN 15459:2007.

The average performance of the building stock that constitutes the basis for the reference buildings is not applicable to NZEBs because the current average building cannot become NZEB according to the cost-optimal analysis, even with major refurbishments. Uniform input parameters for the selection of the necessary level of thermal insulation of the external envelope were achieved by optimising the building concept with regard to solar energy capture and protection from excessive solar gains. The differences in the investment cost for different thermal insulation levels are negligible in relation to the total cost and do not have a significant role in determining the optimal level. The relations between technological solutions of the system are mostly fixed, regardless of the thermal performance of the external envelope; as in all cases, this refers to a necessary small effect of the heating and cooling systems that operates during the peak load regimen during a very small share of time.

A comparison of the cost-optimal analysis in relation to the existing regulations cannot be given, since at the time of the studies, energy needs for heating had not been particularly regulated for each building type, and primary and final energy had not been regulated at all. The results of the cost-optimal study with regards to maximum energy consumption for each building type expressed as energy needs for heating ($Q_{H,nd}$), primary energy (E_{prim}) and final energy (E_{del}) are listed in Tables 5 and 6. Relevant requirements shall be set with the new technical regulation of 2015.

Table 5: Maximum allowed requirements for new buildings heated to a temperature of 18 °C or more.

New buildings Building type	$Q_{H,nd}$ [kWh/m².year] Continental			$Q_{H,nd}$ [kWh/m².year] Littoral			E_{prim} [kWh/m².year]		E_{del} [kWh/m².year]	
	$f_0 \le 0.20$	$0.20 < f_0 < 1.05$	$f_0 \ge 1.05$	$f_0 \le 0.20$	$0.20 < f_0 < 1.05$	$f_0 \ge 1.05$	Cont.	Litt.	Cont.	Litt.
Single-family houses	40.50	$32.39 + 40.58 \cdot f_0$	75.00	24.84	$17.16 + 38.42 \cdot f_0$	57.50	115	70	80	50
Apartment blocks	40.50	$32.39 + 40.58 \cdot f_0$	75.00	24.84	$19.86 + 24.89 \cdot f_0$	45.99	120	90	80	60
Offices	16.94	$8.82 + 40.58 \cdot f_0$	51.43	16.19	$11.21 + 24.89 \cdot f_0$	37.34	70	70	40	40
Educational buildings	11.98	$3.86 + 40.58 \cdot f_0$	46.48	9.95	$4.97 + 24.91 \cdot f_0$	31.13	65	60	60	60
Hospitals	18.72	$10.61 + 40.58 \cdot f_0$	53.21	46.44	$41.46 + 24.89 \cdot f_0$	67.60	300	300	220	220
Hotels and restaurants	35.48	$27.37 + 40.58 \cdot f_0$	69.98	11.50	$6.52 + 24.89 \cdot f_0$	32.65	130	80	90	50
Sports facilities	96.39	$88.28 + 40.58 \cdot f_0$	130.89	37.64	$32.66 + 24.91 \cdot f_0$	58.82	400	170	290	110
Wholesale and retail trade services buildings	48.91	$40.79 + 40.58 \cdot f_0$	83.40	13.90	$8.92 + 24.91 \cdot f_0$	35.08	450	280	290	170
Other non-residential	40.50	$32.39 + 40.58 \cdot f_0$	75.00	24.84	$19.86 + 24.89\ f_0$	45.99	150	100	/	/

Table 6: Maximum allowed requirements for major refurbishments of buildings heated to a temperature of 18 °C or more.

Major refurbishment Building type	$Q_{H,nd}$ [kWh/m².year] Continental			$Q_{H,nd}$ [kWh/m².year] Littoral			E_{prim} [kWh/m².year]		E_{del} [kWh/m².year]	
	$f_0 \le 0.20$	$0.20 < f_0 < 1.05$	$f_0 \ge 1.05$	$f_0 \le 0.20$	$0.20 < f_0 < 1.05$	$f_0 \ge 1.05$	Cont.	Litt.	Cont.	Litt.
Single-family houses	50.63	$40.49 + 50.73 \cdot f_0$	93.75	27.00	$19.24+38.82 \cdot f_0$	60.00	135	80	120	60
Apartment blocks	50.63	$40.49 + 50.73 \cdot f_0$	93.75	27.00	$21.59 + 27.06 \cdot f_0$	50.00	180	130	120	85
Offices	21.18	$11.03 + 50.73 \cdot f_0$	64.29	17.60	$12.19 + 27.06 \cdot f_0$	40.60	75	75	40	40
Educational buildings	14.98	$4.84 + 50.73 \cdot f_0$	58.10	10.81	$5.40 + 27.06 \cdot f_0$	33.83	90	75	60	60
Hospitals	23.40	$13.26 + 50.73 \cdot f_0$	66.51	50.48	$45.06 + 27.06 \cdot f_0$	73.48	340	330	250	230
Hotels and restaurants	44.35	$34.21 + 50.73 \cdot f_0$	87.48	12.50	$7.09 + 27.06 \cdot f_0$	35.50	145	115	90	80
Sports facilities	120.49	$110.35 + 50.73 \cdot f_0$	163.61	40.91	$35.50 + 27.06 \cdot f_0$	63.93	420	215	295	190
Wholesale and retail trade services buildings	61.14	$50.99 + 50.73 \cdot f_0$	104.25	15.11	$9.71 + 27.06 \cdot f_0$	38.13	475	300	290	185
Other non-residential	50.63	$40.49 + 50.73 \cdot f_0$	93.75	27.00	$21.59 + 27.06 \cdot f_0$	50.00	180	130	/	/

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

Calculations were carried out for cost-optimal levels of minimum energy performance requirements for all types of buildings during 2013 and 2014. Furthermore, NZEB definitions were proposed and implemented in the technical regulations OG 97/2014 and 130/2014 for all types of buildings.

The primary energy needs for NZEBs (Table 7) have been established as the lowest primary energy value among the analysed systems, as long as they do not correspond to a high global cost. Thereby it is ensured that for NZEBs, technically feasible solutions are determined.

The least-cost measures have been determined by cost-optimal analysis; therefore the optimal level of energy consumption of buildings has been determined. In contrast, in determining the requirements for NZEBs, the solutions with the lowest primary energy have been chosen with no criteria for the global cost size.

At least 30% of the annual primary energy must be covered from RES generated on-site (i.e, at the building or in its vicinity).

All new buildings that are under construction must comply with the NZEB standard by 31 December 2020, and all new buildings owned or occupied by public authorities must have NZEB performance after 31 December 2018. Increasing the number of NZEBs is planned to be achieved by stimulating construction through programmes for the energy renovation of buildings (four programmes according to building type).

The number of low-energy and passive buildings increases in Croatia on a yearly basis and in particular for single-family houses (Table 8). By December 2014, there were a total of 22 buildings (of which 3 apartment blocks) with energy class A+, representing an energy consumption for heating ($Q_{H,nd}$) under 15 kWh/m².year. Although the detailed national application of the NZEB definition took place in November 2014 and no NZEB according to that regulation has been built yet, examples of existing buildings that already fulfil the envisaged NZEB requirements can be provided. The multi-family building "*Šparna hiža*" (in the local dialect, the name for a low-energy house) in the city of Koprivnica, was designed at the level of energy class A+ with a final energy consumption for heating being less than 15 kWh/m².year, with the total final energy consumption amounting to 33.66 kWh/m².year, and with a renewable solar energy source.

Table 7: Maximum primary energy for NZEBs by building type (Technical regulation 2014 current status).

NZEB Buildings categories	**E_{prim} [kWh/m².year]**	
	Continental climate	Littoral climate
Single-family houses	40	30
Apartment blocks	80	50
Offices	30	25
Educational buildings	55	50
Hospitals	200	190
Hotels and restaurants	80	65
Sports facilities	190	100
Wholesale and retail trade services buildings	170	140

Figure 2:
First Šparna hiža in Koprivnica.

Figure 3:
Third Šparna hiža in Koprivnica.

Table 8:
The planned annual increase in NZEBs according to the National Action Plan to increase the number of NZEBs by 2020 (published in 2014).

Building categories	**NZEBs annually target [m²]**	**Approximate number of NZEBs***	**Specific additional NZEBs cost in relation to the new buildings [€/m²]**	
			Continental climate	Littoral climate
Single-family houses	63,000	400	127	87
Apartment blocks	90,700	200	244	159
Offices	19,736	6	71	19
Educational buildings	3,612	2	118	205
Hospitals	4,723	2	66	118
Hotels and restaurants	14,630	2	7	50
Sports facilities	1,428	1	144	255
Trade services buildings	20,879	6	38	70

* The approximate number of buildings based on the estimated useful floor area for each type of building in the cost-optimal studies can therefore vary according to the real size of the constructed building.

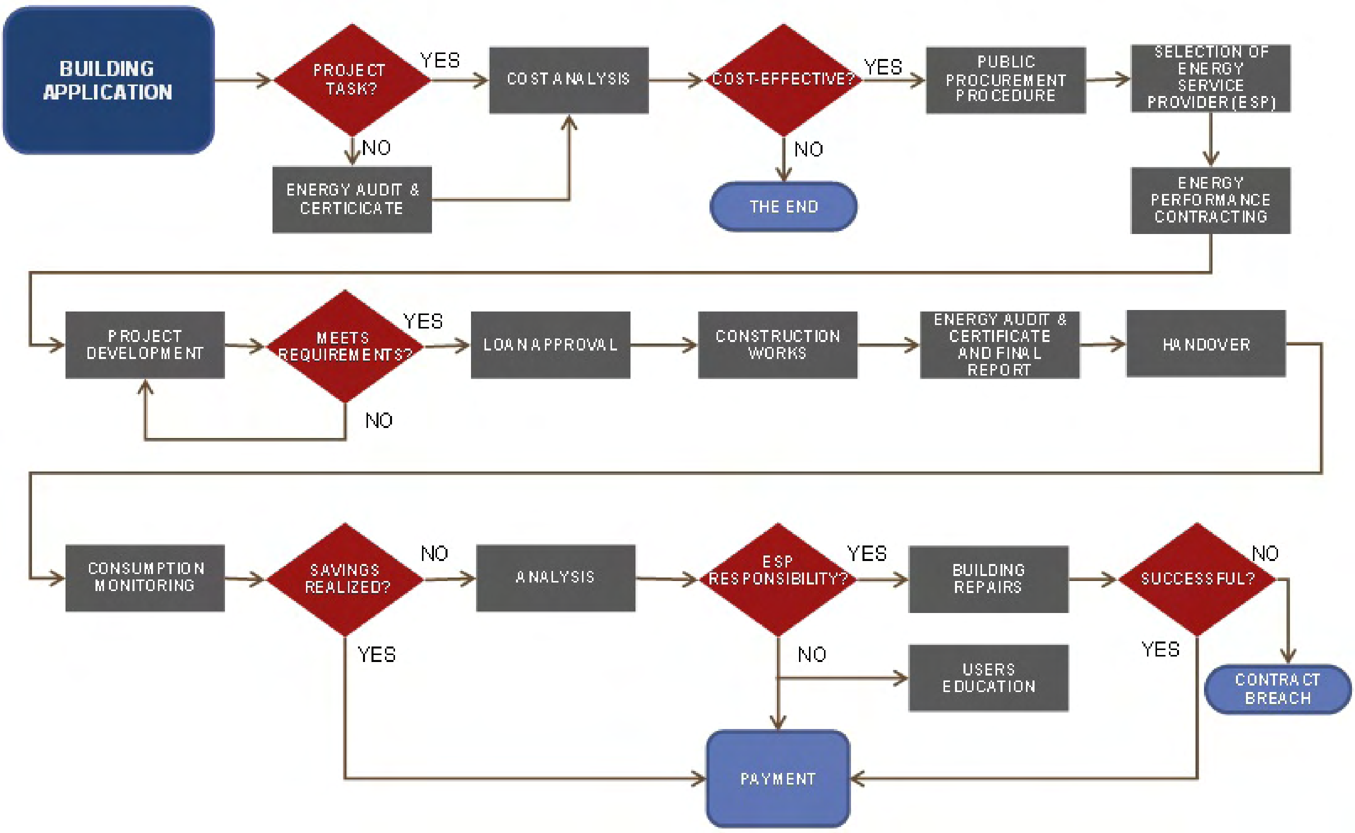
I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The long-term strategy for mobilising investment in renovating the national building stock in Croatia was published in the Official Gazette on June 2014. The strategy's main objective is to identify, on the basis of the established optimal economic and energy model for building renovation, effective measures for long-term mobilisation of cost-effective deep renovation of the building stock in the Republic of Croatia by 2050, including all buildings from the residential and non-residential sectors. The strategy deals with several topics: an overview of the national building stock of the Republic of Croatia, analysis of key elements of the building renovation programme, policies and measures to stimulate cost-effective deep renovations of buildings, a forward-looking perspective to guide individual investment decisions, the construction industry and financial institutions up to 2050, and an evidence-based estimate of expected energy savings and wider benefits based on calculations and model data, including wider economic benefits from energy savings, and improved housing and quality of work.

When selecting measures aimed at increasing energy efficiency, along with renovating the external building envelope pursuant to the technical regulations and overall building renovation pursuant to passive, as well as active building standards, the introduction of systems using RES were also concurrently considered to the highest possible extent, with as aim to meet the requirements from Article 9 of the EPBD, which prescribes the approximation of the building/renovation standards of NZEBs.

Achieving the objectives of energy renovation according to NZEB standards, requires significant funds for investment and operational costs, estimated at nearly 7 billion € up to 2050. With the proposed dynamic of energy renovation, the total reduction of CO_2 emissions by 2020 will be 87.22%. The sources of financing currently available are not sufficient to realise the set goals, so new, innovative financing mechanisms are proposed, which combine public and market instruments customised so that a wide range of investors are introduced. Structural and investment funds of the European Union will represent the primary source of funds for the removal of barriers in the financial sector, and will gradually allow more involvement of

Figure 4: Energy renovation of public sector buildings flowchart according to the Programme for energy renovation of public sector buildings 2014-2015.



financial institutions and private investors in the energy services market. The required energy saving level in central government buildings (774 buildings with 1,325,000 m^2), pursuant to the EED, must be achieved through an alternative approach, in line with Article 5 of the EED. The annual savings (equivalent to renovating 3% of the buildings owned and occupied by the central government) have been calculated to reach 1,36 GWh (4,89 TJ) per year. This consumption corresponds to approximately 17 buildings being renovated annually, and represents 0.0045% of the total final consumption within all buildings in 2012 (ca 29,777.78 GWh).

The Programme for the energy renovation of public sector buildings promotes the complete reconstruction of the building, which therefore includes measures for the building envelope and for technical systems. For these measures, private capital investment is used, with no extra cost to the state budget. The programme envisages the energy renovation of existing buildings in which profitability is established, or for building a new building in which the provider of energy services can offer the energy savings provided by the project. All the costs, including the costs of maintenance, design, financing and other costs, must be appropriate to compensate for the fee paid by the client. To be included in the programme, the building must meet the following criteria:

1. the building has a large annual energy consumption (usually > 200 kWh/m^2);
2. the building is not part of a complex, and the energy consumption can be clearly separated from the neighbouring buildings;
3. the building has no non-compliances in terms of other essential requirements of building;
4. the building is not protected as cultural heritage, because that could raise the investment costs and the pay-back period over 14 years.

I.vi. Other relevant plans

Although financial institutions have developed market models with more favourable loan conditions for energy efficiency projects, in this sector the role of the government continues to be crucial for the success of the implementation. For this reason, the MCPP launched the development of energy renovation programmes for four identified building purposes (public, commercial, multi-residential and family houses). Four programmes for energy renovation of buildings were adopted:

> The Programme for energy renovation of public sector buildings 2014-2015, as described in connection to implementation of Article 5 of the EED.

  This programme regulates the procedure of carrying out energy services in the public sector in such a way that the private sector plays the role of energy services provider, and the cost-effectiveness of the investment is supported by grants of the Environmental Protection and Energy Efficiency Fund, privileged loans of the Croatian Reconstruction and Development Bank, and guarantees of the Croatian Agency for SMEs, Innovations and Investments Agency.

> The Programme for energy renovation of family houses 2014-2020 and the Programme for energy renovation of multi-residential buildings 2014-2020.

  These programmes provide co-financing for energy renovation of family houses and multi-residential buildings with funds from the Environmental Protection and Energy Efficiency Fund, EU structural instruments and budgets of local and regional self-government units.

> The Programme for energy renovation of commercial buildings 2014-2020.

  This programme provides co-financing of energy renovation of commercial purpose buildings with the following financial mechanisms foreseen:

  - establishment of revolving funds following the JESSICA model;
  - introduction of priority measures of energy efficiency renovation within the framework of operative programmes for the use of funds from EU structural instruments;
  - introduction of legal obligations to energy suppliers to achieve energy savings of their customers;
  - continuous implementation of programmes and projects of the Environmental Protection and Energy Efficiency Fund.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS(TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

Requirements for technical systems are prescribed in the Technical regulation on rational use of energy and heat retention in buildings. The designed and installed heating systems in new buildings must compensate for heat losses in order to maintain indoor thermal comfort. Amongst other requirements, a heating system must have thermally insulated pipework, low design temperature (e.g., ≤ 60 °C, recommended ≤ 40 °C) of the heating medium (e.g., water) and a balanced regulation of indoor temperature in the building. The energy efficiency of the system for DHW is met by the selection of heat generation equipment (through tanks or instantly), energy efficient distribution and balanced regulation of the systems in the building.

In case of the reconstruction of the technical system in existing buildings, such as replacements of heat generators, energy fuel, central ventilation units, lighting systems, etc., the requirements for the technical regulation relating to the new building are applied if the total cost of the reconstruction exceeds 25% of the technical system value. If reconstruction does not exceed 25% of the technical system value, the energy efficiency of the building must not be lowered, and the system must at least have the technical characteristics that it had before reconstruction (existing technical characteristics). The Technical regulation for heating and cooling systems in buildings determines the requirements for energy performance, design elements, installation, fitness for purpose, maintenance, etc. The Technical regulation on ventilation, partial air-conditioning and conditioning systems in buildings prescribes the technical performance of ventilation, partial AC and AC systems in buildings, as well as the requirements for their design, execution, fitness for use, maintenance, and other requirements for these systems.

II.ii. Regulation of system performance, distinct from product or whole building performance

The regulations indicate that new residential buildings comprising more than 3 residential units must be equipped with a centralised heat generation system. This is not required under the following circumstances:

> for buildings connected to a district heating system;

> for buildings with gas-fired heating systems;

> for buildings equipped with heating systems with air/air heat pumps, if the seasonal heating factor of individual heat pumps is SCOP ≥ 4.0;

> for buildings equipped with heating systems with air/water, water/water and soil/water heat pumps, if the seasonal heating factor of individual heat pumps is SPF ≥ 3.0. This seasonal factor includes the heat pump, regulation, auxiliary heating unit and other parts of the system, such as pumps and ventilators on the side of the heat storage tank;

> when the annual thermal energy needs for heating per surface area unit of the useful building floor area $Q''_{H,nd}$ (KWh/m^2.year) in which a controlled temperature is maintained does not exceed 15 kWh/m^2.year.

There are no specific requirements for heating systems in non-residential buildings. The technical regulation requires the use of a centralised heat generation system in residential buildings, because they generally have more than one owner (e.g., dwellings in apartment building), so this reduces private investment and additional costs for each owner in every building unit separately. This problem does not occur in non-residential buildings, because non-residential buildings typically have one owner who provides a centralised heat generation system for the entire building.

The air change rate of indoor air in buildings where persons stay or work shall be at least 0.5 h^{-1}. At the time when the building is unoccupied, an air change rate of at least 0.2 h^{-1} should be provided. The lowest air change rate shall be higher in individual parts of the building if necessary for the purpose of avoiding threats to hygiene and health conditions, and/or due to the use of open-flame heating and/or cooking devices. If it is not possible to ensure natural air ventilation that meets the requirements for the prescribed air quality, hybrid or mechanical ventilation should be designed. For multi-family residential buildings, airtightness requirements must be fulfilled for each apartment. For non-residential buildings, airtightness requirements must be fulfilled for the building envelope.

When installing a new forced ventilation or AC system, or in case of an extensive reconstruction of the existing one, the specific fan power must be at least class I according to HRN EN 13779:2008: SFP < 500 W/(m^3/s).

Heat recovery must be provided if the building (residential or non-residential) meets all the following requirements:

> it is ventilated by a mechanical device;
> the air exchange rate exceeds 0.7 h^{-1}, in line with the intended use of the building;
> the outdoor air flow rate exceeds a total of 2,500 m^3/h (694 l/s).

If heat recovery is installed, then it must comply with the following minimum efficiency (η) requirements:

> heat recovery circulation system: total η ≥ 0.55 (application only in case of separate installation of the pressure and extraction ventilation unit);
> other heat recovery systems: total η ≥ 0.70.

Building automation and control systems include products, software and technical services for automatic regulation, supervision and optimisation, human intervention and control. They are calculated pursuant to the HRN EN 15232:2012 standard. Four system efficiency classes are established: A, B, C and D, with class A relating to buildings with a highly efficient system, and class D referring to non-efficient systems. In new and existing buildings that are undergoing renovation, the designed automation and control system must be of A, B or C efficiency class (Table 9).

II.iii. Provisions for installation, dimensioning, adjustment and control

There are a series of technical measures for heat distribution elements in a building that must be fulfilled when designing a new system or during major refurbishment of existing systems. A heating element supplying heat to a room must have a heat regulator installed (e.g., a thermostatic radiator valve in the central heating system) if the usable surface area of the net floor area of a room exceeds 6 m^2.

New and refurbished systems providing heating and DHW must include pipework insulation. The minimum thermal insulation thickness must be:

> 2/3 of the pipe diameter, and not exceeding 100 mm for conduits or fittings in a non-temperature-controlled building area;
> 1/3 of the pipe diameter, and not exceeding 50 mm for conduits or fittings inside the walls and grooves of the intermediate structure, at the conduit intersection, near central heating medium distributors;
> 1/3 of the pipe diameter, and not exceeding 50 mm for conduits or fittings in a temperature-controlled building area;
> 6 mm if acoustic insulation in the intermediate structure for conduits and fittings in the surface layer of the floor.

Thermal insulation is also necessary for heat accumulation tanks (at least 50 mm). When designing the construction of a new system or renovating an existing one comprising a heat storage tank (e.g., for DHW), the tank must be provided with at least a 50 mm thick insulation, so as to minimise thermal losses of connection pipes and fittings.

Requirements for sizing the system are set in the main design. Sizing, adjustment and control is carried out by an authorised designer in line with professional standards. The functionality of the technical system is tested according to the requirements in the project documentation before commissioning. In addition, the supervising engineer carries out the control of the whole construction according to the main design.

II.iv. Encouragement of active energy-saving control (automation, control and monitoring)

As indicated above, there are energy factors to be applied if the building includes automation controls (depending on the class). This also serves as an encouragement measure, e.g., in the Programme of energy renovation of public sector buildings. One of the criteria in the public procurement procedure includes automation of fuel and/or water consumption metering.

BACS class	Efficiency factor for heating and cooling energy				
	Residential buildings	Offices	Schools	Hospitals	Hotels
A	0.92	0.70	0.80	0.86	0.68
B	0.93	0.80	0.88	0.91	0.85
C	1.00	1.00	1.00	1.00	1.00
D	1.08	1.51	1.20	1.31	1.31

Table 9: Energy efficiency of automation and control – residential and non-residential buildings – heating and cooling.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

The Ordinance on energy audits of buildings and energy certification (OG 48/2014) prescribes, amongst others, the method of energy certification, the content and form of the EPC of buildings, energy management in buildings, and the establishment of measures for improving energy efficiency in buildings.

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

An EPC is mandatory as of July 2013 for the sale of a building or a building unit. Energy certification is preceded by the energy audit mandatory for new buildings prior to permit issuance, for existing buildings that are being sold, and for existing public buildings for which the display of EPCs is prescribed. Only those EPCs entered in the registry kept by the MCPP are valid. Currently there is no obligation to produce an EPC for renting out or leasing a building or a building unit. This obligation must apply from January 2016.

In order to produce an EPC, an energy audit of the building or building unit is required. The method of carrying out these energy audits is officially established in the Methodology for carrying out energy audits of buildings. Energy audits of independent building units (apartments or offices) must include the following actions:

> on-site inspection and data gathering on the energy performance of the building, its technical systems, the effective regimen and parameters of building use and the actual consumption of energy and water (over the last three years bills);
> analysis of the building energy performance and its technical systems;
> analysis of the existing energy management;
> energy calculation (demand, final, primary) according to algorithms and standardised regimen of use, for real and reference climatic data;
> development of an energy balance and models according to the actual use (control on the basis of gathered bills);
> proposal of economically justified measures for improving the energy performance of an independent building unit, and general recommendations for the building if energy generation is centralised – calculated on the basis of the actual manner of the use of the independent building unit.

Upon having performed the energy audit and the energy audit report, the EPC is prepared which includes a proposal for measures to improve the energy efficiency of these systems or the application of alternative solutions.

EPCs are valid for a period of 10 years. In case of reconstruction that affects the energy class, the new EPC can be issued before the expiration of 10 years. For buildings that are included in the energy renovation programmes (regardless of whether it is minor or major refurbishment), energy certification after renovation is mandatory, as well as the calculation of achieved energy savings in relation to pre-renovation.

How flats are certified in apartment buildings

For new multi-residential buildings, prior to the issuance of the use permit, a single EPC is prepared for the entire building. It is also possible to have an EPC additionally issued for an individual building unit, if requested by the investor. In such a case, for this individual building unit, the separately issued EPC is also valid. When individual building units are sold, then only the specific building unit on sale will require a certification. As indicated before, the obligation of obtaining an EPC when renting out or leasing a flat must also be applied as of 1 January 2016.

Format and content of the EPC

EPCs of residential and non-residential buildings contain 5 pages. The first page indicates the energy class that is highlighted and data on the authorised person who prepared the certificate. The energy class is expressed as energy needs for space heating $Q_{H,nd}$. The second page contains climatic data, data on technical systems, the thermal characteristics of the individual envelope elements, the energy needs of the building (annual demand for heating, DHW preparation, ventilation, lighting), the total annual delivered and primary energy, and carbon dioxide emissions.

The third page contains a proposal of measures for improving the energy performance of the building, including instructions to the occupant on where more detailed information on energy efficiency improvement measures is available. In case of new buildings, the third page also includes recommendations to the new building owner concerning the use of the building in order to achieve the designed energy consumption. The fourth and fifth pages contain explanations of technical terms and a list of applied regulations and standards.

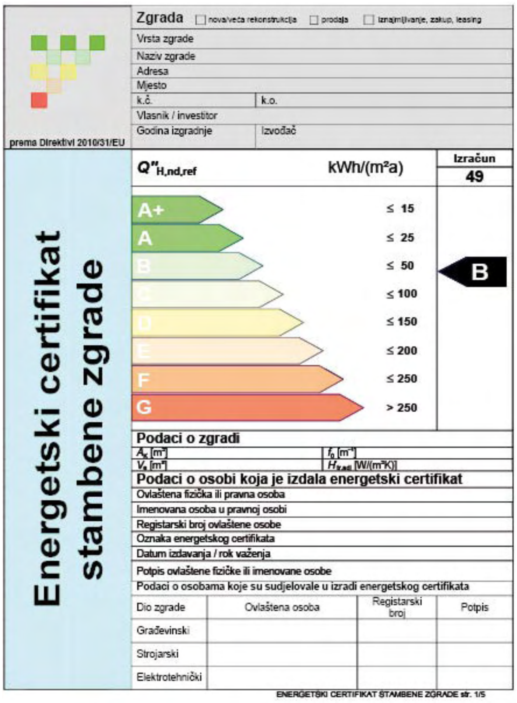
The energy class is expressed as specific thermal energy needs for heating ($Q_{H,nd}$) in the reference climate (continental or littoral).

The relative value of the annual thermal energy needs for heating for non-residential buildings, $Q_{H,nd,rel}$ [%], is the ratio of the specific annual energy needs for heating for reference climatic data, $Q'_{H,nd,ref}$ [kWh/m³.year] and the permitted specific annual energy needs for heating for reference climatic data, $Q'_{H,nd,dop}$ [kWh/m³.year], and is calculated according to the following expression:

$$Q_{H,nd,rel} = Q'_{H,nd,ref} / Q'_{H,nd,dop} \times 100 \text{ [\%]}.$$

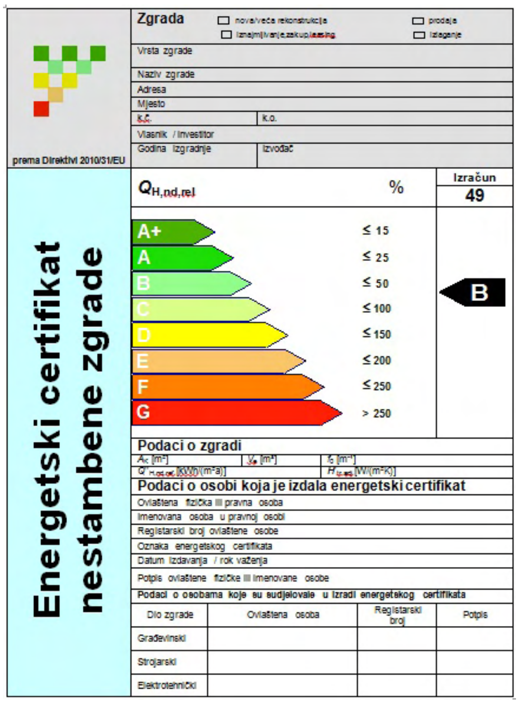
A special format of EPC is established for other non-residential buildings that are heated to a temperature between 12°C and 18°C and in which energy is used to achieve certain conditions. For these types of buildings, no energy class is stated, but a proposal of measures is also given to improve the energy performance (e.g., warehouses, production facilities, workshops, garages, etc.).

Figure 5:
EPC of a residential building – first page.



NOTE: Energy classes of residential buildings are expressed as $Q''_{H,nd,ref}$ – specific annual energy needs for heating for reference climatic data in kWh/m².year according to the following scale:

A+	≤ 15
A	≤ 25
B	≤ 50
C	≤ 100
D	≤ 150
E	≤ 200
F	≤ 250
G	> 250



NOTE: Energy classes of non-residential buildings are expressed as $Q_{H,nd,rel}$ – relative value of the annual thermal energy needs for heating expressed in % and according to the following scale:

A+	≤ 15
A	≤ 25
B	≤ 50
C	≤ 100
D	≤ 150
E	≤ 200
F	≤ 250
G	> 250

Figure 6:
EPC of a non-residential building – first page.

Figure 7:
EPC of other non-residential buildings – first page.

EPC activity levels

Since first issued in 2010, there has been an increasing growth in the number of EPCs, both for new and existing buildings, especially from July 2013 onwards. As of December 2014, there are a total of 64,560 EPCs for both new buildings (12,260) and existing buildings (52,300). This also includes EPCs for the purpose of display in public buildings.

Classes B and C are prevailing in new buildings, and C and D in existing ones. In addition, new buildings have less EPCs with a low energy class and more with a high energy class, whereas in existing buildings, there is a reversed situation.

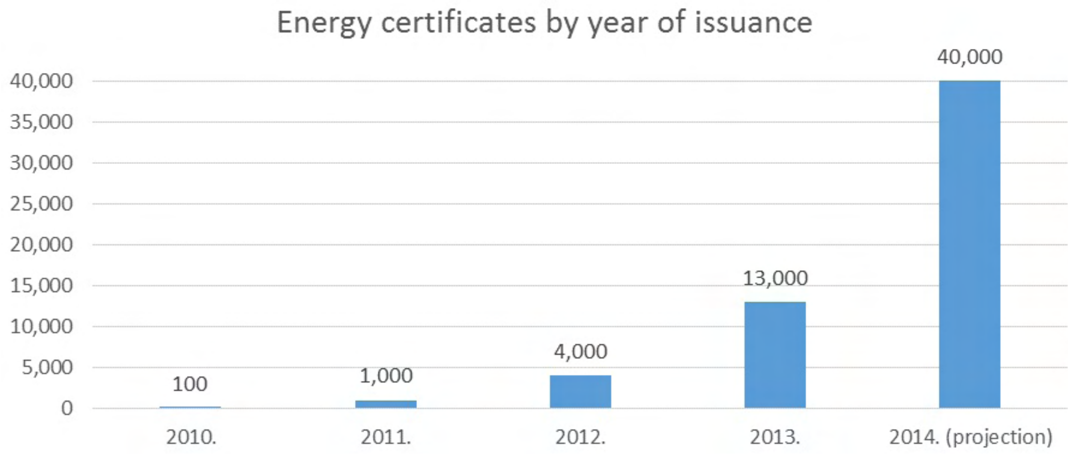


Figure 8: Issued EPCs.

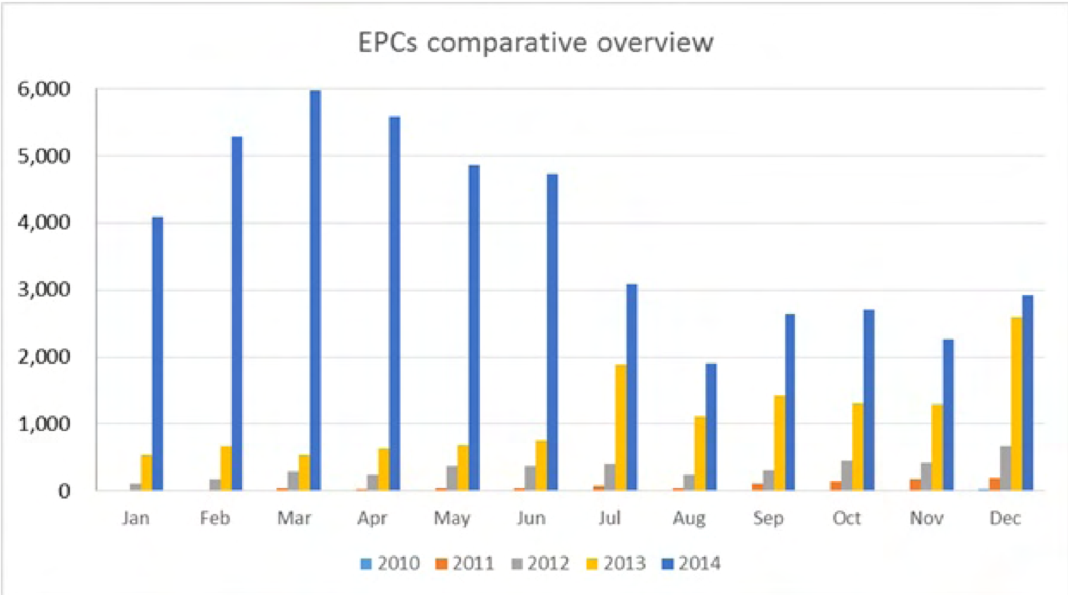


Figure 9: Issued EPCs comparative overview.

Figure 10: Issued EPCs by type of building: residential and non-residential.

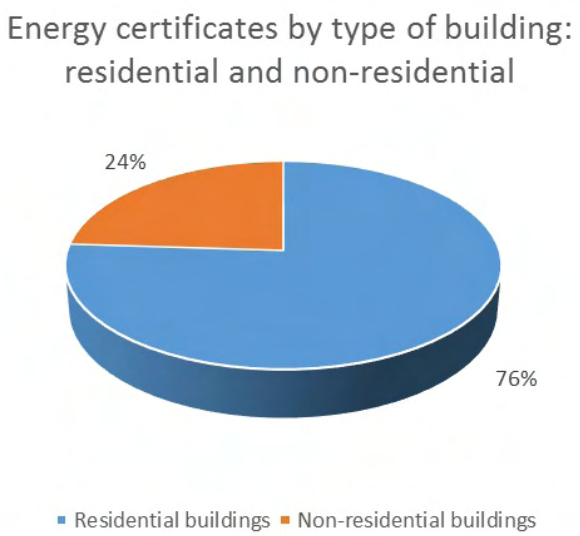
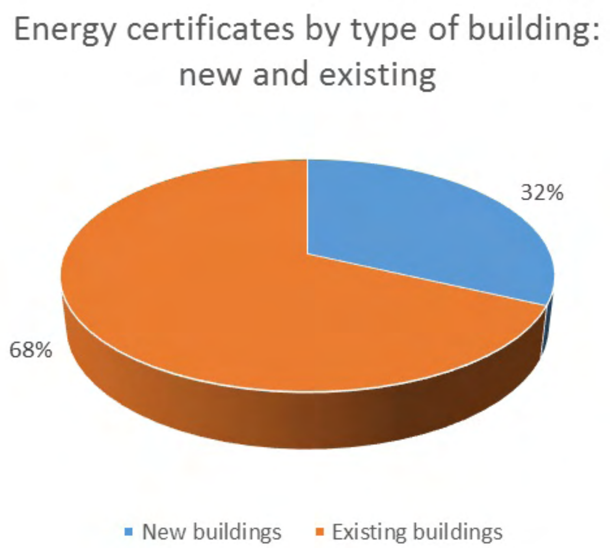


Figure 11: Issued EPCs by type of building: new and existing.



Considering all the certified buildings together, the common class is C, so this represents the average energy class for the building stock in Croatia. Nearly a quarter of the issued EPCs are in Zagreb. In addition, more developed counties have more issued EPCs, and vice versa.

Typical EPC costs

Initially, the maximum price for EPCs was prescribed for buildings and individual units in relation to their size. Since 2014, the Decision on maximum prices is no longer in force and price formation is market based.

The average market price of an EPC for an existing apartment in a building amounts to approximately 1,000 kuna (130 €). For entire buildings, the price depends on the complexity of technical systems, and the shape and size of the building. The price includes the costs of the energy audit, the preparation of the energy audit report and the preparation of the EPC, including the suggested measures for improving the energy performance of the building. The estimated average cost of an EPC for an average house (150 m^2) is approximately 2,000 kuna (270 €), and for an average apartment building (500 m^2) 5,000 kuna (670 €). For an average non-residential building (3,000 m^2), the cost varies very much depending on the building type (e.g., an office building is much cheaper than hospitals), but it can be estimated to cost, on average, about 15,000 kuna (2,000 €). The cost for EPCs experienced a decrease in 2013 due to an increasing number of authorised persons.

Assessor corps

The requirements for persons issuing EPCs and carrying out regular inspections of heating systems, and cooling or AC systems in buildings are prescribed by the Ordinance on requirements and criteria for persons performing energy audits of construction works and energy certification of buildings (OG 81/2012 and 64/2013).

Energy certification of buildings is performed by both authorised natural and legal persons. Authorisation is granted by the MCPP for:

> energy audits and certification of buildings with a simple technical system (natural and legal persons);
> energy audits of buildings with a complex technical system (natural and legal persons);
> energy certification of buildings with a complex technical system (legal persons).

Figure 12:
Issued EPCs by classes - existing buildings.

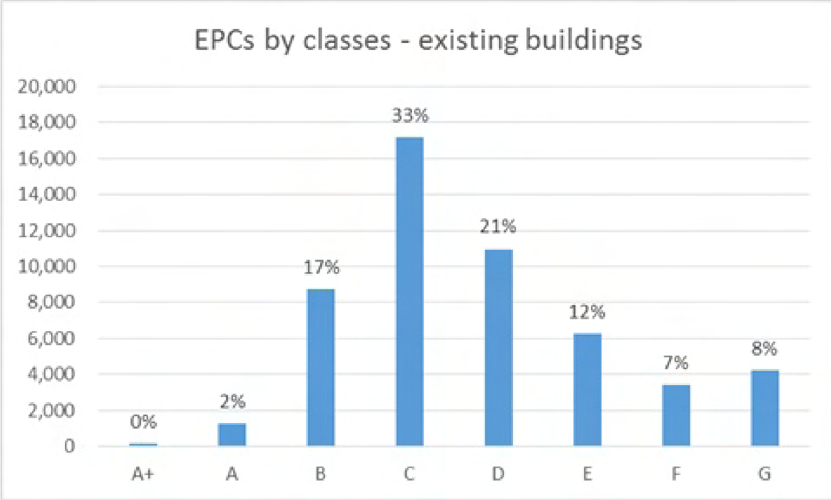


Figure 13:
Issued EPCs by classes - new buildings

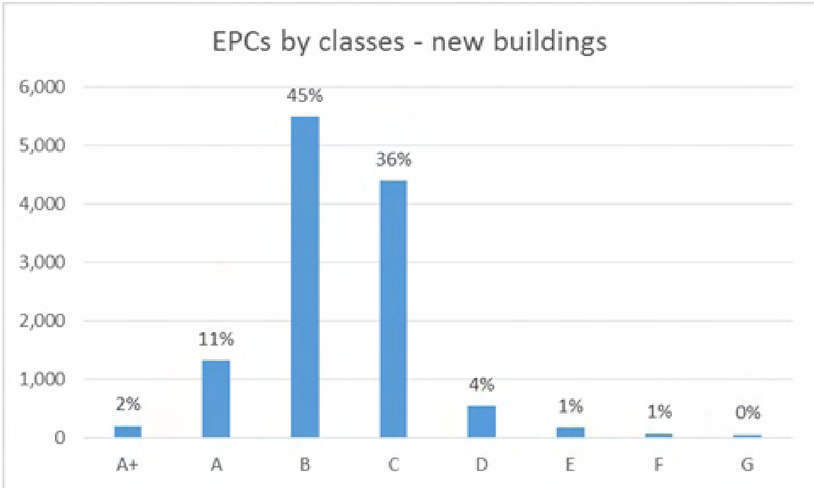
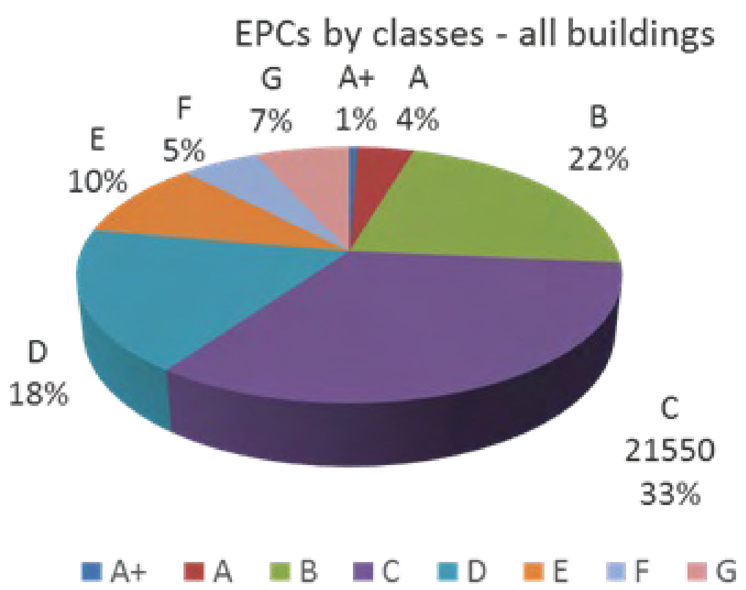


Figure 14:
Issued EPCs by classes - all buildings.



The authorisation to audit and certify complex systems also authorises the audit and certification of simpler systems.

The energy audits of buildings with a complex technical system (a requirement for EPCs), must be carried out by authorised persons:

> for the mechanical part of the building, a person qualified in the field of mechanical engineering;
> for the construction part of the building, a person qualified in the field of architecture or civil engineering;
> for the electrical engineering part of the technical system, a person qualified in the field of electrical engineering.

Figure 15: Authorised persons according to qualification.

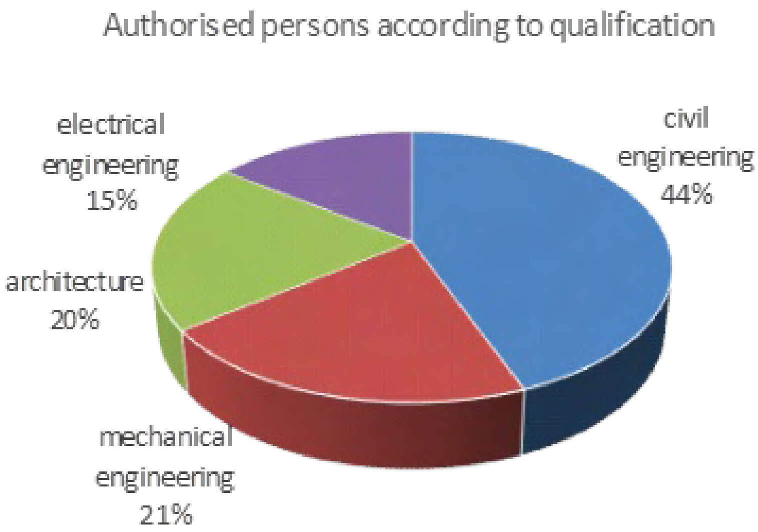
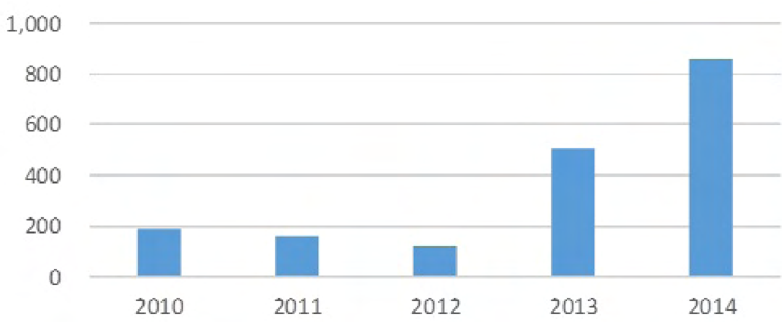


Table 10: Accreditations for simple and complex technical systems by the end of December 2014.

	Simple technical systems – Module 1	Complex technical systems – Module 2	Total
Natural persons	663	277	940
Legal persons	204	529	733
Total	867	806	1,673

Figure 16: Authorised persons according to first accreditation.



The EPC must be signed by the person authorised to issue EPCs and by all persons who participated in the energy audit.

The authorisation is granted for a period of 5 years, whereupon it can be extended for the same period. The requirements for authorisation include a completed graduate university study in the field of architecture, civil engineering, mechanical engineering or electrical engineering, and 5 years of professional working experience. The requirements also include the successful completion of the appropriate professional training programme carried out by authorised institutions (Module 1 and Module 2). The training programme consists of two modules, one following up the other, and a Continuous Development Programme (CPD). Module 1 enables authorisation for energy audits and certification of buildings with a simple technical system, and Module 2 enables authorisation for energy audits and certification of buildings with a complex technical system.

Module 1 has a duration of 40 hours and contains themes related to regulations (EU directives in the field of energy efficiency and national legislation transposing their provisions), themes from the field of building physics, on heating systems, electric lighting, on the methodology of carrying out energy audits and applying computer tools. Module 2 also has a duration of 40 hours. It builds on the themes of Module 1, but with additional themes, e.g., RES, alternative energy supply systems, cooling devices, regulation and automation systems in buildings, electric lighting in buildings, public lighting, etc. In Croatia, there are 13 regionally distributed institutions (faculties and professional organisations) that were granted authorisation for carrying out the training programme. By the end of December 2014, authorisation had been granted to 1,673 natural and legal persons (Table 10).

Compliance levels by sector

There are penalties prescribed by law for those owners who fail to provide an EPC at sale, if they fail to deliver it to buyers, or if they fail to indicate the energy class in sale advertisements published in the media. Penalties are also established for authorised real estate brokers if - acting on behalf of their clients to which they provide brokerage services - they fail to include the energy class in the media advertisements. The prescribed fines for owners and real estate brokers amount to 15,000 to 30,000 kuna (approximately 2,000 - 4,000 €), for a legal person, and to

5,000 to 10,000 kuna (approximately 700 - 1,300 €), for owners and real estate brokers who are natural persons. No fine has been issued yet. The supervision of the compliance with this obligation is under the competence of the Ministry of Economy - market inspectorate.

Authorised persons have the obligation to submit the EPCs, together with the reports on performed energy audits, to the registry within 15 days from being issued. The fines prescribed for legal persons range from 30,000 to 45,000 kuna (approximately 4,000 - 6,000 €), and from 15,000 to 30,000 kuna (approximately 2,000 – 4,000 €) for natural persons. No fine has been issued yet.

Quality Assurance (QA) of EPCs

All issued EPCs undergo administrative controls during their entry into the data base (registry). Administrative control includes checking whether the EPC is made by a person with the appropriate authorisation, whether all the required files are submitted, whether the EPC is properly marked, etc.

The method of carrying out the control of EPCs is prescribed by the Ordinance on the control of EPCs of buildings and of reports on energy audits of construction works (OG 81/2012 and 79/2013). Persons authorised for carrying out the control of EPCs are legal persons who comply with the requirements regarding experience in providing EPCs. On this basis, 5 legal persons have been authorised to carry out controls.

Detailed quality control of 105 EPCs (84 residential building EPCs, 21 non-residential building EPCs) was carried out during the period of December 2013 to September 2014. This represents 0.2% of all the EPCs that were issued. The control included control of input data, accuracy of energy class calculations and proposed measures for improved energy performance of buildings. An EPC is declared invalid if it contains calculation results, input data or proposed measures with significant deviations (more than 30%). If an EPC is declared invalid, the information is published on the ministry's website, the responsible expert must draft a new EPC free of charge, and a fine is imposed. The fines prescribed for legal persons range from 30,000 to 45,000 kuna (approximately 4,000 - 6,000 €), and from 15,000 to 30,000 kuna (approximately 2,000 - 4,000 €) for natural persons. In case several EPCs from the same authorised person are declared invalid, their authorisation may be revoked.

The result of carried out control shows that almost 15% of controlled EPCs are declared invalid, and others contain certain irregularities that do not affect the energy class. These results can be explained due to the very small sample of the controlled EPCs, and the fact that a significant amount of EPCs were controlled due to complaints, and not by random selection. Authorised persons have to issue a new EPC to replace the one declared invalid. Also, the misdemeanour proceedings for the imposition of fines were started. A further approximately 200 detailed quality control of EPCs began at the end of 2014, bringing the total sample of quality controlled EPCs to 0.5% of the total issued EPCs.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

Public buildings, for which an EPC must be displayed, include several types: buildings used by public authorities for performing their activities (e.g., ministry buildings), buildings used for community living (e.g., nursing homes, student dorms) and non-residential buildings in which a number of people are present, or a larger number of people are provided a service (e.g., retail shops, hotels). These definitions may apply to an individual building or a part of a building.

All public buildings with a total useful floor area over 500 m^2 must display the EPC. From July 2015, this requirement also applies to public buildings with a total useful floor area over 250 m^2. Municipal services officers verify whether these EPCs are adequately displayed, by visiting the buildings and making a report. In case of non-compliance with the regulation, they shall ask the owner to display the EPC.

EPCs for public buildings are of the same format as that of non-residential buildings, and follow the same procedures (audit followed by issue of EPC). The assessors of public buildings also follow the same requirements as those for non-residential buildings. Out of the total issued building EPCs, 19% refer to public buildings, approximately 12,000. Public buildings account for approximately 90% of the non-residential EPCs. The costs for a public building EPC is the same as previously described for non-residential buildings (approximately 15,000 kuna or 2,000 €). EPCs are also valid over a period of 10 years. If measures are carried out on a building, whereby an improvement of the building energy performance is achieved, the EPC must be re-issued.

Fines for public building owners who fail to display the EPC are established by law and amount to 15,000 to 30,000 kuna (approximately 2,000 - 4,000 €) for legal persons, and 5,000 to 10,000 kuna (approximately 700 - 1,300 €) for natural persons. No fines have yet been issued. This obligation is commonly followed.

III.iii. Implementation of mandatory advertising requirement

As of January 2014, there is an obligation to indicate the energy class in sale advertisements published in the media (papers and other press, radio and television programmes, electronic publications, teletext, etc.). Portals that have the sole purpose of advertising and do not contain edited programme contents published daily or periodically by an electronic publication provider for purposes of public information and education, namely real estate portals, are not considered media. This obligation is commonly followed.

Figure 17: Clip from an animated film promoting energy certification.

Figure 18: Clip from an animated film promoting energy certification.

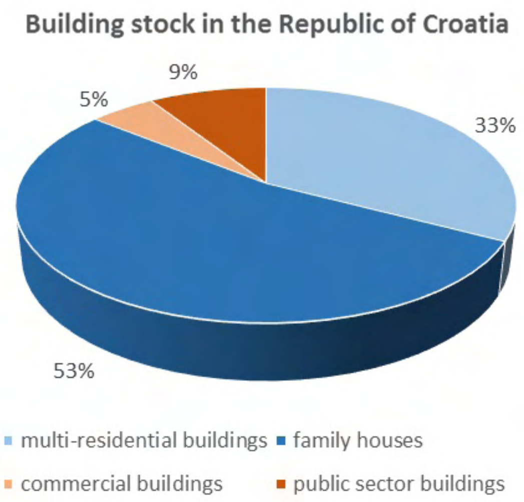


Figure 19: Building stock in Croatia.

III.iv. Information campaigns

In order to improve public information on the need and significance of the energy certification of buildings, a number of activities have been carried out. There are help desks providing information to citizens, and the ministry's official website provides additional information to citizens and authorised persons. For the purposes of promoting national programmes of energy renovation of buildings, workshops with interest groups were carried out, and additionally, an animated film covering the topic has been made and broadcast during 2013.

The Energy Efficiency and Environmental Protection Fund, within the scope of its activities, also supports energy efficiency programmes, including carrying out energy audits of buildings and preparing EPCs. In 2013, for the purposes of carrying out energy audits and presentation activities, 268,842.24 kuna (approximately 36,000 €), were spent, and in 2014, 5,082,547.27 kuna (approximately 678,000 €). For encouraging educational and information activities in the field of energy efficiency, 153,980 kuna (approximately 21,000 €) were spent in 2013 and 2,063,212.39 kuna (approximately 275,000 €) in 2014. In 2014, public tenders were carried out for co-financing of energy audits, production of EPCs, energy renovations, RES, or other energy efficiency projects in buildings (www.fzoeu.hr). These activities represent 34,029,783.01 kuna (approximately 4,537,000 €) in investments.

III.v. Coverage of the national building stock

According to several sources, the overall building stock in Croatia consists of 899,107 buildings (Table 11).

The residential building stock covers 86% of the national building stock and includes 294,317 (33%) multi-residential buildings and 477,594 family houses (53%). The majority of the non-residential buildings consists of public sector buildings and commercial purpose buildings. There are 45,541 (5%) commercial purpose buildings, including shops, hotels, restaurants, etc, and the number of public sector buildings amounts to 81,655 (9%).

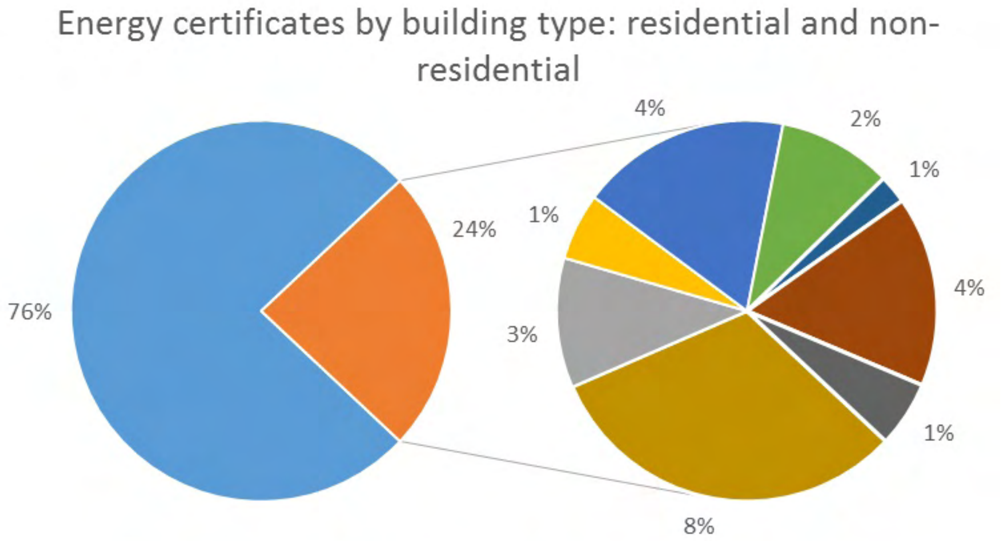


Figure 20: Issued EPCs by types of residential and non-residential buildings.

RB	Residential buildings (with one, two or more dwellings, and buildings for community housing)
NRB	Non-residential buildings
NRB1	Office, administrative and other commercial buildings of similar prevailing purpose
NRB2	School and faculty buildings, nursery schools and other educational institutions
NRB3	Hospitals and other buildings for health, social and rehabilitation purposes
NRB4	Hotels and restaurants and similar buildings for short-term dwelling (incl. apartments)
NRB5	Other non-residential buildings heated to a temperature of +18°C or more (e.g.: buildings for transport and communications, terminals, stations, buildings for transport, post offices, telecommunication buildings, buildings for culture and art and entertainment, museums and libraries, etc.)
NRB6	Construction works for sports
NRB7	Wholesale and retail buildings (shopping centres, buildings with stores)
NRB8	Other non-residential buildings in which energy is used to achieve certain conditions

Number of building units in the country (end of 2013)	899,107
Number of building units with EPC (end of 2014)	64,560
% of building units with/without EPC (end of 2014)	7.18% / 92.82%
EPCs issued in 2013 for new and existing buildings	13,446
EPCs issued in 2014 for new and existing buildings	46,009

Table 11: Percentage of the Croatian building stock with an EPC at the end of December 2014.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

In response to Articles 14 and 15 of the EPBD, Croatia has opted for carrying out regular inspections of heating systems and cooling/AC systems in buildings. This obligation has been transposed first by the Act of Energy End-use Efficiency in 2012. Now, the Building Act is the legal basis for regular inspections, including the dynamics for carrying out regular inspections of these systems. Regular inspections include inspections of accessible parts of the heating system and AC system. The report to be drafted on the performed inspection must also include a proposal of measures for improving the energy performance. Development of the registry of reports is in progress and will be in function by the end of 2015.

i. Progress and current status on heating systems and AC systems

Overview, technical method and administration system

Regular inspection of the heating system and cooling or AC system in a building must be carried out concurrently with the energy audit of the building for purposes of EPC issuance because for now, these two obligations overlap.

When not concurrent with EPC issuance, heating systems with a boiler of an effective rated output of more than 20 kW are regularly inspected every 10 years. Those with a boiler of an effective rated output of more than 100 kW are inspected every 2 years, or 4 years in the case of a gas-fuelled boiler. Cooling or AC systems in buildings with effective rated output of more than 12 kW must be regularly inspected at least once every 10 years.

A regular inspection of the heating system and cooling or AC system in a building includes collection and inspection of documents, visual and functional inspection of the heating system and of heated areas, the necessary measurements, assessment of the size of the system relative to building needs, development of a proposal of measures for improving the energy efficiency of the system and/or application of alternative solutions and drafting of the final report. The report must contain information on all actions carried out within the framework of the regular inspection, measurement results, comparisons with technical specifications of the manufacturer, and a proposal of measures for improving the energy efficiency of the system. Reports are prepared by authorised persons. The report content is determined by the Ordinance and Methodology for carrying out energy audits of buildings.

Inspectors are the same persons who can perform energy audits of buildings with a complex technical system, but only a person who is also qualified in the field of mechanical engineering. By the end of 2014, a total of 213 authorised persons (natural and legal) are allowed to carry out regular inspections of heating and AC systems in buildings. Enforcement and penalties for regular inspections of heating and AC systems are the same as for the energy certification of buildings. However, as no separate heating and AC reports were issued in 2013 and 2014 (they are carried out as part of issuing EPCs), no fines have yet been issued. A new ordinance under preparation will better regulate this issue.

Promotional activities for regular inspections of heating and AC systems were carried out within the framework of promotional activities for the energy certification of buildings.

Quality control of inspection reports

The method of carrying out control of inspection reports is prescribed by the Ordinance OG 81/2012 and 79/2013. On this basis, to date, 4 legal persons have been authorised for carrying out controls (the same legal persons have been authorised for carrying out control of EPCs of buildings) and employ natural persons with completed university qualifications in the field of mechanical engineering. The content of the controls includes verification and control of the validity of input data, completeness of reports, and completeness of the measures proposed to improve energy efficiency. As no separate heating and AC reports were issued so far, no inspection reports were controlled in 2013 and 2014.

3. A success story in EPBD implementation

Dissemination and training on energy efficiency for professionals in the field of architecture, construction and building services (mechanical and electrical) started with implementing the first professional training programmes for persons who would perform energy audits and energy certification of buildings. These programmes have been implemented since 2009 and have been developed in such a way to be applicable to all the indicated professions. The objective of the programmes is to enhance knowledge in fields linked with energy consumption in buildings for the indicated engineering professions, and to acquire certain knowledge and skills from

Figure 21: Proposal of measures for improving the energy efficiency in the reports of regular inspections of heating and AC systems in a building.

16. Proposal of measures for improving the energy efficiency of the heating system

No.	Title and description of the measure	Final energy savings [kWh/year]				Energy cost savings [kn/year]	Needed investments [kn]	Simple pay-back period [years]	CO_2 emission savings [tCO_2/year]
		Energy source 1	Energy source 2	Energy source 3	Energy source 4				
1.									
...									

9. Proposal of measures for improving the energy efficiency of the air-conditioning system

Br.	Title and description of the measure	Final energy savings [kWh/year]				Energy cost savings [kn/year]	Needed investments [kn]	Simple pay-back period [years]	CO_2 emission savings [tCO_2/year]
		Energy source 1	Energy source 2	Energy source 3	Energy source 4				
1.									
...									

other professions in order to establish a pool of engineers that, with their competencies, are able to consider construction works and buildings as a whole in terms of energy.

The programmes are carried out by professional institutions - 7 faculties, 2 institutes and 4 professional organisations, with lecturers being recognised professionals. Since the beginning of programme implementation, more than 2,200 engineers have completed these training programmes, of which the majority are authorised to carry out energy audits, energy certification of buildings and regular inspections of heating and cooling or AC systems in buildings. By the end of 2014, 1,673 authorisations were issued to legal and natural persons. This Croatian model of creating professional and competent staff for carrying out energy audits and energy certifications of buildings has also been implemented by other countries in the Balkan region.

Furthermore, energy efficiency has also found its place in the curriculum of university institutions. Thus, as of the 2013/2014 academic year, the Faculty of Civil Engineering in Osijek has been carrying out, within the framework of the graduate university study, the elective course Energy-efficient construction works. In terms of content, the course comprises three units: (1) Legislative framework and technical regulations in the field of energy efficiency; (2) Methodology of thermal energy calculation and thermography, and Technology and construction works, aimed at energy efficiency increase; and (3) Economic aspects of energy efficiency. Upon successful completion of the course programme, students are able to calculate the heat transmission coefficient and the necessary energy for heating and cooling needs of residential buildings, to determine technological measures and to describe the works necessary for buildings in order to increase energy efficiency, and to evaluate different solutions on the basis of economic cost-benefit analyses.

In order to ensure adequate skills and abilities of construction workers and installers on the Croatian market, the MCPP launched the project CROSKILLS - Build Up Skills Croatia, in June 2012. This project focuses on improving the education system of construction workers and installers of technical systems in the field of energy efficiency. The project is part of the EU initiative for a workforce in the area of sustainable construction within energy efficiency and renewable energy, and it is jointly carried out in 30 European countries. The project Build up Skills Croatia (CROSKILLS) – Pillar I has been successfully implemented, defining the needs for educated workers on energy efficiency tasks. Furthermore, the project resulted in establishing a national platform of relevant stakeholders as an advisory body when carrying out the set targets for the project BUILD UP Skills: Strengthening energy efficiency skills and certification schemes for building workers (CROSKILLS II) - Pillar II. Through implementation of this project, a certification scheme is to be established for the lifelong training of workers on energy efficiency tasks. The project's duration is 3 years and ends in August 2017.

Presentations on the importance of energy efficiency in buildings held at the Faculty of Civil Engineering and the Faculty of Architecture in Zagreb were useful for students, enabling them to realise the importance of this field, especially for their profession, and in 2011 they established the students' association SUPEUS (www.supeus.hr) for energy efficiency promotion and consultation. SUPEUS assembles students of various faculties in Zagreb (civil engineering, architecture, mechanical engineering, electrical engineering, economy) and organises workshops for students and various competitions. At the initiative of SUPEUS members, a team from the University of Zagreb participated in the SOLAR DECATHLON 2014 international competition in Paris, where they built and presented the MEMBRAIN (www.membrain.com.hr).

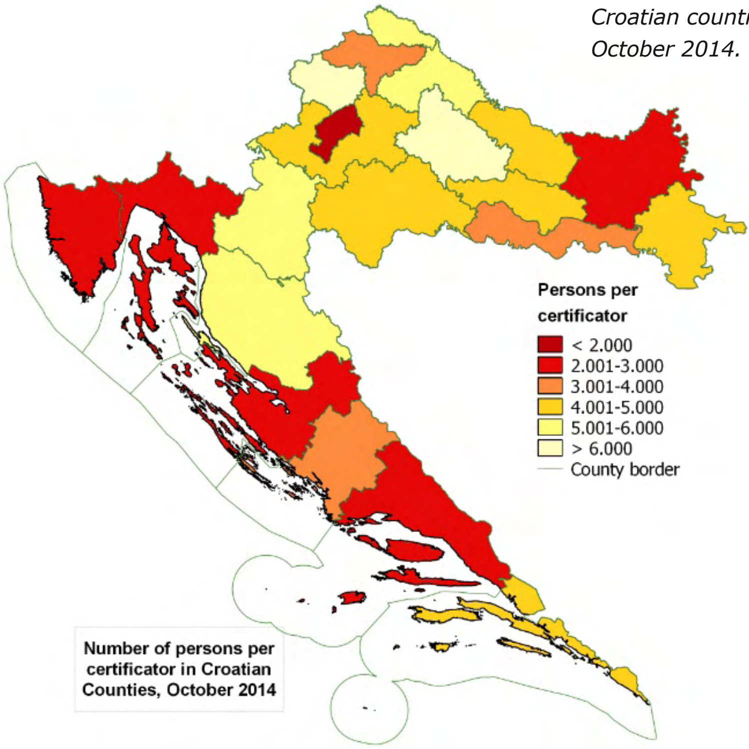


Figure 22: Number of inhabitants per qualified expert in Croatian counties, October 2014.

4. Conclusions, future plans

Following the calculations for defining reference buildings and setting requirements for new buildings as well as for the reconstruction of existing buildings within a cost-optimal framework, the implementation of the new technical regulation 2015 has become the standard to follow in practice. Several computer programmes have been developed in order to facilitate the calculations based on European standards. Some are commercial programmes, but the government envisages the development of a programme that would be available to all users free of charge. The national methodology for the energy performance of buildings (algorithms) that was adopted for this purpose is periodically corrected, in line with the experience acquired in implementing cost-optimal analyses.

For the purposes of promoting alternative systems in the designs of new buildings, a study on the applicability of alternative systems was prepared. This also included the development of type solutions for the application of alternative systems, and should be used when designing new buildings with a surface area of 50 - 1,000 m^2. A designer is required to develop an alternative system study prior to developing the main design, and deliver it to the investor. The study provides guidance to the designer on how to develop the project. Application of the study, i.e., type solutions for alternative systems, is mandatory as of 1 January 2015.

NZEBs are defined by primary energy consumption in continental and littoral climate zones. A public debate related to energy standards of NZEBs was carried out, and following this, a number of information workshops for stakeholders were held, in order to present them this standard and to enable the building industry to adequately prepare for meeting the new requirements for the construction of these buildings. The definitions for NZEBs for all types of buildings are implemented in the Technical regulation on rational use of energy and heat retention in buildings (OG 97/2014 and 130/2014).

Figure 23: The self-sustaining house MEMBRAIN concept at the Solar Decathlon competition in Paris, 2014.

As the building sector in Croatia accounts for 43% of final energy consumption, special attention must be paid to more intense implementation of national programmes of building renovation. Therefore, a continuation of promotional activities is planned. The establishment of an internet platform for information on available energy efficiency mechanisms and financial and legal frameworks and instruments is envisaged in order to better spread information to all relevant market participants. The establishment and administration of a system for monitoring, measurement and verification of energy savings is planned in order to appropriately monitor the implementation of measures for energy efficiency improvement.

Regulations to certify RES installers for smaller and biomass fuelled boilers, solar thermal systems, shallow geothermal systems and heat pumps were published in May 2015 (OG 56/15). For installers of photovoltaic systems, a regulation is in force and implemented, pursuant to which more than 80 installers obtained certification by October 2014.

A new Ordinance on the energy certification of buildings is under preparation. According to the new ordinance, the energy class will be expressed as delivered (final) energy instead of net energy needs at present. Reporting of delivered energy on EPCs will be mandatory, and it will include energy to be delivered to the technical building system in order to meet needs for heating, cooling, ventilation, and preparation of DHW, and for non-residential buildings, lighting. Continuation of quality controls of issued EPCs of buildings (including reports on completed regular inspections of heating and cooling/AC systems in buildings) is planned to reach the same minimum scope as in 2014, in order to carry out controls for every authorised person at least once during their period of authorisation. Data on completed controls, i.e., annulled EPCs, will also be made available to the public in order to contribute to increasing their quality and instilling confidence in the beneficiaries of the energy certification of buildings.

Implementation of the EPBD in Cyprus

STATUS IN DECEMBER **2014**

1. Introduction

In Cyprus, the first attempt to promote energy efficiency in buildings was made in 1999 with the voluntary standard CYS98:1999 for the Insulation and Rational Use of Energy in Dwellings. With the accession of Cyprus into the European Union in 2004 and considering the mandatory targets in energy and environment for 2020, the 'Grant Scheme for Promoting the Renewable Energy Sources and the Conservation of Energy' was introduced. The scheme included the building sector by subsidising thermal insulation, double glazing, efficient lighting and renewable energy systems for heating and cooling.

However, the big leap was made in December 2007 when the first ministerial order of minimum energy performance requirements was issued, and since then, minimum requirements have been revised twice. Another important milestone in the implementation of the Energy Performance of Buildings Directive (EPBD) was the launch of the national scheme for certifying the energy performance of new and existing buildings in 2009. In the same year, the inspection schemes for air-conditioning (AC) systems and heating systems with boilers were commenced.

In December 2012, Cyprus transposed Directive 2010/31/EU in the national legislation by the Law 210(I)/2012 which amends the Law for the regulation of the energy performance of buildings. Based on the new legal framework, the cost-optimal levels of minimum energy performance requirements were calculated and revised, minimum requirements on technical systems were implemented and measures to promote Nearly Zero-Energy Buildings (NZEB) have been taken. The implementation of the EPBD in Cyprus is the overall responsibility of the Ministry of Energy, Commerce, Industry and Tourism (MECIT). This report is an overview of the current implementation status of the EPBD in Cyprus.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

Energy performance requirements, since their implementation, have a major contribution in the effort of reducing national energy consumption. It is estimated that a new building consumes around 50% less energy than a similar building that was built before the implementation of energy performance requirements. The target of constructing only NZEBs by 31 December 2020 and the calculation of the cost-optimal levels of minimum requirements are the catalysts for tightening minimum energy performance requirements.

The current minimum energy performance requirements for new residential buildings regulate the building elements and the building as a whole and promote the use of Renewable Energy Sources (RES). The building elements requirements consist of maximum U-values for the building envelope and a maximum shading factor for windows. The maximum shading factor is the percentage of solar gain entering the building, taking into consideration external shading (movable and non-movable) and the window's solar transmittance. The requirements regarding RES remain as they were in the 2010 ministerial order which requires the installation of a solar heater for the production of Domestic Hot Water (DHW) and the necessary provision in the event that RES will be installed in the future for the production of electricity. An energy class of B or better is required, while for new single-family homes, a maximum average U-value for walls and windows is required that does not apply for new residential building units.

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The requirements of building elements for new non-residential buildings are the same as for new residential buildings. Also, an energy class of B or better is required as well as a maximum average U-value that is higher than what is required for single-family residences. Since 2013, it is required that at least 3% of the primary energy consumption in new non-residential buildings comes from RES. Some buildings can be exempted from this requirement if they get approval from the MECIT. This exception has to be justified on the grounds of technical and financial feasibility by submitting a report.

The current minimum energy performance requirements for existing buildings vary between buildings that have a useful floor area above or below 1,000 m². The regulation requires that buildings above 1,000 m² that undergo major renovations shall meet the same level of energy efficiency as new buildings to the extent which is financially viable and technically feasible, while for smaller buildings, the requirements are limited to the building elements that are replaced or retrofitted.

Public buildings, new and existing, have to comply with the same requirements as private buildings.

I.i. Progress and current status

In December 2007, the first ministerial order of minimum energy performance requirements was issued. The ministerial order was only setting maximum U-values for the building envelope of new buildings and buildings with a floor area larger than 1,000 m² that undergo major renovations. In January 2010, a new ministerial order was implemented adding to existing requirements the issuing of an Energy Performance Certificate (EPC) of energy class B or better, a maximum average U-value, the installation of solar heater for DHW in houses, and the necessary provision in the event that production of electricity from RES will be installed.

By March 2013, the cost-optimal levels of minimum energy performance requirements were calculated, and based on the results of that calculation, the current requirements were issued in December 2013 (see Table 1). The major changes in the current requirements compared with the requirements of 2010 are that the maximum U-values of the building envelope elements have been reduced and requirements for solar protection of windows and RES for non-residential buildings have been introduced.

Table 1: Minimum requirements before and after calculating cost-optimal levels.

Minimum energy performance requirement	**Since January 2010 (Κ.Δ.Π. 446/2009)**	**Current requirement, since December 2013 (Κ.Δ.Π. 432/2013)**	**Cost–optimal calculated**					
			New			Existing		
			single-family homes	apartments	non-residential	single-family homes	apartments	non-residential
Energy class on the EPC	B or better for all new buildings and buildings larger than 1,000 m² that undergo major renovations	B or better for all new buildings and buildings larger than 1,000 m² that undergo major renovations	B		C	B		C
Maximum U-value for walls part of the building envelope in contact with the external environment (W/m².K)	0.85	0.72	0.53	0.44	0.72	0.34	0.38	0.23
Maximum U-value for roofs and floors in contact with the external environment (W/m².K)	0.75	0.63	0.42	0.45	0.35	0.27	0.35	0.44
Maximum U-value for windows and doors in contact with the external environment (W/m².K)	3.8	3.23	2.98	2.90	3.45	6.0	4.75	3.6
Maximum mean U-value for all building elements in contact with the external environment (W/m².K) –not including roofs and floors (*does not apply for building units*)	1.30 for residential 1.80 for non-residential	1.30 for residential 1.80 for non-residential	It was not calculated, since it is planned to be abolished					
Minimum percentage of primary energy consumption to be covered by renewable energy sources	Installation of solar water heater for the production of DHW in new residential buildings and provision for the future instalment of RES that produces electricity in all new buildings	In addition to 2010 requirements, at least 3% of primary energy consumption has to be covered by RES for new non-residential buildings	25%	For building units, the current requirement, installing only a solar heater, is at cost-optimal level.	3%	9%	For building units, the current requirement, installing only a solar heater, is at cost-optimal level.	7%
Maximum shading factor	-	0.63	Movable and non-movable external shading and low-transmittance glazing are included in almost all energy-efficiency packages which are at the cost-optimal level					

Energy class on the EPC	B or better
Maximum U-value for external walls (W/m².K)	0.72
Maximum U-value for external roofs and floors (W/m².K)	0.63
Maximum U-value for external windows and doors (W/m².K)	3.23
Maximum U-value for floor above closed unheated spaces (W/m².K)	2.0
Maximum mean U-value for all external building elements (W/m².K) (it does not include roofs and floors and it does not apply for building units)	1.3
Maximum shading factor	0.63
Installation of solar water heater for the production of domestic hot water	
Provision for future installation of RES for producing electricity	

Table 2: Minimum requirements for new residential buildings.

Energy class on the EPC	B or better
Maximum U-value for external walls (W/m².K)	0.72
Maximum U-value for external roofs and floors (W/m².K)	0.63
Maximum U-value for external windows and doors (W/m².K)	3.23
Maximum U-value for floor above closed unheated spaces (W/m².K)	2.0
Maximum mean U-value for all external building elements (W/m².K) (it does not include roofs and floors and it does not apply for building units)	1.8
Maximum shading factor	0.63
At least 3% of primary energy consumption has to be covered by RES	
Provision for future installation of RES that produces electricity	

Table 3: Minimum requirements for new non-residential buildings.

Energy class on the EPC	B or better
Maximum U-value for external walls (W/m².K)	0.72
Maximum U-value for external roofs and floors (W/m².K)	0.63
Maximum U-value for external windows and doors (W/m².K)	3.23
Maximum U-value for floor above closed unheated spaces (W/m².K)	2.0
Maximum mean U-value for all external building elements (W/m².K) (it does not include roofs and floors and it does not apply for building units)	1.8
Maximum shading factor	0.63

Table 4: Minimum requirements for existing buildings above 1,000 m² that undergo major renovations.

Maximum U-value for external walls (W/m².K)	0.72
Maximum U-value for external roofs and floors (W/m².K)	0.63
Maximum U-value for external windows and doors (W/m².K)	3.23
Maximum U-value for floor above closed unheated spaces (W/m².K)	2.0
Maximum shading factor	0.63

Table 5: Minimum requirements for building elements that are replaced or retrofitted (including major renovations).

Additionally, since 2013, the requirements are separated for new buildings (Tables 2 and 3), new building units, existing buildings that are above 1,000 m² and undergo major renovations (Table 4) and building elements that are replaced or retrofitted on existing buildings (Table 5).

The current requirements are considered to be an intermediate step towards cost-optimal levels. In 2015, officials are planning to start a public dialogue in order to reach cost-optimal levels of minimum requirements by 2016. The major forum for discussing minimum requirements are the committee for implementing the Law for the regulation of the energy performance of buildings and the committee for the promotion of NZEBs and energy conservation in public buildings. Both committees are established by law and all the stakeholders of the building sector are participating. Their role is to consult the minister in related matters. Furthermore, in August 2014, a ministerial order was issued defining the requirements that a building has to fulfil in order to be a NZEB.

The calculation of the cost-optimal levels of minimum requirements has shown that NZEBs are for some types of buildings very close to the cost-optimal levels.

I.ii. Format of national transposition and implementation of existing regulations

The Minimum Building's Energy Performance Requirements ministerial order of 2013 (Κ.Δ.Π. 432/2013) defines minimum requirements for all buildings. All compliance calculations are documented in the 'Guide of Thermal Insulation of Buildings' (Figure 1) and the 'Methodology for Calculating the Energy Performance of Buildings' (Figure 2). The 'Guide of Thermal Insulation of Buildings' was first issued in 2007 in order to guide engineers and architects to calculate U-values and inform them on different insulation techniques. The 2nd edition, which was published in 2010 and is currently in force, includes more detailed calculation methods for U-values and parameters related to thermal mass. The 'Methodology for Calculating the Energy Performance of Buildings' describes all the algorithms and assumptions used to calculate energy consumption. It includes heating, cooling, DHW and lighting needs, expressed in terms of primary energy. Both documents are based on CEN standards, and they are both of mandatory use in the calculation of the energy performance of all types of buildings (existing or new).

Figure 1: Guide of Thermal Insulation of Buildings (2nd Edition)

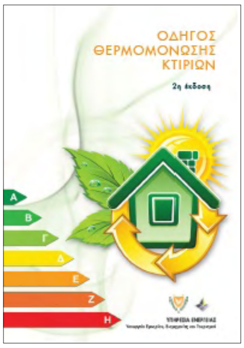


Figure 2: Methodology for calculating the energy performance of buildings.

The energy performance calculation is based on the comparison of the building with a reference building (Table 6). For the calculation of the heating and cooling demand, preset temperatures are used, which vary according to building type and building area activity. For the calculation of the heating and cooling demands, the methodology requires that all information about buildings' elements orientation, U-values, thermal mass and external shading (movable or not), be provided. Additionally, natural and mechanical ventilation, if any, is included in the calculation. However, indoor air quality is not a concern for calculating purposes.

Infiltration and thermal bridges are also taken into consideration. However, there are insufficient airtightness tests or detailed methods for assessing thermal bridges readily available in the market. To compensate this, default values are used in the calculations most of the time. In heating and cooling calculations, it is assumed that thermal comfort is achieved, although that might not be the case in a real building, especially in the case of existing buildings.

When needed, the MECIT issues directives to Qualified Experts (QE) who perform the energy performance calculations. These directives usually are about clarifications and frequent mistakes. The calculation methodology is simulated by the software SBEMcy, developed by the MECIT. However, other software can be used if it is approved by the MECIT.

The minimum requirement (EPC in a B category) is achieved only if the building needs the same or less primary energy than the reference building. The reference building has predetermined energy performance characteristics like U-values, thermal mass and technical systems. Although the energy consumption of a building that complies with current minimum energy requirements is not fixed, a single-family house typically has a maximum primary energy consumption of 200 kWh/m^2.year and an office building 250 kWh/m^2.year.

The implementation of minimum energy performance requirements is checked on a random basis by appointed inspectors of the MECIT. According to the law, these inspectors have the right to enter any building and construction site and inspect if the building complies with the minimum energy performance requirements, to check the validity of the information used for issuing the EPC and any other matter related to the energy performance of buildings. Initially, a decision is made about the buildings that are going to be inspected. This decision is based on the criteria of including all types of buildings and all geographical areas. Then, the inspectors visit the buildings at different stages of construction. If they notice non-compliance, a written warning is delivered that demands the owner or owners to comply within a deadline. In case of non-compliance, legal measures are taken against the building owners. The inspectors in most cases know in advance the energy performance characteristics of the building, as they can be obtained from the EPC database. So far, legal measures have been taken for nineteen cases. Court decisions have issued fines, although most of the cases are still in the court phase.

I.iii. Cost-optimal procedure for setting energy performance requirements

For the calculation of cost-optimal levels of minimum energy performance requirements, virtual reference buildings were established to represent 1 new single-family house, 1 new office building, 1 new apartment building, 2 existing

Exposed element	U-value (W/m².K) (residential)	U-value (W/m².K) (non-Residential)
Roofs* (irrespective of pitch)	0.63	0.63
Walls	0.72	0.72
Floors	0.63	0.63
Ground floors	1.6	1.6
Windows, roof windows, roof lights, and pedestrian doors	3.23	3.23
Vehicle access and similar large doors	Same as real building	Same as real building

* Any part of a roof having a pitch greater or equal to 70° is considered a wall

Table 6: Building envelope parameters of the reference building.

Energy class on the EPC	A
Maximum primary energy consumption for residential buildings (kWh/m².year)	100
Maximum primary energy consumption for non-residential buildings (kWh/m².year)	125
Maximum U-value for external walls (W/m².K)	0.40
Maximum U-value for external roofs and floors (W/m².K)	0.40
Maximum U-value for external windows and doors (W/m².K)	2.25
At least 25% of primary energy consumption has to be covered by RES	
Maximum average power lighting installed in office buildings (W/m²)	10

Table 7: Requirements and technical characteristics of NZEBs.

single-family houses, 2 existing office buildings, 2 existing apartment buildings and 1 existing retail building. The reference buildings were created based on statistical data regarding the use of the existing buildings, their size and their energy related characteristics such as thermal insulation and technical systems. The input of stakeholders was used to establish reference buildings for new buildings and to make a cost database for building materials, technical systems and renewable energy systems for buildings. In total, 252 packages of efficiency measures were simulated to assess their energy-saving potential and their corresponding economic benefit. The main conclusions reached from the calculation are the following:

1. The requirement of at least energy class B for new residential buildings and for existing buildings that undergo major renovations is on the right value. For non-residential buildings, the cost-optimal level seems to be on the borderline between energy class C and B.
2. U-values for roofs and floors that are part of the building envelope have to be reduced significantly for all buildings.
3. U-values for walls and windows have to be reduced for residential buildings.
4. Movable and non-movable external shading and low-transmittance glazing are included in almost all energy-efficiency packages which are at the cost-optimal level.
5. Energy-efficient lighting is a cost-optimal measure in office buildings.
6. The share of RES in the cost-optimum packages appears in all reference buildings, though it varies from 3% to 25%.

The consultation for issuing new minimum energy performance requirements led to the reduction of maximum U-values by 15% for new and existing buildings and the requirement to cover at least 3% of primary energy consumption in new non-residential buildings from RES. A revision of the energy performance requirements is planned for 2016 in order to meet cost-optimal levels.

I.iv. Action plan for progression to Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The definition of NZEB for residential and non-residential buildings in Cyprus is prescribed by the Requirements and the Technical Characteristics of the NZEB ministerial order of 2014 (Κ.Δ.Π. 366/2014); see Table 7. The requirements for NZEBs are stricter than the current minimum energy performance requirements. They require lower U-values, energy class A (the best class), a maximum consumption of primary energy and at least 25% of the demand to be covered by RES. The requirements apply for new and existing buildings. The National Action Plan for increasing the number of NZEBs in Cyprus identifies a list of actions to be taken by 2015. All actions can be grouped in the following areas:

> Information and education: Measures are already taken to educate building professionals about constructing NZEBs and renovating existing buildings to NZEB standards. The MECIT has organised two informative sessions about NZEBs that were directed to architects and engineers (Figure 3). The sessions included the legislative framework and best-practice examples. Similar sessions are planned to be organised again. Also, the MECIT is preparing a technical guide to be used as a reference, facilitating the design of NZEBs. The use of the technical guide will be on a voluntary basis and will be upgraded accordingly so as to remain in use even after the mandatory construction of NZEBs. Regarding the other professionals of the building industry, the MECIT is in close cooperation with the Ministry of Education, workers' unions and employers' organisations in order to identify and fill any skills gaps. A very useful tool towards this direction is the results of the European programme 'BUILD UP Skills' as well as the second pillar of the programme WE-Qualify 'Improve Skills and Qualifications in the Building Workforce in Cyprus' initiated in December 2013.

> Improve the legislative framework: The legal definition of NZEB by August 2014 is considered a milestone, since it gives the opportunity for those interested to construct or renovate buildings to the NZEB level before it becomes mandatory. The action plan provides that the minimum energy performance requirements have to be revised gradually until they reach the requirements of NZEB by 2020. The cost-optimal study indicates that there is in many cases a lot of improvement that can be done. Other legislative improvements are those considering professionals of the building industry. The qualifications and training programs of RES installers on buildings have been regulated since January 2014. Similar regulations are planned to be formed for buildings' technical systems installers and installers of other building elements that are critical to energy performance.

> Incentives: A new support scheme called 'Save – Upgrade' has been commenced by the end of 2014 for upgrading the energy performance of existing buildings. This new scheme is co-funded by the EU for the period of 2014 – 2020 and is planned to supply more than 30 M€ for the renovation of households and buildings used by small- and medium-sized enterprises. The scheme provides a subsidy of 50% for renovations (reaching class B or 40% energy savings) or a 75% subsidy for upgrading an existing building up to the NZEB level. There are also other incentives which are not for NZEB, but can be used to complement a building owner's effort to build or renovate an existing building to NZEB levels. These comprise, e.g., the directive issued by the Ministry of Interior in 2014 where an additional 5% extra useful area can be allowed to be built if the building has energy class A and at least 25% of energy consumption is covered by RES. In addition, the scheme 'Solar Energy for All' gives the opportunity for households and local authorities to install photovoltaic (PV) systems of up to 3 kW under net-metering. The subsidy on the initial cost of PV systems is provided only to low-income families and other socially disadvantaged consumers. Additionally, the scheme allows businesses to install PV systems on their buildings, although only for self-consumption.

> Research and development: In the last few years, more universities and other organisations are taking research initiatives related to NZEBs. The MECIT is supporting several EU funded research projects by disseminating the results and giving a policy point of view. The goal is to make a synthesis of all the available results and identify practices that are technically and financially viable for Cyprus.

The calculation of the cost-optimal levels of minimum requirements has indicated that NZEBs are not at the cost-optimal level. However, in all cases, including major renovations, NZEBs are cost effective for the investor compared to the 'taking no efficiency measures' scenario. Additionally, the calculations clearly show that a NZEB is more economically feasible if more emphasis is given on increasing roof and wall insulation, while PV systems seem to be an attractive investment for the building's renewable energy provider.

Figure 3: Information session about NZEBs.

Figures and statistics on existing NZEBs

At the moment there are no recorded NZEBs in Cyprus, since their technical definition in a legal document is relatively new. However, there are many buildings that are highly energy efficient, and they include many 'good practice elements' and can be considered the precursors of NZEBs. An example of this is the new Nicosia town hall which constitutes a group of buildings (mainly offices; see Figure 4). One of these buildings was completed in 2013. The building has U-values much lower than the current minimum requirements and an architectural design which enables night cooling, maximises natural lighting and minimises heat gains in the summer. The building uses only a small solar water heater as RES. The measured electricity consumption, the only type of energy used in the building is 20 kWh/m^2.year, while the average public building consumes around 130 kWh/m^2.year. It has to be noted that according to the national definition of NZEB, the calculated energy performance of a non-residential NZEB must not exceed 46 kWh/m^2.year of electricity consumption, considering that this is the only type of energy used.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The 'Strategy for mobilising investments in the sector of building renovations' was published in April 2014 as part of the 3rd National Energy Efficiency Plan. The aim is to upgrade the energy efficiency of the existing building stock in the most cost-effective way for the owner, while maximising the economic, environmental and social benefits for the country (Figure 5). The document highlights quantitative and qualitative indicators of the problems caused by the low energy efficiency of the existing building stock, and the opportunities offered by greater mobilisation of investment in major renovations. It also identifies the main obstacles encountered, how these can be overcome and the main stakeholders to be involved. The process of making the document gave the chance to all stakeholders, including the financial sector, to get together and identify challenges and synergies.

Part of this effort is the 3% annual renovation of the total floor area of buildings that are owned and used by central government authorities. The renovations should be made to at least fulfil current minimum energy performance requirements. Already by decision of the Cabinet of Ministers, the Minister of Communications and Works has been authorised to submit a comprehensive plan for upgrading the energy efficiency of public buildings. For the implementation of this measure, a working group was created consisting of the following entities:

i. Energy Service of the MECIT;
ii. Public Works Department of the Ministry of Communications and Works;
iii. Department of Electrical and Mechanical Services of the Ministry of Communications and Works;
iv. Internal Audit Department of the Ministry of Communications and Works;
v. Scientific and Technical Chamber of Cyprus (ETEK).

One of the first tasks completed by this working group was to collect all data regarding energy efficiency, consumption, size and any other useful information about the buildings owned and occupied by the central government. It is estimated that an area of 120,000 m^2 of public buildings must be renovated for the period 2014 – 2020. The next step is to evaluate the buildings from a technical and financial point of view. For this evaluation, the buildings' EPCs, the recommendations accompanying them, and energy audits, where applicable, will be used. The renovation of public buildings has already begun in the framework of the European programme of Territorial Corporation. The programme titled 'ENERGEIN' is focused in upgrading the energy efficiency of public infrastructure in Cyprus and three island peripheries of Greece. The programme funds the upgrading of four public buildings in Cyprus. At the same time, the

Figure 4: The new Nicosia town hall.

Figure 5: Renovating and upgrading the energy efficiency of an existing apartment building.

working group is trying to implement all available ways of financing. This includes energy performance contracting and co-financing by EU programs. The Department of Electrical and Mechanical Services has prepared a prototype of an energy performance contract that can be used as a guideline by every public body and even the private sector.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The overall energy performance, the proper installation and dimensioning, adjustment and control of buildings' technical systems is regulated by various legislations. The regulations cover heating, hot water, air-conditioning and ventilation in new and existing buildings, but they do not cover every type of technical system to the same extent. In more details (see Table 8):

> Heating systems with boilers: the requirements include dimensioning, adjustment, installation and control.

> Hot water: the requirements include dimensioning, adjustment, installation and control if it is produced by the same boiler that is producing heating, and requirements about dimensioning and installation if it is produced by the same heat pump that produces AC. Additionally, in the case where a solar heater is installed in a house the energy performance, the proper installation and dimensioning is also regulated.

> Air-conditioning: the requirements are about dimensioning and installation while there is a requirement for the energy efficiency of air-conditioners.

> Ventilation systems: the requirements are about dimensioning and installation.

Regulation Κ.Δ.Π. 111/2006 ensures that the systems are at optimum size. As of July 2013, central heating systems with boilers with a power output rated above 20 kW have to be adjusted and controlled every two years at a level that ensures optimum performance. This process is described in the 'Guide for adjusting and controlling central heating systems with boilers' and includes many maintenance features. It is performed by technicians and it is distinct but complementary to inspections. A similar regulation is currently under development for AC systems above 12 kW or when the sum of all AC units' rated output in the same building is above 50 kW.

As of November 2013, minimum requirements are in force regarding the energy performance of boilers with a power output rated between 20 kW and 100 kW, and for split-unit air-conditioners with a power output rated under 12 kW. In the case of installed or replaced ventilation systems that move more than 500 l/s of air, the provision of heat recovery is required.

II.ii. Regulation of system performance, distinct from product or whole building performance

Regulation Κ.Δ.Π. 111/2006 was issued prior to the implementation of the EPBD in Cyprus. It regulates the submission to the building authority of drawings, calculations and catalogue of equipment and materials for central heating, the AC system and the ventilation system that will be installed in

Table 8: Main requirements for technical building systems which are installed in existing buildings.

Technical system	**Requirements**
Central heating system	• Dimensioning and installation (except single-family homes) • The efficiency of boilers with rated power output above 20 kW and up to 100 kW must be no less than 92%
Air-conditioning system	• Dimensioning and installation (except single-family homes) • The seasonal efficiency of air-conditioning units with rated output up to 12 kW must be at least 3.4 in heating and 3.6 in cooling
Ventilation	• Dimensioning and installation (except single-family homes) • Heat recovery has to be installed in case the ventilation system moves more than 500 l/s of air
DHW	• Dimensioning in the event that hot water is produced by the central heating system (except single-family homes) • Installation and dimensioning according to 'The technical guide for solar water heating systems' when solar water heater is installed in residential buildings

a building. Though the regulation does not specify a minimum overall energy performance, one of its main goals is to ensure that all technical parameters will be taken into consideration in order to achieve high performance. The overall sizing and performance of new solar heaters for producing DHW is regulated in both new and existing buildings, since installers have to follow the 'Technical guide for solar water heating systems'.

II.iii. Encouragement of intelligent metering

The Electricity Authority of Cyprus (EAC), which is the only electricity company supplier as well as the distribution system operator in Cyprus, concluded that the introduction of smart meters for electrical consumption of buildings is cost effective. However, the uncertainties are very high and small changes in input parameters could result in different business cases. To minimise these uncertainties, a final decision shall be taken only after conducting a pilot Advanced Metering Infrastructure (AMI) application project, consisting of the installation of 3,000 smart meters in the near future. Furthermore, the upcoming subsidy schemes that will be implemented for the period 2014 – 2020 will include smart meters as an eligible cost in all kinds of existing buildings that are renovated.

In the public sector, the Department of Electrical and Mechanical Services has installed smart meters of electricity consumption in selected public buildings. The aim is to gather more and precise data for buildings which are in the list of being renovated either through public funds or through energy performance contracting. The installation of smart meters in all buildings owned and used by the government is planned to be done by 2020. This will provide insights into electricity consumption patterns for different uses in buildings, including Technical Building Systems (TBS).

In addition to the above, the University of Cyprus is participating in a project with the EAC and the Cyprus Energy Regulatory Authority (CERA), as well as other partners, for providing smart meters of electricity to households with installed PV systems under the net-metering support scheme. Three hundred consumers/producers will be selected based on their geographical distribution and energy consumption. The results of this project will be investigated in order to further increase the PV penetration in a cost-effective manner and achieve a win-win scenario for both consumers and energy utilities. This will facilitate the implementation of NZEBs in Cyprus.

II.iv. Encouragement of active energy-saving control (automation, control and monitoring)

The active energy-saving control is promoted in two ways. According to the methodology for calculating the energy performance of buildings, the consumption of lighting, AC or central heating is reduced by 5% if an automatic system for metering and monitoring is installed. For the central heating systems, if there are automated features like weather compensation and optimum start/stop control, this can be indicated in the calculations. Also, in the lighting calculations, different kinds of sensors and dimmers are taken into account. In each case, the building can get a better rating on the EPC scale if it has active energy-saving control. This serves as an incentive for building owners and property developers to use them.

Energy savings through controls were promoted from 2004 to 2013 under the 'Grant Scheme for Promoting the Renewable Energy Sources and the Conservation of Energy' where the installation of Building Energy Management Systems (BEMS) was subsidised in office buildings, hotels and other commercial buildings. The new support scheme, 'Save - Upgrade', includes active energy-saving control for non-residential buildings. Additionally, more BEMS are planned to be installed in public buildings in combination with the installation of smart meters.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

The EPC is required to be issued when a new building is constructed, or when a building is being sold or rented out. It is also required for buildings with a useful floor area of over 500 m^2 that is occupied by a public authority and is frequently visited by the public. In all cases, the responsibility of issuing the certificate is on the building owner and its validity is ten years. The EPC scheme in Cyprus has undergone a revision in 2013. The changes were based on the experience from the implementation in the last four years. The first change was the introduction of energy class B$^+$. It has been observed that almost all new buildings are energy class B and rarely energy class A. The insertion of an energy class in between has the aim to give an extra incentive to property developers that are constructing or renovating buildings that are better than those just complying with minimum requirements (energy class B), however still not highly energy efficient (energy class A). The second change was in the recommendation report. This became more detailed, as it now has to cover both single targeted measures and combinations of measures. Also, the report gives for every building element a comparison with the minimum requirements and an indication on how much better or worse it is positioned against minimum requirements.

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

EPCs are produced by QEs. The MECIT is responsible for maintaining the registry of QEs and EPCs. All EPCs have to be submitted via email by a QE, and within one working day they receive it back with a unique number that proves its validity. The MECIT is managing the national database of EPCs which is used for control, but they also extract statistics that are used to shape future policy-making decisions.

How flats are certified in apartment buildings

The law gives the option to issue an EPC for the whole building or for individual building units. When it comes to apartment buildings, the most common approach is to certify each individual flat.

Format and content of the EPC

In Cyprus, the EPC adopts a similar image to the energy certification of electrical appliances (Figure 6). The most emphasis is given on the energy class scale, but other information is available, in particular, the address of the building, the name of the QE, the CO_2 emissions and the percentage of energy covered by RES.

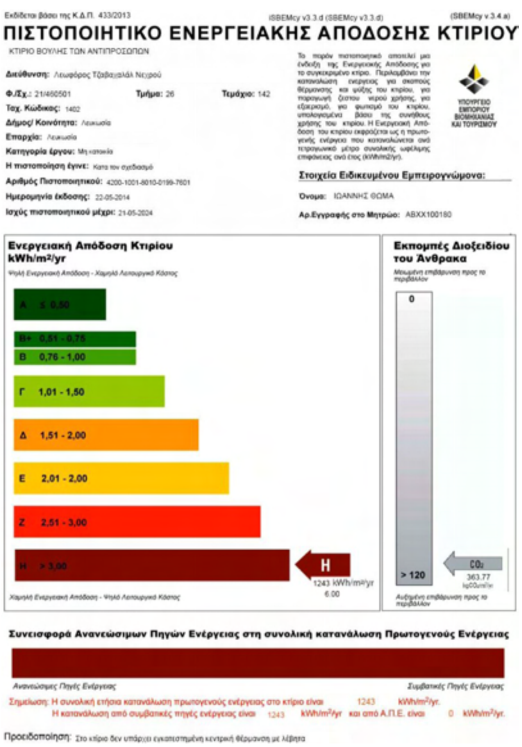


Figure 6: Energy Performance Certificate.

EPC activity levels

Up to September 2014, 20,831 EPCs have been issued, of which 1,484 are for existing buildings and 19,347 are for new buildings. There are 18,836 EPCs for residential buildings and 1,994 EPCs for non-residential buildings.

Typical EPC costs

In February 2012, the MECIT conducted a survey among QEs in order to identify, among other things, the cost of an EPC (Figure 7). More than 50% have responded that they charge 2 - 3 € per m^2 for residential buildings. Regarding the cost for non-residential buildings, 65% did not respond at all. Certification for non-residential buildings is more complex, which makes putting a fixed price tag on the EPC more difficult. No meaningful conclusions could be obtained from this survey.

Assessor corps

QEs are separated in QEs for residential and QEs for non-residential buildings. By the beginning of 2014, their qualifications have been revised. These are the current requirements to become a QE:

> They must be members of the Scientific and Technical Chamber of Cyprus (ETEK) in the field of architectural, civil, mechanical, electrical, chemical or environmental engineering. The last two academic backgrounds apply only for residential buildings.

> They must have one year of experience for residential buildings and three years of experience for non-residential buildings in matters of energy, buildings or buildings' technical systems. Non-residential QE candidates that do not have three years of experience can still be eligible if they have issued at least 90 EPCs for residential buildings.

> They must pass an exam that is organised by the MECIT. There is a different exam for each of the two QE categories.

Training is not mandatory, though it is provided by the MECIT in order to prepare candidates. Considering residential buildings, the training is sixteen hours and it covers legislation, methodology, the use of software and recommendations. The training for non-residential QEs is about calculating the energy performance of non-residential buildings with more emphasis on complex building services and giving recommendations. Since 2009, when the EPC scheme was put in place, more than 1,000 people went through these training programmes.

Currently there are 252 QEs, from which 135 can issue certificates only for residential buildings, while the rest can issue certificates for all kinds of buildings.

Compliance levels by sector

The compliance levels are improving over time. For residential buildings, 2.6% of the EPCs checked were cancelled in 2010, while in 2013 the number dropped to 0.12%. The non-residential buildings compliance is at the same level.

Enforcement with building owners and real estate actors

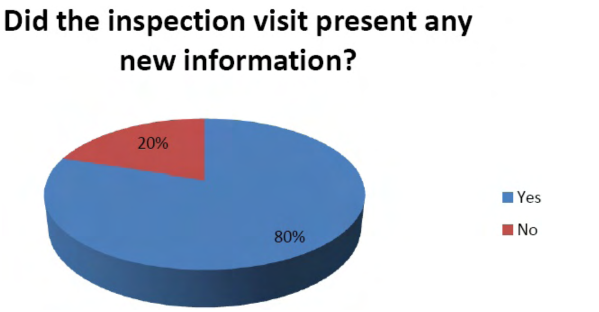
In 2014, the MECIT has commenced a campaign to check compliance on how EPCs are displayed when renting and selling. Real estate agencies, building development companies and commercial property owners are the three main actors in the Cyprus real estate market. The campaign includes visits to the offices of real estate agents and property developers where informing and compliance checks are performed at the same time. Also, seminars have been organised with the associations of real estate professionals and property owners with the exclusive subject of the EPC on sales and renting. In the last two years, any actions regarding selling and renting are including compliance with advertising as well.

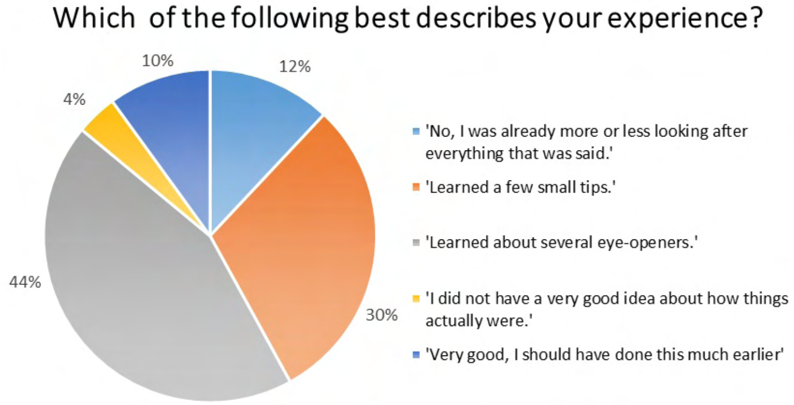
Quality Assurance of EPCs

The MECIT has been implementing quality assurance on EPCs since 2010. EPCs are checked on three levels:

> desk audit from the data retrieved from the EPC database;
> auditing the QE who has issued the EPC at his or her office;
> on-site visits.

The checks are on sample basis and there are EPCs that went through only one of the above mentioned checks or a combination of two or all three. From 2010 to 2013, 10% of all issued EPCs went through desk audit, and 21% of all EPCs went through an on-site check. Also, 22% of all QEs have been audited. The result of these checks was the cancellation of 218 EPCs and the suspension of 3 QEs. The cancellation is a measure usually taken immediately when it is recorded that an input in energy performance calculation is not valid or when a calculation is done wrong. A QE is suspended if it is observed that he or she is making mistakes in calculating the energy performance that result in wrongly depicting the energy performance of the building, mainly by not calculating the right energy class. The QE first receives a warning where he or she is called to correct the errors observed and to submit a new EPC, if it was cancelled. If this is not done by a deadline defined by the MECIT or if it is observed that the same mistakes are repeated, the QE is suspended. The time of suspension varies and it depends on the QE's ability to prove that he or she can perform correct calculations. In the event that it is proven that the QE is changing data and/or manipulating calculations on purpose, the suspension might be for life. However, so far, no such case has been recorded.





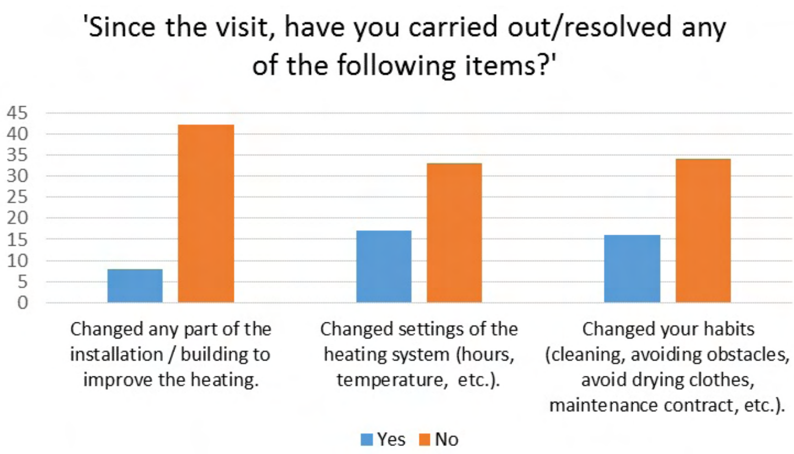


Figure 7: Survey results for heating systems inspections (source: MOVIDA; survey results - Cyprus).

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The public buildings in Cyprus can be separated by buildings that are used by:

> the central government, like ministries and law enforcement services;
> local authorities like municipalities;

> public schools, public universities and other public educational institutes;
> the military.

The central government is housed in 1,066 buildings, but almost half of them are rented. The Department of Electrical and Mechanical Services has the overall responsibility of issuing EPCs for the buildings that are owned and used by the central government. This is done most of the time by outsourcing and sometimes by in-house QEs. The issuance of EPCs for buildings used by the government that are rented is the sole responsibility of the building owner. Municipalities and community authorities have to issue an EPC if they use buildings that are above 500 m^2 and visited by the public, but this has to be done using their own financial and human resources. The 833 public schools in Cyprus are not considered to be visited by the public; therefore, an EPC only has to be issued for new schools and the overall responsibility lies with the Ministry of Education and Culture. The same applies for buildings that are used by the army, and the overall responsibility for issuing an EPC for a new such building belongs to the Ministry of Defence. In order to increase transparency, the MECIT has published a catalogue of public buildings and their energy class on its website.

Format and content of the EPC

EPCs issued in Cyprus all have the same format and are required to be updated with the same frequency for all buildings. The 2012 amendment of the Law for the regulation of the energy performance of buildings introduces the option of issuing a certificate based on the operational rating for public buildings. However, regulations regarding the methodology and ratings of the operational certificate are on hold due to the upcoming CEN standards regarding the methodology for calculating the energy performance of buildings.

Activity levels

Currently, there are 29 EPCs issued out of the 149 buildings that are owned and used by the central government, as this is defined in Article 5 of the EED, with a useful area larger than 500 m^2. Out of 29 of the EPCs that have been issued, only three are for new public buildings and only one is for renovations, since the construction activity in the public sector is very low. However, the goal of renovating public buildings under Article 4 of the EED has brought out a boost in the certification of such buildings.

Costs

The public sector is predominantly certifying office buildings. The QE is selected after competition, with low cost as the main criterion. The current trend is to obtain lower costs for the central government. The cost of the last three EPCs for office buildings of 4,000 to 5,000 m^2 was 2,000 € on average.

Quality Assurance (QA) of EPCs

The quality of assurance for public buildings' EPCs is done under the same framework as for the rest of the buildings. However, it differentiates only in that there is an exchange of information with the Department of Electrical and Mechanical Services and with the Public Works Department. This way, data used to issue an EPC for a public building is verified to a great extent and instances of non-compliance and EPC cancellation are very rare. The MECIT has the responsibility of enforcing the issuance and display of EPCs in public buildings. In 2014, 61 building owners of public buildings, private owners and public bodies have been notified by the MECIT for the obligation of issuing and displaying the EPCs. In three cases of non-compliance, corrective measures were requested.

III.iii. Implementation of mandatory advertising requirement

Indicating the energy category of the EPC became mandatory in all commercial advertisements on 28 December 2012. Before the implementation, the MECIT has informed all relevant interest groups. In 2014, the ministry commenced sample checks on the implementation of this requirement. The MECIT has initially focused on building-development companies and real estate agents. The law allows the MECIT to impose a fine of up to 30,000 € in case of non-compliance. So far, fines were imposed in eleven cases. The result of these actions is that the energy class now appears on advertising billboards, in newspaper advertisements and in other commercials in media related to renting or selling buildings.

III.iv. Information campaigns

The MECIT has the main responsibility of informing the public as well as the professionals of the building industry about the benefits of improving the energy efficiency of new and existing buildings. This is done in various ways.

Leaflets and advertising flyers informing the public about the EPC, as well as about the inspection of central heating systems with boilers and AC systems, have been issued and made available in places where frequent services are offered to the public. In 2011, an advertisement campaign addressing the EPC was also launched in the print media.

The MECIT organises or participates in seminars and presentations especially directed at professionals in the building industry. Presentations especially organised for professional organisations have so far targeted the Cyprus Association of Property Owners, the Cyprus Association of Property Valuators and Property Consultants, the Cyprus Hotel Association, the Real Estate Agents' Association and the Federation of Associations of Building Contractors of Cyprus.

The annual exhibition 'SAVENERGY' is probably the most important public event regarding the energy efficiency of buildings (Figure 8). The exhibition started in 2004 and it gives an opportunity for the public to come into direct contact with the companies that sell and install energy-saving systems and renewable energy systems. In 2014, the participants included companies offering holistic solutions in the energy efficiency of buildings, including financing, in the model of Energy Services Companies (ESCOs).

III.v. Coverage of the national building stock

The existing building stock in Cyprus consists of 431,059 residential buildings and 85,198 non-residential buildings. Almost half of all residential buildings are single-family houses and 22% are apartments. Likewise, half of all non-residential buildings are office buildings and the rest are mainly retail buildings. EPCs have been issued so far for 4% of all residential buildings and 2% of all non-residential buildings (Figure 9). In general, the existing building stock has very low energy efficiency, since 91% of all houses were built before the implementation of minimum energy performance requirements and 50% have not implemented any kind of insulation measure.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

With regards to Articles 14 and 15 of the EPBD, Cyprus has chosen the option of inspections for air-conditioning systems and heating systems with boilers. The inspections of heating and air-conditioning systems are recognised as complementary to, or even as part of the energy audit. Performing inspections is eligible as 'related work experience' required for a person to become a building energy auditor. Also, the inspections of air-conditioning systems are combined with the requirements of f-gas regulations, in order to make them more effective and reduce costs for the building owner.

There is no synergy between inspections and the activities foreseen in the national implementation of the EED (national Energy Efficiency Action Plan).

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

The law defines different frequencies of inspection as follows:

> For central heating with a boiler of a power output rated between 20 kW and 100 kW, the inspection must take place every five years.

> For central heating with gas boiler of a power output rated over 100 kW, the inspection must take place every two years.

> For central heating with a boiler of liquid or solid fuel with a power output rated over 100 kW, the inspection must take place every four years.

Figure 8: SAVENERGY 2014.

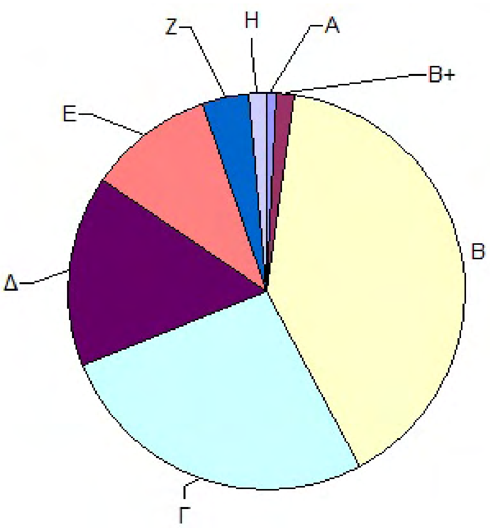


Figure 9: Distribution of EPCs for existing buildings by energy class.

The methodology for the inspection of boilers is described in the 'Guide for the Inspection of Central Heating Systems with Boilers'. It is based on EN 15378 and it covers all accessible parts of the heating system. A written report is filled out and submitted to the owner of the building after each inspection. Suggestions and recommendations for improving the efficiency of the boiler and the performance of the system are included in the report.

Arrangements for assurance, registration and promotion of competent persons

The inspection of heating systems with a boiler of a power output rated between 20 kW and 100 kW can be carried out by an independent expert appointed by the MECIT or by a registered inspector, while for heating systems with a boiler of a power output rated over 100 kW, the inspection can be done only by a registered inspector. The experts appointed by the MECIT went through theoretical and practical training in order to be able to implement the 'Guide for the Inspection of Central Heating Systems with Boilers'. The inspections are offered by the MECIT and are free of charge. They are usually offered to households on demand and to those responsible for public buildings.

It has been estimated that if the user of the system implements the recommendations of the inspector, a 10% energy savings on average can be obtained. This will also result in a reduction of CO_2 and other pollutants, although the impact that the inspection has on reducing them has not been estimated.

So far, all inspections have been carried out by the appointed experts, and therefore, no costs have been charged to building owners.

For registered inspectors, the following qualifications apply:

> successful completion of a written and practical examination;
> degree in mechanical engineering;
> member of ETEK.

The exam can be offered only by organisations approved by the MECIT. As the process of approval of exam organisations is still ongoing, there are no registered experts yet.

Promotional activities

The MECIT communicates the need for inspections to the public every year before the winter season begins. This usually is done through an announcement that is posted on the MECIT's website, which is a site frequently visited by the public, since the MECIT is also the competent authority for consumer protection. Also, the announcements are circulated through consumers' associations. In order to increase public awareness regarding the energy savings that can be obtained from heating systems, information material has been prepared regarding easy-to-implement ways to reduce energy consumption. Also, the associations of mechanical engineers and heating system installers are in close corporation with the MECIT in promoting the inspection and its benefits to the public.

Enforcement and penalties

A fine of up to 30,000 € can be issued in case a central heating system is not inspected. However, the deadline for all systems to be inspected is 31 December 2014; no fines have been issued so far. At this stage, efforts are focused on informing the public, and the issuing of fines will be examined later.

Quality control of inspection reports

Beginning in 2010, 220 inspections have been conducted for heating systems with a boiler of rated output above 20 kW. These inspections mainly covered households and public schools. All reports are kept in a database maintained by the MECIT.

The Cyprus University of Technology with authorisation by the MECIT has performed a control of 5% (11) of all inspections in order to verify the validity of the inspections and the level of satisfaction among building owners. The control was performed in the framework of the Intelligent Energy Europe funded project 'MOVIDA'. The majority of the building owners responded that the inspection had a positive effect on helping them understand how they can improve a system's energy efficiency; however, the uptake of measures was low.

Though penalties are foreseen for lack of inspections, no penalties have yet been issued as of the end of 2014.

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

As of 1 October 2010, Cyprus has made mandatory the regular inspection of air-conditioning (AC) systems with an effective rated output above 12 kW, or when the total output of several systems in the same building exceeds 50 kW.

The inspection frequency of the AC system depends on the rated output and is divided into three categories as follows:

i. ≥ 12 kW per AC unit, once every five years;
ii. ≥ 250 kW per AC unit, once every three years;
iii. ≥ 50 kW per total installed capacity, once every five years.

The MECIT published the 'Guide for the Inspection of Air-Conditioning Systems' which describes the technical and methodological approach of the AC inspection and is based on EN 15240. The inspector should follow this guide in order to produce a report containing (among others) recommendations regarding sizing and effectiveness of the system, as well as a checklist focusing on the general condition of the AC system. The original copy of the report is given to the owner and a copy is kept by the inspector for future quality control checks. All reports are submitted to a database maintained by the MECIT.

For an inspection for a building smaller than 1,000 m^2, the cost is between 400 € and 500 €. For larger buildings, it is difficult to give a cost estimate because of the limited number of inspections that have been performed.

An impact assessment of the costs and benefits of AC inspections has not been performed so far. This is planned for 2015.

Arrangements for assurance, registration and promotion of competent persons

The inspections must be conducted by inspectors registered at the national registry which is publicly available and handled by the MECIT. The following qualifications are required in order to become an air-conditioning inspector:

> be a mechanical engineer and member of ETEK;
> be certified for the installation, recovery, maintenance and repair regarding fluorinated gases according to regulation (EC) 842/2006;
> undergo mandatory training courses in matters of health and safety related to AC installation and operation.

Promotional activities

The MECIT has published flyers directed to the public regarding inspections of AC systems. The MECIT also organised informative sessions directed to special groups of interest such as hotel owners.

Enforcement and penalties

The MECIT is responsible for enforcing AC inspections. It is the AC system owner's responsibility to select the inspector and inspect the system at the predefined time intervals. A fine up to 30,000 € can be issued in case an air-conditioning system is not inspected.

Quality control of inspection reports

As of June 2014, there were 68 registered AC inspectors and 59 inspections had been performed that produced an equivalent number of inspection reports.

Up until now, 6 inspection reports (a 10% sample) have been checked. The inspection controls in some cases dealt with giving the required information on the report and in other cases with on-site visits at the time the inspection was performed. A different way of controlling the quality of the AC inspection reports is by obliging inspectors to inform the Energy Service one week in advance of the envisaged time and location of each inspection. This enables the MECIT to check on them during the inspection on a random basis. No non-compliance issues have been recorded so far.

IV.iii. Other relevant plans

An amendment of the regulations regarding the qualifications and obligations of heating systems inspectors and AC system inspectors has been formed after public consultation. The new regulations are subject of approval by the Parliament and expected to be voted on in the first half of 2015.

The MECIT is in the process of preparing a survey questionnaire to send out to all AC owners to enquire if their system has been inspected. The response from the survey will be used for improving the quality of AC inspections. In addition, it is expected to help in future review on the AC inspection frequency.

3. A success story in EPBD implementation

The Hellenic Bank is the second largest bank of Cyprus. In 2012, the organisation took the initiative to make a pilot study by implementing energy efficiency measures in one of its branches. The measures were targeted based on the recommendations that were given after issuing an EPC. When a remarkable 50% reduction in energy consumption was evidenced on the first pilot implementation, the Hellenic Bank decided to implement an energy management policy based on three pillars:

> **Taking various organisational measures aiming to reduce energy consumption:** By data analysis of the previous years' energy consumption, goals have been set

for every building. The management has appointed in each building a member of the staff which is responsible for energy savings and energy matters. Guidelines and checklists have been prepared and circulated to all staff. The staff responsible for energy efficiency in every building is meeting on a regular basis in order to discuss challenges and help one another. Furthermore, in 2014, an 'energy-savings championship' was implemented, which is basically a competition between its branches/ buildings for achieving the highest energy savings.

- **Implementation of measures that will upgrade energy efficiency of existing infrastructure:** In the last two years, 15 branches/ buildings have been converted into 'energy-friendly shops', or 'Green Offices', as the bank calls them. The measures applied in these stores are insulation on the roof, installation of thermal-insulating glazing, installation of highly energy-efficient air-conditioners and LED lighting. These measures have brought a reduction of energy consumption of 50 to 60% in these shops. The technical services department of the bank is continuously expanding the implementation of similar measures to more buildings, as well as considering other measures that will increase energy efficiency even more. All measures are examined in the framework of cost effectiveness and in upgrading the energy class on the EPC.
- **Staff awareness:** The management communicates with all the staff in matters of energy efficiency either directly or through the people responsible for every building. Additionally, regional meetings are organised for informing the staff and to exchange views with other colleagues. Also, the technical services department visits the buildings to discuss with the staff their experiences, potential problems and how these can be overcome. The bank, again, as a matter of increasing staff awareness, has taken initiatives for certification with external bodies of its buildings and its energy management practices.

Companies and organisations engaged in similar activities and/or similar buildings could reduce their energy consumption by similar approaches. The chances of succeeding are higher when the management of the organisation is determined in slashing energy costs and when upgrading energy efficiency is an integrated part of its economic and corporate responsibility strategy.

4. Conclusions, future plans

During the last decade, the energy-efficiency measures implemented in buildings have improved in quantity and quality. In new buildings, the implementation of minimum energy performance requirements is estimated to reduce consumption by at least 50% compared with the same building built prior to the EPBD. The gradual tightening of minimum requirements based on the calculation of cost-optimal levels will eventually lead to NZEBs. The MECIT estimates that it is technically feasible to achieve new buildings that will halve energy consumption for the average building built in line with the current performance.

The other challenge lies with the existing building stock that was built before the implementation of the EPBD, and therefore has a big energy-savings potential. Although some improvement has been done in existing buildings due to firstly financial incentives and secondly regulatory measures, the full potential is far from being materialised. In order to accelerate renovations, the MECIT has commenced the scheme 'Save – Upgrade' which is focused on existing buildings of all kinds, and it is designed to promote the most cost-effective measures by employing EPC and its recommendations, inspections and energy auditing. The scheme requires participants to issue an EPC and recommendations. The recommendations must direct households and businesses to reach energy class B or achieve at least 40% in energy savings at their buildings. The scheme will subsidise thermal insulation of the building's envelope, energy-efficient windows, external shading, highly energy-efficient technical systems, metering and automatic controls, and RES for heating and cooling. For buildings with a useful area larger than 1,000 m^2, energy auditing is required, in addition to the EPC. The scheme also offers the option to renovate further and reach the NZEB national definition and receive more funding.

The energy efficiency of buildings is backed by the implementation of Directive 2012/27/EU on energy efficiency. Cyprus put in place the legislative framework for energy auditors in 2013, and for ESCOs and energy performance contracting in 2014, and already there are energy auditors and ESCOs available in the market. These developments are complementary to the existing experts and mechanisms such as EPCs and inspections, and are increasing the confidence of building owners and other stakeholders interested in investing in energy efficiency.

Implementation of the EPBD in the Czech Republic

STATUS IN DECEMBER **2014**

1. Introduction

The Energy Performance of Buildings Directive (Directive 2010/31/EU - EPBD) has been fully implemented in the Czech Republic. The implementation at national level is the responsibility of the Ministry of Industry and Trade. The EPBD has been transposed through the Energy Management Act No. 406/2000 Coll with the last amendment coming into force in April 2013. The main change in the amended Act relates to the methodology of the calculation of the Energy Performance Certificate (EPC), whereby the energy performance expressed by the total calculated (asset rating) annual delivered energy consumption has been replaced by a reference building approach.

This amendment also covered gaps in legislation, e.g., it introduced an obligation to present the EPC or to show the energy performance indicators in advertisements for sale or rental of buildings. All accompanying decrees relating to the methodology/calculation of the EPC and the appearance of the new label have been in place since April 2013.

Building energy efficiency is discussed particularly in connection with the efforts to reduce energy requirements for buildings, increased requirements on the quality of the indoor environment and in connection with requirements on efficient building energy management.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Legislation governing energy efficiency is moving forward rapidly. During 2012, the Ministry of Industry and Trade, together with advisory groups established at the Czech Technical University and the Chamber of Commerce, worked on the implementation of the Directive 2010/31/EU requirements, as well as on the improvement of the calculation methodology. Then, at the end of 2012, the Energy Management Act was amended and harmonised with the EPBD requirements coming into force in January 2013 and introducing a number of changes. The points discussed the most are the requirements towards Nearly Zero-Energy Buildings (NZEB) and EPCs of buildings.

Moreover, the Energy Efficiency Directive (2012/27/EU - EED), which aims to reduce primary energy consumption by 20% by 2020, and the Ecodesign Directive (2009/125/EC), have also been transposed into national law.

In the Czech Republic the following general regulatory barriers to energy efficiency in the building sector had to be adressed in order to achieve full implementation of the EPBD:

AUTHORS

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Jan Pejter, ***ENVIROS, s.r.o.***

Karel Kabele, Jan Tywoniak, ***Czech Technical University***

> insufficient regulation and implementation of the EPBD, e.g., secondary legislation for Air-Conditioning (AC) inspection was not ready when the Energy Management Act required inspections of AC systems; similarly, building certification was not mandatory for existing buildings when rented of sold;
> ineffective incentives and insufficient subsidies: existing subsidy programmes opened again in 2015 to improve energy efficiency of residential and public buildings.

The amendments for the corresponding legislation to transpose Directive 2010/31/EU were prepared by several working groups. Their work was based on the knowledge and conclusions derived from several years of experience with Directive 2002/91/EC.

I.ii. Format of national transposition and implementation of existing regulations

The implementation of Directive 2010/31/EU in the Czech legislation changed the methodology of building evaluation from a measured rating to an energy performance calculation (asset rating). The new methodology compares the evaluated building with a reference building. The calculated energy performance value is a function of parameters describing the thermal and technological characteristics of the building structure and the efficiency of building systems with respect to the operation of the building under certain climatic conditions.

In April 2013, the new Decree 78/2013 on Energy Performance of Buildings came into force, replacing the previous Decree 148/2007. The new Decree defines cost-optimal levels of energy performance requirements for buildings and the method of calculating the energy performance. It also states how to assess the feasibility of Renewable Energy Sources (RES) both from the economic, and the ecological point of view. Compared to the previous Decree, there is a greater emphasis on reduction of the primary energy consumption.

In the Decree 78/2013 on Energy Performance of Buildings, the energy performance is defined by energy demand indicators which include:

> total primary energy per year;
> non-renewable primary energy per year;
> delivered energy (for a new building and renovation of an existing building);
> U-value of a whole building envelope (for a new building and renovation of an existing building);
> U-value of each element (only for changed elements);
> efficiency of technical systems (only for replaced technical systems).

Delivered energy is the sum of the calculated energy consumption and auxiliary energy. The calculation of the total delivered energy and the energy delivered for different needs is performed for each zone by a calculation method at intervals no longer than one month. The total delivered energy consists of energy consumptions for heating, cooling, ventilation, humidity adjustment, hot water and lighting.

The total primary energy and the non-renewable primary energy for the assessed building are calculated as the sum of energy consumptions according to the energy carrier, multiplied by the primary energy factor/non-renewable primary energy factor (Table 1).

The average U-value is calculated as the weighted average of standard required

Table 1: Primary energy factors.

Energy carrier	Total primary energy factor	Primary non-renewable energy factor
Natural gas	1.1	1.1
Black coal	1.1	1.1
Brown coal	1.1	1.1
Propan-butan/LPG	1.2	1.2
Fuel oil	1.2	1.2
Electricity	3.2	3.0
Wooden pellets	1.2	0.2
Lump wood	1.1	0.1
RES (electricity and heat) from nearby sources (wind, solar, heat pumps, etc.)	1.0	0.0
Electricity - supply outside the building	-3.2	-3.0
Heat - supply outside the building	-1.1	-1.0
District heating with 80% and more share of RES	1.1	0.1
District heating with 50% and more up to 80% share of RES	1.1	0.3
District heating with 50% and less share of RES	1.1	1.0
Other energy carriers	1.2	1.2

Description of the building component	construction type	required U-values	recommended U-values
Flat and pitched roof pitch up to 45° included Floor above external space	light	0.24	0.16
Ceiling bellow the unheated attic with the roof without thermal insulation Floor and wall with heating	heavy		
External wall	light	0.3	0.2
Steep roof with the roof pitched exceeding 45°	heavy		
Floor and wall in contact with the soil* Ceiling and internal wall from a heated to an unheated space		0.6	0.4
Ceiling and internal wall from a heated to a partially unheated space		0.75	0.5
Windows and other 'opening fillers' in the envelope of the heated space, including the respective frame**		1.8	1.2
Door, gates and other fillers from partially heated space to unheated space of the heated building		3.5	2.3

* ČSN 73 0540: These values apply to walls in contact with the soil bellow a depth of 1 m from the surface, as well as to floors in contact with the soil. The insulation is to be placed on the outer surface of the structure. Above that level, the required U-value for walls in contact with the soil is the same as for the walls above the soil.

** ČSN 73 0540: Windows, skylights, doors, roof hatches and other glazed elements, as well as lightweight cladding, are collectively referred to as 'frames' and their maximum allowed U-value is 2.0 W/m^2.K.

Table 2: U-values (W/m^2.k) set in the standard ČSN 73 0540.

heat transfer coefficients (individual U-values) of all heat transfer surfaces of the building envelope. Required U-values of building constructions are defined in the norm ČSN 73 0540 (Table 2).

The main regulations are:

> the Energy Management Act no. 406/2000 Coll;
> Decree 78/2013 on Energy Performance of Buildings;
> Decree 193/2013 on the control of air-conditioning systems;
> Decree 194/2013 on the control of boilers and heat distribution networks;
> the Czech standard ČSN 73 0540-2/Z1:2011 and other standards or Technical Standardising Information.

The Energy Performance Building Classes are defined in Decree 78/2013 (Table 3).

Thermal bridges are not analysed to a great extent in the national regulations for new buildings, and even less so for the renovation of existing buildings. In the case of renovations, a simplified approach is taken, e.g., default values for including the increased thermal losses due to thermal bridges. Certain studies have assessed whether the impact of thermal bridges can be ignored, or substituted by default values; one such study is the 'Influence of thermal bridge details on the energy performance of houses with different energy quality', analysing the growing impact of thermal bridges on the improved energy level of houses.

In order to evaluate the energy performance of an existing or a planned building using the method of comparison with the reference building, it is necessary to define the building using a set of parameters. Reference parameters are divided into two groups. The first contains reference parameters of building construction; the other contains reference parameters of Heating Ventilation and Air-Conditioning systems (HVAC), lighting and hot water supply.

The reference building is a building of the same type, size and geometric shape, (which includes glass surfaces and shielding from surrounding buildings and natural obstacles), as well as the same internal structure, with the same type of typical use and climatic data as the assessed building, but with the reference value of the building construction and Technical Building Systems (TBS) (Tables 4 and 5). The reference building as stated in Decree 78/2013 is determined in accordance with the methodology of the EC and is compulsory.

Table 3: The energy performance of buildings' classes as defined in Decree 78/2013.

The energy class	The value for the upper limit of the energy class		Verbal expression of the energy class
	Energy	U_{em}	
A	0.5 E_R*	0.65 $_R$	Extremely efficient
B	0.75 E_R	0.8 E_R	Very efficient
C	E_R		Efficient
D	1.5 E_R		Less efficient
E	2 E_R		Wasteful
F	2.5 E_R		Very wasteful
G			Extremely wasteful

* E_R is the energy indicator (calculated for the reference and assessed building - total delivered energy) which is required for the assessed building. Energy indicators for comparison are categorised into energy classes defined by their upper limit according to Table 1.

Heating			
Heat generation efficiency factor	$\eta_{H,gen,R}$	%	80
Heat distribution efficiency factor	$\eta_{H,dis,R}$	%	85
Emission efficiency factor	$\eta_{H,em,R}$	%	80
Cooling			
Energy efficiency ratio	$EER_{C,gen,R}$	W/W	2.7
Energy efficiency ratio of other cooling sources	$EER_{C,gen,R}$	W/W	0.5
Efficiency distribution factor for cooling	$\eta_{C,dis,R}$	%	85
Emission efficiency factor for cooling	$\eta_{C,em,R}$	%	85
Delivered energy for family and apartment houses (or zones with this operation)	$Q_{fuel,C}$	kWh	0
Ventilation			
Specific fan power of forced ventilation	$P_{SFPahu,R}$	W.s/m³	1,750
Efficiency of forced ventilation heat recovery with volume flow of ventilating air to 7,500 m³/h	$\eta_{H,hr,R}$	%	60
Efficiency of forced ventilation heat recovery with volume flow of ventilating air over 7,500 m³/h	$\eta_{H,hr,R}$	%	40
Humidity adjustment			
Humidification system efficiency	$\eta_{RH+,gen,R}$	%	70
Dehumidification system efficiency	$\eta_{RH-,gen,R}$	%	65
Efficiency of forced ventilation humidification recovery	$\eta_{RH,r,R}$	%	0
Hot water preparation			
Heat source efficiency	$\eta_{W,gen,R}$	%	85
Specific heat loss of hot water container; container up to total volume 400 l	$Q_{W,st,R}$	Wh/l.day	7
Specific heat loss of hot water container; container over total volume 400 l	$Q_{W,st,R}$	Wh/l.day	5
Specific heat loss of hot water distribution system based upon the length of distribution system	$Q_{W,dis,R}$	Wh/m.day	150
Lighting			
Lighting average specific wattage for family and apartment houses and relative to the zone illumination	$P_{L,lx,R}$	W/m².lx	0.05
Lighting average specific wattage for other building relative to the zone illumination	$P_{L,lx,R}$	W/m².lx	0.1
Light dependency factor	$F_{D,R}$	(-)	1

Table 4: Reference parameters of heating and cooling systems.

Parameter	Quantity symbol	Unit	Reference value		
			Existing building and its change	New building	NZEB
Required reduction factor for basic average U-value	f_R	-	1.0	0.8	0.7
One zone building average U-value or particular zone of multi-zone building	$U_{em,R}$	W/m².K	*		
Average U-value of multi-zone building	$U_{em,R}$	W/m².K	$U_{em,R} = \frac{\sum(U_{em,R,j}.V_j)}{\sum V_j}$		
Surcharge on the effect of thermal bonds	$\Delta U_{em,R}$	W/m².K	0.02		
Internal heat capacity	C_R	kJ/m².K	165		
Total solar energy transmittance (solar factor)	g_R	-	0.5		
Shading factor for active shading devices (solar protection)	$F_{sh,R}$	-	0.2		
Electricity produced	$Q_{el,R}$	kWh	0		
Solar, wind and geothermal energy used	$Q_{env,R}$	kWh	0		

*$U_{em,R}$ = $U_{em,N,20,R}$ for θ_{im} 18-22 °C included, except NZEB buildings where 18 °C is also included; $U_{em,R}$ = $U_{em,N,20,R}$. 16/(θ_{im} - 4), for other θ_{im}

Table 5: Parameters of the reference building.

The calculation method is based on delivered energy needed under standard indoor and outdoor conditions. The total delivered energy across the building envelope is the amount of energy actually consumed, or the expected amount of energy to be consumed for the fulfilment of various needs related to the standard use of a building.

Delivered energy is the energy expressed per energy carrier, supplied to a TBS through the system boundary, to satisfy the different needs (heating, cooling, ventilation, Domestic Hot Water (DHW), lighting, appliances, etc.), or to produce electricity. This relates in particular to heating, hot water generation, cooling, lighting, treatment of air by ventilation, and parameters for modification of the indoor environment by the AC system.

The aim of the calculation procedure is to calculate the total annual delivered energy across the building envelope, including heating, cooling, ventilation, auxiliary and other energy required for the functional needs of the building. Then the building is compared with the reference building and classified into the energy performance classes from A to G. For new buildings or for major renovation of existing buildings, the assessed building or renovation must reach class A to C, or else the building permit is not issued.

I.iii. Cost-optimal procedure for setting energy performance requirements

Cost-optimal level requirements were calculated and incorporated in national standards by studying the calculated energy performance of a sample consisting of different building types with defined parameters and best practice rules. The results of the cost-optimal procedure are set in Decree 78/2013 as definition of the reference building parameters - U-value, efficiency of technical systems.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

A Nearly Zero-Energy Building (NZEB) is defined in the Energy Management Act 406/2000 as a building with very low energy performance whose energy consumption is to a very significant extent covered by RES. The definition compares the evaluated building with a reference building of the same type, size, geometrics, orientation, etc., but with pre-defined construction and technological specifications.

The following energy indicators are considered:

a) average U-value of the building envelope;
b) delivered energy (without taking into account on-site renewables);
c) non-renewable primary energy.

The Czech legislation requires that all new buildings must fulfil the cost-optimal level and be NZEBs after 2020. Therefore, the Decree 78/2013 gradually decreases the energy performance indicator - non-renewable primary energy - for the reference building (Table 6). The assessed building must meet this stricter requirement either by increasing the share of renewable energy, or by improving the building envelope. The NZEB must then meet the decreased non-renewable 2014 value requirement by 25% for family houses, 20% for apartment houses, and 10% for other buildings.

There are only two steps in the requirements incorporated in the legislation: the cost-optimal level requirements which came into force on 1 April 2013 for energy performance of buildings, and the gradual tightening of requirements towards NZEB depending on the size and type of the building, which will be coming into force between 1 January 2016 and 1 January 2020.

Parameter	Marking	Units	Sort of building or zone	Reference value		
				Finished building and its change since 01/01/2015	New building since 01/01/2015	NZEB
Reduction of non-renewable primary energy sets for the reference building	$\Delta e_{p,R}$	%	Family house	3	10	25
			Apartment house	3	10	20
		%	Other buildings	3	8	10

Table 6: Reduction of non-renewable primary energy needs relating to the 2014 reference building (Decree 78/2013) for NZEB standard.

Specifically, to ensure that all new buildings completed by 31 December 2020 will be NZEBs, the legislation sets out the following requirements in relation to the energy reference area (roughly equals the total outer floor area):

> buildings of 1,500 m^2 or greater must be NZEB when submitting an application for construction permit on 1 January 2018 or later;
> buildings of 350 m^2 or greater must be NZEB when submitting an application for construction permit on 1 January 2019 or later;
> smaller buildings (less than 350 m^2) must be NZEB when submitting an application for construction permit on 1 January 2020 or later.

Requirements for public buildings are identical, but are set 2 years earlier than for other buildings - 2016, 2017, 2018.

Figures and statistics on existing NZEBs

Statistics about existing NZEBs are not available yet, as the national definition of NZEB was given by Decree 78/2013 with the obligatory compliance starting from 2017. This means that the majority of new buildings are built to fulfil current requirements, i.e., to achieve an energy certificate of at least class C. Under the existing, widely used scheme based on Passive House standard (which can be considered one way to achieve NZEB), most of the advanced energy efficient buildings built recently were declared as passive or active houses. In 2012 the Czech Republic recorded about 100 houses meeting the Passive House standard, and within the Green Investment Scheme (a national support scheme) approximately 500 applications for passive houses are pending (these houses have not been built yet). In Prague, 296 apartments which reach the passive standard are offered for rent. Since 2012 the number of passive houses has doubled each year. An example of a NZEB in the Czech Republic is shown in Table 7 and Figure 1.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Article 4 of the Energy Efficiency Directive (EED) requires Member States (MSs) to establish a long-term strategy for mobilising investments in the renovation of the national stock of residential and commercial buildings, both public and private. The Czech Republic prepared this strategy as part of the National Action Plan for Energy Efficiency, and within it five scenarios for building stock renovation were identified. These scenarios were created for bringing building renovation to the recommended passive standard with the necessary investments calculated. These scenarios are:

1. basic without new political measures (business as usual);
2. fast but shallow building renovation;
3. slow building renovation but thorough on energy performance;
4. fast building renovation but thorough on energy performance;
5. hypothetical ideal case.

The scenarios were developed using a model of the Buildings Performance Institute Europe (BPIE). They include a certain amount of measures, such as political measures (results are taken into account in preparation of the State Energy Concept), financial measures (such as using national and structural funds for building renovation), legislative and administrative measures, etc.

Article 5 of the EED requires MSs to ensure gradual renovation of buildings owned and used by the central

Table 7: Specifications of example of NZEB in the Czech Republic located in the Ostrava region.

Specific heat demand for heating according to Passive House standard (PHPP)	11.5 kWh/m^2.year
Energy Category	≤ 15 kWh/m^2.year - Passive house
Total primary energy according to PHPP	111 kWh/m^2.year
Overall airtightness n_{50}	0.17 h^{-1}, measured
Specific heat consumption according to PHPP	15 W/m^2
Type of building	Administrative/Offices
State	Completed
Type of construction	New building
Construction	Brick walls
Purpose of the building	Education
Built-up area	385.6 m^2

Figure 1: Example of NZEB in the Czech Republic located in the Ostrava region.

government (while also setting an example in the country). MSs are obliged to provide an annual renovation of at least 3% of the corresponding floor area between 2014 and 2020.

The obligation arising from Article 5 of the EED in the Czech Republic covers 41 institutions and 919 buildings above 250 m^2 of conditioned floor area. The total floor area of these buildings is 2,735,000 m^2.

Nearly 45% of the total floor area of these buildings does not fulfil the 2014 energy performance requirements. The standard method for these buildings would be a renovation of 3% of the floor area annually. However, the Czech Republic has chosen an alternative approach: the total floor area for renovation was recalculated to the equivalent amount of energy saving. This calculated equivalent of accumulated energy saving is 206, 500 MWh for 2014 – 2020 and it must be accomplished within the reference period.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The Decree 78/2013 on the Energy Performance of Buildings includes requirements on the efficiency of new and upgraded TBS (Table 4).

The basic principle of energy performance evaluation consists in calculating indicators of energy performance and subsequently classifying the evaluated building into the relevant energy performance class under Appendix B to the national standard ČSN EN 15217 (Table 8). The limits of the individual classes are determined based on the reference indicator E_R, which is the reference value of the required energy performance indicator, corresponding to the required value specified in the amendment to the Regulation. The energy performance class for the above energy performance indicators are determined based on the rules specified in Table 3.

II.ii. Regulation of system performance, distinct from product or whole building performance

Each energy system is described by its efficiency and it covers the efficiency of the energy source, the storage, the distribution and the emission. Regulation of the system includes efficiency of the source and the emission, calculated according to EN 15316. Typical values for frequently used systems (Table 4 for new buildings and Table 8 for existing buildings) are published in Technical Standardising Information TNI730331 and may be used on a voluntary basis.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

While the value of thermal and technological characteristics of construction elements for evaluated buildings is commonly used in the construction field in the Czech Republic, typical efficiency values for individual technological systems are rarely used. At present, there is no literature or standard that tackles the topic as a whole. Specific individual parameters are listed in a range of standards containing relatively difficult calculation methods which are not generally used in practice.

A similar situation can be seen in the case of determining building-usage profiles and climatic data. Although these aspects do not directly influence classification using the reference building method (evaluated building and reference building are ‘burdened’ by the same inner and outer marginal conditions), such marginal conditions could substantially influence the absolute value of energy performance. These parameters are not systematically tackled and they are dispersed in various technological standards and legal regulations.

This inspired the development of Technical Standardising Information, a non-binding normative tool containing commensurate values of typical parameters used in the calculation of energy performance of buildings, shown in Tables 4 and 8. It contains information on collecting source data for calculation and evaluation of energy performance of buildings for the needs of legislation valid from 2013.

Table 8: Reference parameters and values for changed TBS.

Parameter	Quantity symbol	Unit	Reference value
Generation efficiency for heating and/or hot water preparation	$\eta_{H,gen,R}$	%	80
Energy efficiency ratio	$EER_{C,gen,R}$	W/W	2.7
Energy efficiency ratio of other cooling sources	$EER_{C,gen,R}$	W/W	0.5
Coefficient of performance of heat pump	$COP_{H,gen,R}$	W/W	3.0
Efficiency of forced ventilation heat recovery	$\eta_{H,hr,sys}$	%	60

II.iv. Provisions for installation, dimensioning, adjustment and control

There are no existing required provisions for installation, dimensioning, adjustment and control, nor for intelligent metering.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The obligation to obtain and hand the EPC over to the client when selling or renting a building or part of the building came into force with the amendment of the Energy Management Act in 2013. This obligation binds the building owner. The EPC can be issued only by a so-called 'Energy Specialist', who is an expert authorised by the Ministry of Industry and Trade. The Energy Specialist is obliged to register all issued EPCs in ENEX, the electronic database maintained by the Ministry.

How flats are certified in apartment buildings

The issued EPC for an apartment building serves as an EPC for each apartment unit within the building. In case of sale or rental of an apartment unit, the Apartment Owners Association must provide the EPC to the apartment unit owner. If the Apartment Owners Association of the apartment building refuses to provide the EPC, the apartment unit owner can process the EPC for the apartment unit separately. Alternatively, the EPC can be replaced by invoices for gas, electricity and heating for a three-year period in order to fulfil the legislative obligation (nevertheless the Apartment Owners Association still has the obligation to provide the EPC and can be fined if it does not do so). This option can be used only as a 'last resort'. When the EPC for rented or sold apartments became mandatory in January 2014, the EPC requirement for existing residential and office buildings was phased-in over a four-year period depending on the floor area of the building as illustrated below:

- buildings above 1,500 m^2 by January 2015;
- buildings above 1,000 m^2 by January 2017;
- buildings below 1,000 m^2 by January 2019.

Format and content of the EPC

The graphic design and the protocol for filling in the EPC are defined in appendix IV of Decree 78/2012 Coll and this EPC template is valid for all types of buildings.

The graphic part of the EPC (Figure 2) shows the type of the building and its address, and the energy class of the building, calculated as described in section I in the form of total delivered energy indicator and primary non-renewable energy indicator. The graphic part also includes an illustration of each energy

Figure 2: Image of the EPC cover page.

carrier's share in the delivered energy, the Energy Specialist's recommendations for energy saving measures, and specific energy performance indicators of the building (e.g., envelope, heating, cooling, ventilation, humidification, DHW and lighting).

The EPC, independently of the purpose of its issue, is valid for ten years.

EPC activity levels

By the end of 2014, the total number of issued EPCs registered in the ENEX database is 72,112. Unfortunately, ENEX does not classify EPCs according to the different types of buildings. To solve this and other limitations, the ENEX database is undergoing a major update.

Typical EPC costs

The price for issuing an EPC is not regulated and is calculated by the Energy Specialist depending on the type of the building, the time used, the availability of the technical documentation, the purpose of issuing the EPC, etc.

The price of the EPC can typically start at 120 € - 150 € for an apartment in an apartment building or for a single-family house, and may go up to 2,000 € - 3,000 € for hospitals or large apartment buildings.

Assessor corps

As stated above, the EPC can be issued only by an Energy Specialist who is registered with the Ministry of Industry and Trade. To achieve such registration, certain quality criteria must be fulfilled. The Energy Specialist can be any person with background in technical science (minimum secondary school education) in the field of energy or construction and appropriate work experience, who has passed a written and oral examination. Applicants may attend preparatory courses which however are not mandatory. In case of failure in the examination, the applicant can apply for a new examination after a one year period.

Every three years, the Energy Specialist is requested to undergo further education which is concluded by passing a written examination, in order to consolidate, deepen and update professional knowledge. The examination is conducted by technical universities.

In case of a wrongly calculated EPC or failure in the further examination, the Ministry of Industry and Trade may request the re-examination of the Specialist. If the Specialist fails at the re-examination, he is no longer permitted to perform this activity.

The Energy Specialists must have an independent role in the certification process. Specifically, issuing an EPC may not be performed by a person who:

> holds a share in the company or the cooperation that ordered the EPC;
> is a stakeholder in or a member of the cooperation that ordered the EPC, or is a statutory body or a member of the statutory body of the entity that ordered the EPC, or is employed by or has similar relationship to the corporation that ordered the EPC;
> is close to natural or legal persons who, due to their position, might be in a position to influence him.

At the end of 2014, the Czech Republic had 1,356 registered Energy Specialists allowed to issue EPCs.

Compliance levels by sector

The State Energy Inspectorate controls whether or not the EPC was given to the buyer at the time of sale and can impose a fine to the owner in case he does not supply the buyer with the certificate.

Enforcement with building owners and real estate actors

In case of sale or rental of a building or an apartment unit, the owner is required to hand over the original or verified copy of the EPC to the buyer or tenant before signature of the sale/rental contract. Fulfilment of this obligation is controlled by the State Energy Inspectorate which can impose a fine in case of non-compliance. If an EPC is processed incorrectly, the State Energy Inspectorate as well as the Ministry of Industry and Trade can require that the expert requests re-examination if there is a suspicion of possible lack of competence. The State Energy Inspectorate has made 237 controls and imposed 82 fines.

Quality Assurance (QA) of EPCs

The control for the fulfilment of the obligations set by the Energy Management Act concerning the EPC is the responsibility of the State Energy Inspectorate. The State Energy Inspectorate carries out random inspections, as well as inspections based on complaints. The maximum penalty for a poorly calculated EPC by the Energy Specialist is 185,000 €. The State Energy Inspectorate can impose a penalty of up to 7,500 € to a legal person, and up to 1,800€ to a natural person, for not submitting and supplying the EPC when selling or renting a building or an apartment unit.

Before a building is constructed or a major renovation takes place, the builder must submit the EPC to the State Energy Inspectorate for assessment on whether the energy performance obligation is fulfilled. The State Energy Inspectorate inspected 3,774 EPCs and found that 30% of them had to be recalculated.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The Czech Republic runs a database called the Central Register of Administrative Buildings. This register keeps records of 5,000 buildings that are property of the State.

The Energy Management Act sets in §7a an obligation for public authorities and owners of buildings with a total floor area over 500 m^2 occupied by public authorities to have issued the EPC by 1 July 2013, and for buildings with total floor area over 250 m^2 by 1 July 2015. The EPC has the same format as that for non-public buildings, and must be displayed at a prominent place where it is clearly visible to the public.

The EPC must be recalculated as soon as it expires (10 years), or in case of major renovation of the building.

III.iii. Implementation of mandatory advertising requirement

When a building or an apartment is offered for sale or rent, the energy performance indicator from the EPC should be included in the advertisements in commercial media. The obligation to present the energy performance indicator in advertisements started on 1 January 2013. Penalties can be imposed for failing to comply with this requirement: for natural persons, the fine goes up to 3,700 €, and for legal persons up to 7,400 €. By the end of 2014, no penalties had been imposed.

The Ministry of Industry and Trade has prepared an amendment to the Energy Management Act regarding the obligation to display the energy performance indicator of buildings for rent/sale (when) using estate agencies. In many cases in the past, these indicators were not displayed because there were no penalties involved for estate agencies. The amendment, in force from 1 July 2015, ensures that the obligation will be fulfilled.

III.iv. Information campaigns

In the Czech Republic there has been no official state campaign supporting the EPBD implementation. Some energy consultancy companies, technical equipment manufacturers (of pumps, space heating and cooling control systems) and professional associations are running information campaigns, mostly in collaboration with the local municipalities. The Ministry of Industry and Trade established a network of Energy Consulting and Information Centers scattered all over the Czech Republic, providing consultations in the field of energy efficiency, energy saving, insulation, boiler installations, RES installation, etc. The Energy Consulting and Information Centers are funded annually from the EFEKT programme (the EFEKT programme is created and funded by the Energy Management Act since 2000) and for 2014 they were given a budget of 264,000 € in 60 different locations within the Czech Republic. These centers are accessible to the public, the consultation is free of charge and it is held with experts (mostly energy auditors or certified engineers, architects, boiler and AC inspectors, etc.).

In 2013, the EFEKT programme also supported publications and seminars dealing with the energy efficiency in buildings (Figure 3), the EPC presentation method, savings in lightning systems (Figure 4), passive building reconstructions (Figure 5), a product database for energy efficient buildings and many others. Publications are available free of charge on the EFEKT programme website.

In 2013, the EFEKT programme also supported a website called ‘EPC for house’ which contains all the information regarding EPC obligations for owners, tenants or buyers. On this website, a simplified computing application to validate the quality of a processed EPC can also be found. This application allows basic control of the EPC issued for houses or apartment buildings.

III.v. Coverage of the national building stock

According to the 2011 census data, the most recent data available, the building stock of the Czech Republic consists of 2,366,613 buildings in total. The majority is composed of family houses (1,554,794; 66%) and the minority of apartment buildings (211,252; 9%) and other buildings (600,567; 25%) (Table 9). By the end of 2014, 3% of the national building stock was already certified.

Figure 3: Cover of the publication 'EPC for apartment buildings'.

Figure 4: Cover of the publication 'Ecodesing and Labelling of Light Sources and Luminaries focused on Directional Light Sources'.

Figure 5: Cover of the publication 'Passive Houses 2013'.

	Construction period							
Number of floors	**Total**	**1919 and earlier**	**1920-1945**	**1946-1960**	**1961-1980**	**1981-2000**	**2001-2011**	**not identified**
	211,252	**26,077**	**27,775**	**30,573**	**71,429**	**38,042**	**12,674**	**4,682**
1 floor	3,910	1,199	612	473	556	526	488	56
2 floors	37,708	7,939	5,700	6,867	9,734	4,892	2,350	226
3 floors	49,888	7,714	8,909	11,226	12,154	6,209	3,420	256
4 floors	48,000	4,777	5,360	7,313	19,079	8,154	3,084	233
5 floors	23,354	3,175	3,905	2,916	8,573	3,203	1,452	130
6 floors	10,192	598	1,351	827	4,100	2,570	712	34
7 floors	5,716	138	838	272	2,780	1,337	330	21
8 floors	15,259	32	160	81	7,394	7,163	390	39
9 floors	3,216	0	16	12	1,852	1,226	101	9
10 floors	700	0	1	8	504	155	32	0
11 and more floors	3,660	0	15	21	2,397	1,134	88	5
Not identified	9,649	505	908	557	2,306	1,473	227	3,673

Table 9: The total number of apartment buildings in each category.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Within the amendment of the Energy Management Act in 2012, the Czech Republic transposed Articles 14 and 15 of the EPBD with the implementation of regular inspections of heating systems (consisting of 'boiler and heat distribution and control system') and AC systems, except for residential buildings where advice is given instead. The regular inspections were already adopted in 2007, but some new requirements (e.g., presenting the inspection report to the ministry within 30 days, or advice in the case of the residential sector) were added in 2012.

The EFEKT programme in 2013-2014 also supported publications and seminars dealing with the energy efficiency in residential buildings, particularly with advice and alternative measures for increasing the efficiency of heating and AC systems. Publications are available free of charge on the EFEKT programme website (e.g., publications on Figures 3, 4 and 5).

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

According to the Energy Management Act, all heating systems (with a boiler running on natural gas, liquid or solid fuels with a rated output power above 20 kW) must be subject to regular efficiency inspections in compliance with Decree 194/2013 on the control of boilers and hot water supply (formerly Decree 276/2007). This decree sets the scope, manner and frequency of the inspections of heating systems, as well as the form and content of the inspection reports.

Similarly to heating systems, the Energy Management Act requires AC systems with a rated cooling output greater than 12 kW to undergo regular efficiency inspections in compliance with Decree 193/2013 on the control of AC systems (formerly Decree 277/2007), resulting in a written report on the control of AC systems. The decree also sets out the methodology for the control. The inspection of the AC systems consists mainly of:

a) documentation assessment;
b) visual inspection and a check of the operability of the accessible AC units;
c) evaluation of maintenance of the AC system;
d) evaluation of the dimensioning of the AC system in comparison with the cooling requirements of the building;
e) evaluation of the efficiency of the AC system;
f) recommendations for financially feasible improvements of the AC current state.

Table 10: Frequency of heating system inspections.

Rated output	Type of fuel	The first inspection after commissioning	Next control	
			System is permanently monitored (years)	System is not permanently monitored (years)
20 - 100 kW	all types	10	10	10
> 100 kW	liquid and solid	2	10	2
	gaseous	4	10	4

Table 11: Frequency of AC system inspections.

Rated cooling output	First control after commissioning (years)	Next control	
		Under permanent monitoring (years)	Not under permanent monitoring (years)
≥ 12 kW to 100 kW	10	10	10
≥ 100 kW	4	10	4

Arrangements for assurance, registration and promotion of competent persons

The inspections of heating or AC systems can only be carried out by a registered Energy Specialist with authorisation and specialty on heating or AC system inspections. The qualifications of inspectors require the same education and experience as those of building experts.

The inspection report produced by the inspector should also be registered in the ENEX database. The list of heating and AC system inspectors is freely accessible by the owners from the website of the Ministry of Industry and Trade.

At the end of 2014, there were 275 heating system inspectors and 205 AC inspectors registered in the ENEX database.

Dimensioning and functioning of space heating systems are checked once, while the frequency of regular inspections for heating and AC systems are defined in Tables 10 and 11, respectively. The inspection of heating systems covers among others:

a) documentation assessment;
b) visual inspection and check of operation of the boiler and distribution of thermal energy, if available;
c) the state of boiler, maintenance assessment and distribution of thermal energy;
d) assessment of the boiler sizing, in relation to the needs for heating and hot water supply in case of boilers located in the fed building;
e) assessment of the boiler and the thermal energy distribution efficiency;
f) financially feasible recommendations for the current state of the boiler and thermal energy distribution improvements.

Promotional activities

A new website, operated by the Ministry of Industry and Trade and dealing among others with EPCs, heating and AC systems controls, is currently under construction. The website is expected to be available at the end of 2015.

For heating and AC systems which are not subject to controls (i.e., in houses, in line with Article 14 of the EPBD) the Energy Consulting and Information Centers provide free consultations. A person running a heating system in a household can visit an Energy Consulting and Information Center in the appropriate city and discuss problems, controls or recommendations with a competent person.

Relevant information can also be found on the internet portal TZB-info[1] which provides regularly updated information focused on controls, construction, energy conservation and related fields, collectively known as TBS, as well as energy management in buildings. The TZB-info website contains basic and static information on individually selected topics. The information is intended for the general public as well as for professional designers, installers and dealers.

Enforcement and penalties

In total, until 2014, the Czech Republic had 262 registered boiler inspectors and 199 AC system inspectors. In accordance with the Energy Management Act, if an inspection report is processed unfairly, improperly or incompletely, a fine of up to 185,000 € can be imposed. No fines have been imposed yet as the inspection usually starts by attempting to remedy the situation, which means to carry out the control. If there is no compliance, a fine follows.

Inspection activity figures

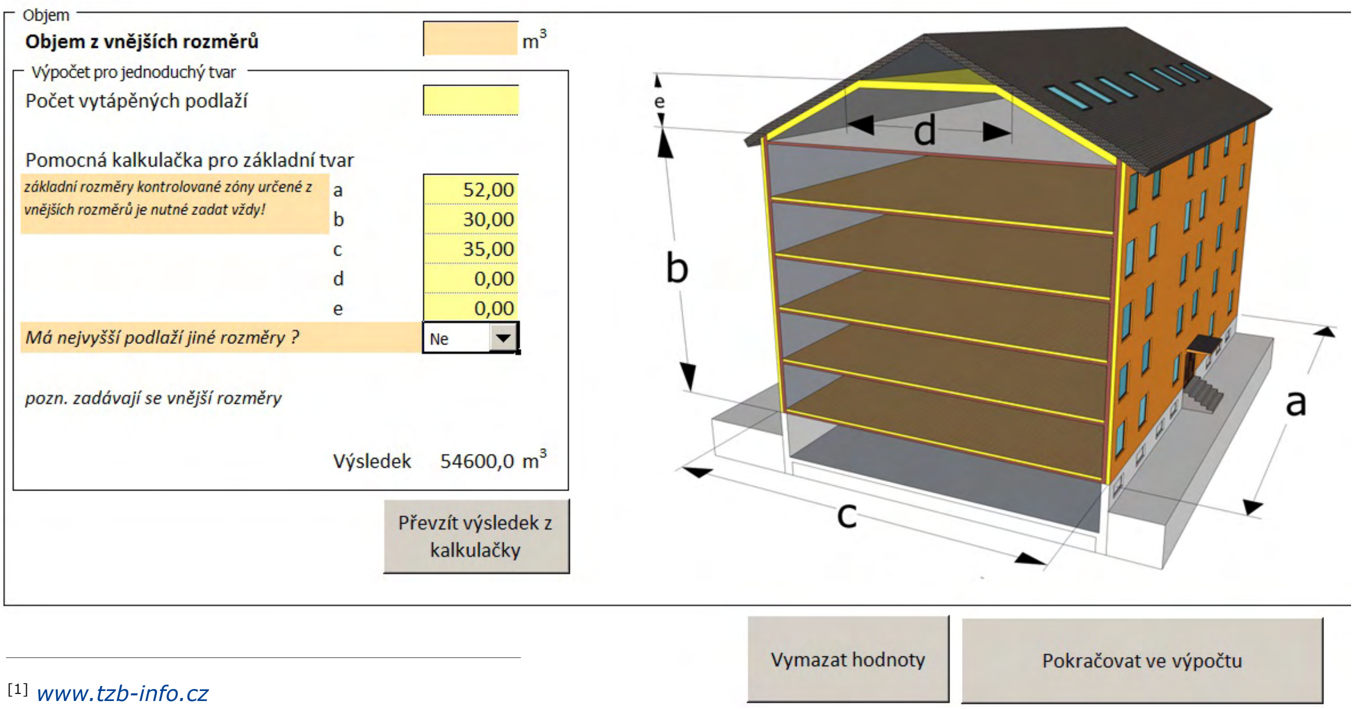
Within 2014 the State Energy Inspection checked 107 heating system inspections and 18 AC inspections. These checks fulfil the obligation for regular control of heating and AC system operators, as well as of the inspection report's quality.

3. A success story in EPBD implementation

Directive 2010/31/EU sets an obligation for building owners to obtain the EPC for a certain type of building or when renting or selling. The quality control of these certificates and the work of Energy Specialists fall under the authority of the State Energy Inspectorate. Due to the high number of EPCs issued per year it is not possible for the State Energy Inspectorate to control all processed certificates. A special tool for verification of the quality of issued EPCs was developed under the state subsidy programme EFEKT (Figure 6). The quality verification tool protects the clients of the Energy Specialists and is designed for all building owners, users or buyers. The EPC quality verification tool is intended for non-professional users and it allows verification of the EPC by a simple and clear calculation in case of suspicion of intentional manipulation.

The user of the verification tool enters the basic building's parameters (ideally acquired from the project documentation) and boundary condition values defined in the processed EPC. The boundary condition values are stated in the issued EPC protocol (results from the software in use). The tool compares the boundary condition values for the assessed building and zones, against the values defined in the publicly available specifications (TNI 73 0331) and displays the discrepancies in a well-structured graphic form. At the end, the verification tool

Figure 6: The EPC quality verification tool.



[1] www.tzb-info.cz

compares the building parameters used by the QE who issued the EPC with the building parameters typed in and calculated by the verification tool. Depending on the size of the deviations, the colour of the fields changes from green (minor discrepancy) to red (radical differentiation).

A simple and clear manual for proper verification has also been developed. The manual explains in a simple way the basic definitions (energy reference area, U-value, delivered energy, etc.), shows which values are to be completed for successful verification and where these values can be found in the original EPC. The result of the verification is a complete new EPC which verifies the correctness of the issued EPC, and whether or not the original was purposefully manipulated to achieve a higher energy class for the assessed building.

The verification tool is available in both a simple and a more sophisticated version, meeting the different needs of the users (quick or more detailed verification of the issued EPC). The tool is accessible free of charge[2]. The website serves as a guide for building owners obliged to process an EPC. It also explains the meaning of each part of the EPC, how to read the EPC itself, and where to find the relevant legislation and links.

In case the user discovers that the EPC was wrongly calculated, he can contact the State Energy Inspectorate which may then carry out a deeper verification, and depending on the outcomes may impose a penalty, or require corrections.

4. Conclusions, future plans

A new amendment of the Energy Management Act has been prepared. The main reason for the amendment is the implementation procedure of the Energy Efficiency Directive (2012/27/EU). The amendment also changes the State Energy Inspectorate's scope of responsibilities which will now focus only on energy performance controls (so far the State Energy Inspectorate is also controlling the Act No. 165/2012 on Promoted Energy Source and all obligations arising from this act). Due to this change, the number of controls will significantly rise. Additionally, the amendment sets the minimum amount of EPCs to be annually controlled, which is 1/20 of the EPCs issued in the previous year.

The obligation of presenting the energy performance indicator in advertisements will also be better defined in the amendment. In addition, a new obligation will be set for estate agents when selling or renting a building or an apartment unit: if they do not receive the energy performance indicator from the owner, the lowest energy class shall be displayed in the relevant advertising material.

The Ministry of Industry and Trade is currently preparing a campaign aiming to communicate the importance and meaning of the EPC, which is usually considered as an administrative burden by the public. The campaign, which is planned to be launched in 2015/2016, will include TV spots, present the EPC in printed media, and prepare a website providing the possibility for consultations.

[2] *www.prukaznadum.cz*

Implementation of the EPBD in Denmark

STATUS IN DECEMBER **2014**

1. Introduction

This report presents an overview of the current Danish implementation status of the Energy Performance in Buildings Directive (EPBD), as well as an overview of planned initiatives. The report addresses the energy performance requirements for buildings, including the outline of the national plan for Nearly Zero-Energy Buildings (NZEBs) and the conclusions of the Danish study on cost-optimality of the Danish energy requirements. An overview is also given on the Danish requirements on Technical Building Systems (TBS) and the report provides an update on the implementation of the Energy Performance Certificate (EPC) and the inspection requirements for heating and Air-Conditioning (AC) systems.

In Denmark, the main focus in 2013 and the first part of 2014 was on the development of a national strategy for the renovation of existing buildings, as required in the Energy Efficiency Directive (EED), Article 4, as well as in the National Energy Agreement approved by a broad coalition in the Danish Parliament in 2012. The strategy was developed on the basis of a collaborative network process involving key stakeholders within building renovation, collectively called the 'Danish Network for Energy Retrofit'. This comprehensive strategy was launched in May 2014 and consists of 21 initiatives to promote and improve the energy performance at renovation of buildings.

Initiatives in the strategy include an update of the energy requirements in the Danish Building Regulation, as well as ensuring a stronger compliance and a reinforcing of the EPC together with information initiatives.

The implementation process has already begun for a number of the 21 initiatives, including a revision process of the energy requirements for buildings, a new one-stop-shop for private house-owners called 'Bedre Bolig' (Better Home) and the introduction of a digital EPC.

In Denmark, the implementation of the EPBD is the responsibility of the Danish Energy Agency (DEA).

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2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

In their current form, energy performance requirements for new residential and non-residential buildings were implemented in the Danish Building Regulation in 2006, after the implementation of Directive 2002/91/EC. These requirements included indicative forecasts for the tightening of the energy performance requirements in 2010 and 2015 - each time by approximately 25% compared with the

NATIONAL WEBSITES
www.ens.dk, www.sbi.dk, www.bygningsreglementet.dk, www.sparenergi.dk, www.boligejer.dk

2006 requirements. In 2009 the requirements were revised, and in the Danish Building Regulation 2010 (BR2010 – Figure 1) the energy performance requirements for new buildings were tightened by 25%, as planned. In the 2010 revision no forecast for the 2020 energy performance requirements was included. However, the building industry requested this forecast, which led to a process of cost-analysis for establishing the different levels of energy performance requirements. The outcome formed the forecast for the energy performance requirements for new buildings in 2020, i.e., the Danish NZEB definition (Figure 2).

For existing buildings, the government has developed a comprehensive strategy for the energy upgrading of the building stock. The implementation of the initiatives started in 2014 including the analyses of the energy requirements for BR2015.

Figure 1: Danish Building Regulations 2010.

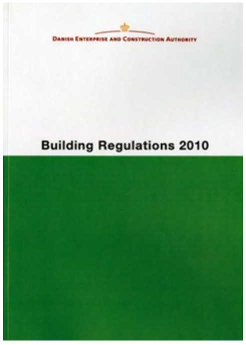
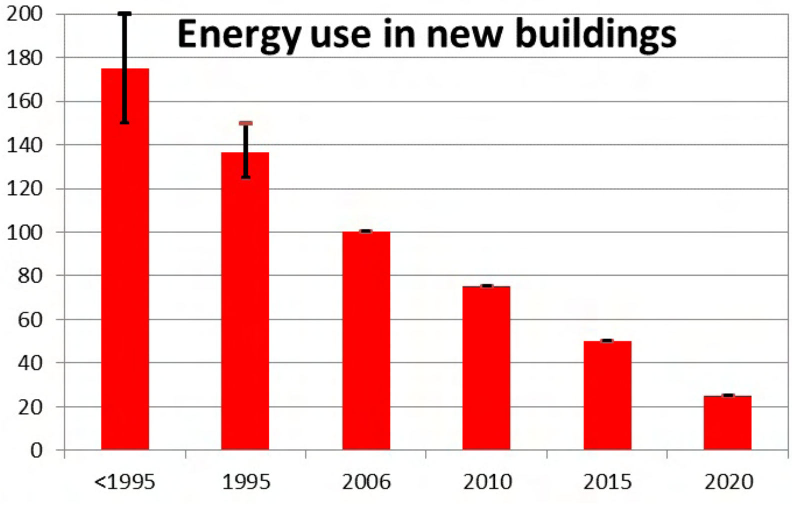


Figure 2: Development of relative energy use in new buildings. 1) Index 100 corresponds to 2006 requirements. 2) The range shown on the top of the first two columns indicates that it is not possible to give a precise value compared to the reference, as the method to set a target was different then.



I.ii. Format of national transposition and implementation of existing regulations

New buildings

BR2010 sets minimum energy performance requirements for all types of new buildings. In addition to the minimum requirements, BR2010 also sets requirements for two voluntary low-energy classes: 'Low-energy Class 2015' and 'Building Class 2020' (NZEB) - see Box 1. These two classes are expected to be introduced as minimum requirements by 2015 and 2020, respectively (Table 1).

The minimum energy performance sets the limit for maximum allowed primary energy demand for a building, including, e.g., thermal bridges, solar gains, shading, infiltration, ventilation, heat recovery, cooling, lighting (for non-residential buildings only), boiler and heat pump efficiency, electricity for operating the building, and sanctions for overheating. The overheating penalty is calculated as a fictive energy demand, equal to the energy demanded by an imaginary mechanical cooling system in order to keep the indoor temperature at 26°C. This additional energy demand is included in the calculated overall energy consumption of the building by the monthly based compliance checking tool Be10.

Buildings that comply with the two voluntary low-energy classes must prove that they have a good thermal indoor climate during hot periods. The indoor temperature in residential buildings (houses and apartments) must not exceed 26°C for more than 100 hours per year, and 27°C for more than 25 hours per year. This can be done either through Be10 or via a dynamic simulation tool. In other building types, the building owner decides the temperature limits, and summer comfort must be proven using a dynamic simulation tool. Additionally, these two classes of low-energy buildings must prove, through a pressurisation test, their compliance with the maximum infiltration rates (1.0 and 0.5 l/s.m², respectively, at a pressure difference of 50 Pa).

Box 1: BR2010 minimum energy performance requirements.

The BR2010 minimum energy performance requirement (A2010) is:
52.5 + 1,650 / A [kWh/m².year] for residential buildings, and
71.3 + 1,650 / A [kWh/m².year] for non-residential buildings,
where A is the conditioned gross floor area.

The minimum energy performance for the voluntary Low-energy Class 2015 (A2015) is:
30 + 1,000 / A [kWh/m².year] for residential buildings, and
41 + 1,000 / A [kWh/m².year] for non-residential buildings.

Finally, the minimum energy performance for the voluntary Building Class 2020 (NZEB - A2020) is:
20 [kWh/m².year] for residential buildings, and
25 [kWh/m².year] for non-residential buildings.

Integration of renewable energy in NZEB 2020 is taken into consideration in the calculation of the primary energy factors (Table 2). Primary energy factors will be lowered over time as Renewable Energy Sources (RES) will make up a larger proportion of the overall energy mix.

Energy from RES installations on the building or the building site can be subtracted when calculating the overall energy consumption, but only within limits – e.g., renewable electricity is subtracted only up to the electricity demand for operating the building. There are local subsidies for private photovoltaic (PV) installations. Produced energy that is not used in the building is sold to the grid (by a low feed-in tariff). There is a maximum system size of 6 kWp for single-family houses.

Local, collective RES installations, e.g., wind turbines, shared solar heating, PV or geothermal systems, are included in the calculation as long as the building owner contributes financially to the installation.

There is a requirement for thermal solar systems in buildings outside district heating areas with high Domestic Hot Water (DHW) consumption (above 2,000 l/day). The requirement should be fulfilled for both new buildings and existing buildings that undergo a major renovation. The installation should cover a demand corresponding to at least 95% of the DHW consumption from May to September.

This requirement will be replaced by a general requirement to install RES in new buildings, or buildings that undergo major renovation. The new requirement will implement the RES Directive (Directive 2009/28/EC), Article 13.4 and is scheduled to enter into force by 31 December 2014. Hence, the choice regarding specific RES technologies will be left with the building owner to ensure maximum flexibility.

BR2010 also sets requirements for calculating the design transmission heat loss for the opaque part of the building envelope for new buildings, as well as the minimum requirements for building components and installations.

The minimum component requirements are primarily intended to eliminate the risk of mould growth due to cold surfaces. It is not possible to construct a building that meets the minimum energy performance solely by fulfilling the minimum component requirements. Both sets of requirements work in parallel with the requirements for the minimum energy performance, and they are set in

Table 1: Development of energy performance requirements (kWh of primary energy per m² of conditioned gross floor area per year) for typically-sized residential and non-residential buildings.

	2006	2010	2015	2020
Residential, 150 m² conditioned gross floor area	84.7	63.0	36.7	20.0
Non-residential, 1,000 m² conditioned gross floor area	97.2	73.0	42.0	25.0

Table 2: Primary energy conversion factors used in the calculation (primary/useful energy).

	2006	BR10 year 2010	Low-energy Class 2015	Building Class 2020
District heating	1	1	0.8	0.6
Fossil fuels	1	1	1	1
Bio fuels	1	1	1	1
Electricity	2.5	2.5	2.5	1.8

order to avoid having new buildings and/or building components and installations with a high level of RES, but poor insulation. A Building Class 2020 building must be constructed so that the design transmission loss does not exceed 3.7 W/m² of the building envelope in the case of single-storey buildings, 4.7 W/m² for two-storey buildings, and 5.7 W/m² for buildings with three storeys or more.

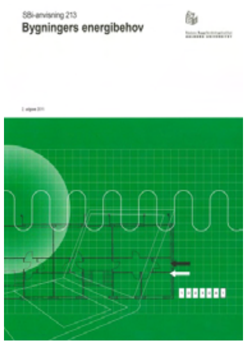
Calculation procedure

The calculation procedure in BR2010 has been updated according to the new requirements and is described in the SBi Directions 213: Energy demand in buildings (Figure 3), published by the Danish Buildings Research Institute (SBi)[1]. The monthly quasi-stationary calculation procedure follows relevant CEN standards with national adaptations. This publication also includes the updated energy performance calculation tool Be10. The calculation core of this program is to be used by all other programs for compliance checks and for energy certification in order to ensure identical calculation of the energy performance of buildings.

Existing buildings

BR2010 tightened the energy performance requirements for individual building components for all building types. This rule applies to the replacement of a component and to major renovation. However, the measures must be financially (plus technically and architecturally) feasible, i.e., they must have a simple payback time of less than 75% of its expected lifetime as defined in the Danish Building Regulations. In case of full replacement of a component (e.g., a new roof, new window, new outer wall), the new component must meet the requirements set in BR2010 (Table 3), regardless of profitability.

Figure 3: SBi Directions 213.



[1] *In Danish at: www.anvisninger.dk – access requires a license*

All existing buildings	Changed use and extensions	Pavilions	Single component requirements	Secondary homes	Maximum requirements, new buildings
U-value requirements [W/m².K]					
External walls and basement walls towards ground	0.15	0.20	0.20	0.25	0.30
Slab on ground etc.	0.10	0.12	0.12	0.15	0.20
Loft and roof constructions	0.10	0.15	0.15	0.15	0.20
Windows	1.40	1.50	1.65 (doors)	1.80	-
Roof windows	1.70	1.80	1.65	1.80	1.80
Cold bridges [W/(m.K)]					
Foundations	0.12	0.20	0.12	0.15	0.20
Joints between windows and walls	0.03	0.03	0.03	0.03	0.06
Minimum energy gain [kWh/m².year]					
Facade windows	-	-	-33	-	-33

Table 3: U-values and cold bridges requirements for existing buildings – examples.

I.iii. Cost-optimal procedure for setting energy performance requirements

The cost-optimality of the current energy requirements in the BR10 was calculated in 2013 according to the procedure and the rules laid down in the Delegated Regulation 2010/244/EU. In relation to the new housing examples, the current minimum energy requirements in BR10 are all up to 16% stricter than the cost-optimal point. With the planned tightening of the requirements for new houses in 2015 and in 2020, the energy requirements can be expected to be tighter than the cost-optimal point, if the costs for the needed improvements do not decrease correspondingly.

For new office buildings the BR10 requirement is too lax by 31% when compared with the cost-optimal point. In relation to the 2015 and 2020 rules, all requirements are stricter than the cost-optimal point based on today's prices. If the differences between the cost-optimal levels and the BR10 requirements for all the new buildings are weighted to an average, based on a mix of building types and heat supply for new buildings in Denmark, there is a difference of 3% for new buildings. The stipulated requirements for 2015 and 2020 are 34% and 49% more strict than the cost-optimal level based on today's prices.

PV is not cost-effective today but is very close to it, especially in buildings with high electricity consumption included in the building operation, e.g., office buildings and houses heated by heat pumps. If the energy prices increase - or the cost of installing PV is reduced - it will soon be profitable to install PV in new buildings. When this occurs, the cost-optimal point will move significantly towards lower primary energy consumption in the buildings.

Component requirements for the building envelope and installations in existing buildings add up to significant energy efficiency improvement, both in the case of major and smaller renovations. The component requirements are in nearly all cases tighter than the cost-optimal point. In the case of a major renovation, the gap between requirements and cost-optimal level is very small. The tightening of the requirements to windows in 2015 and 2020 seems to move the requirements for existing buildings beyond the cost-optimal point. This will probably be solved by a future change in price for more efficient windows.

During 2014, the calculations for cost-optimal levels were revised, since the Low-energy Class 2015 is planned to become the mandatory minimum requirement in 2015. The conclusions from the updated calculations have shown that the additional costs in order to comply with the tightened requirements have decreased over the years. In 2014, the cost of complying with the 2015 requirements is close to cost-optimal point for most building types. Future market focus on the development of cost-efficient solutions is expected to make the 2015 requirements cost-optimal for all building types.

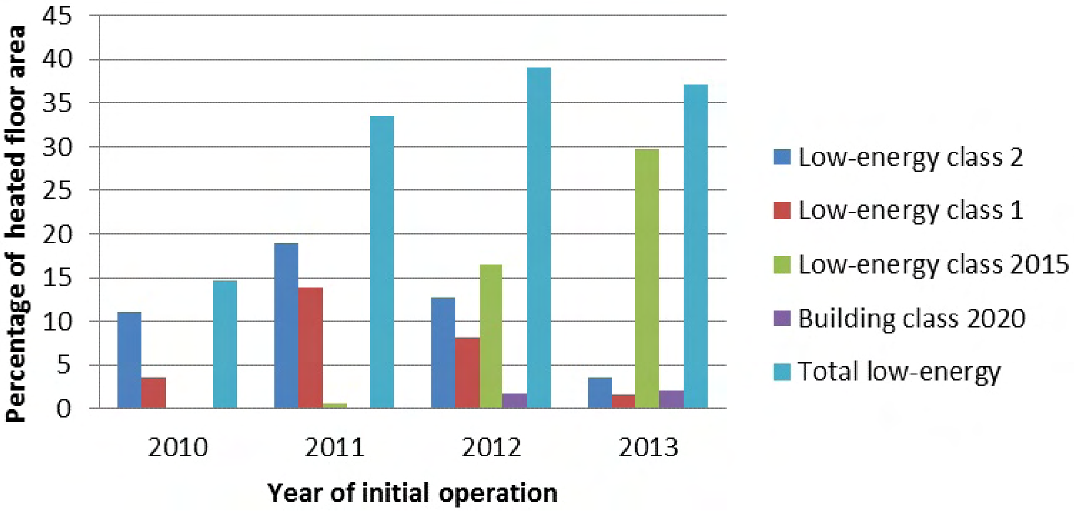


Figure 4: Share of total gross heated floor area.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The Danish national plan for NZEB (2011)[2] lists the initiatives and policies that will increase the number of NZEBs. Examples of strategies and policies are:

> Energy-saving initiative for energy supplying companies: The government has developed a comprehensive strategy for upgrading the energy performance of the existing building stock. Danish supply companies are obliged to provide energy saving corresponding to 2.6% of the national energy consumption (exclusive transport) in 2013-2014, and 3.0% in 2015-2020. Compared with 2010-2012, in 2013 and 2014 the obligation to provide energy saving increases by 75%.

> Changeover to renewable energy: As a general rule, oil and natural gas boilers will not be allowed in new buildings as of 2013.

> Information campaigns: In relation to new buildings, building process guidelines have been drawn up for contractors, architects and engineers who wish to build in an energy efficient manner.

> Public action: Reducing the energy consumption in public buildings by 14% in 2020 compared to 2006 levels.

Figures and statistics on existing NZEBs

The minimum energy performance requirement for the voluntary Building Class 2020 is 20 and 25 kWh/m^2.year for residential and non-residential buildings, respectively. Buildings complying with this voluntary building class have been in the Danish market since 2012.

Figure 5: Example of a new NZEB single-family house.

Figure 6: Sems Have, an example of renovation to NZEB.

Figure 4 shows the share of low-energy buildings per total gross heated floor area of the Danish building stock.

The A2020 label is not restricted to new buildings (Figure 5); renovations can also become NZEB. An example is the renovation and conversion of a dormitory/day-care centre into 30 low-energy apartments called *Sems Have* (Figure 6). The calculated primary energy demand minus the PV production becomes 16.2 kWh/m^2 of the gross floor area.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

In May 2014, the Danish government launched a comprehensive strategy for energy renovation of the existing building stock by compiling initiatives to promote and improve energy renovation of buildings

[2] *http://eur-lex.europa.eu/legal-content/DA/TXT/HTML/?uri=CELEX:52013DC0483R(01)&from=EN*

Figure 7: Strategy for energy renovation.

(Figure 7). The strategy is based on comprehensive analysis and includes 21 initiatives targeting specific building types from single-family houses to multi-apartment blocks, office and public buildings. It is estimated that by 2050 the initiatives in the strategy will reduce the net energy consumption for heating and DHW in the existing building stock by 35% when compared with today. Initiatives include an upgrade of the energy requirements for buildings and building parts, reinforcing of information activities, enhancement of data availability concerning tools and technical solutions for improving energy efficiency in buildings, financing, compliance, and steps to making the EPCs more robust and ensure further support of the energy renovation of buildings. Furthermore, the strategy includes a number of initiatives targeting training, education and innovation.

Analyses of the Danish building stock and energy-saving potential are made in the report *"Potential heat savings during ongoing renovations of buildings until 2050"*, SBI 2016:04[3], as the foundation for the Danish Strategy for energy performance upgrading of the existing building stock, *"Vejen til energieffektive bygninger i fremtidens Danmark"*.

Denmark has committed to reduce the energy consumption in buildings owned and used by the government by 14% by 2020, with 2006 as base year. This initiative targets energy efficiency in public buildings and it will also ensure implementation of the EED Article 5. The initiative is a continuation of a long term Danish effort since 2006 to reduce the energy consumption in buildings used by the government. In parallel, existing voluntary agreements between the government and local/regional authorities to enhance energy efficiency in buildings used by these authorities will be revised to reflect the EED.

The voluntary agreements concern energy-efficient behaviour, equipment purchasing and buildings, including introduction of energy management, implementation of profitable energy-saving projects and energy efficient-operation, maintenance and reconstruction. For the period 2015-2016 approximately 100 M DKK (13.5 M€) are allocated to advance maintenance of public buildings, where at the same time energy optimisations can be implemented. The voluntary agreements mean that the owners of the public buildings have full flexibility with regard to the method for achieving energy savings. Within this context, the EPCs constitute one tool among others which are used to achieve this goal.

I.vi. Other relevant plans

On 22 March 2012, the Danish Parliament decided on an Energy Agreement which lays down a number of initiatives to be implemented in the period 2012-2020. By 2020 the Energy Agreement will give the following main results:

- more than 35% renewable energy in final energy consumption;
- approximately 50% of electricity consumption to be supplied by wind power;
- 7.6% reduction in gross energy consumption in relation to 2010;
- 34% reduction in greenhouse gas emissions in relation to 1990.

Furthermore the Energy Agreement outlines the contents of a strategy for upgrading the energy performance of the existing building stock. This strategy was finalised in 2014 and it contains a number of initiatives for increasing the number of energy performance upgrading projects in the most cost-efficient way. A large network consisting of representatives from the construction and other sectors has contributed to these initiatives.

For the future there are several political ambitions relating to energy:

- 2030 – no more use of coal in power plants;
- 2035 – all electricity and heating covered by renewable energy;
- 2050 – all energy covered by renewable energy (electricity, heating, transports, industry).

[3] *ec.europa.eu/energy/en/topics/energy-efficiency-directive/buildings-under-eed*

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The energy supply system in Denmark is undergoing great changes. In the future, the system will be based primarily on renewable energy, and the ambition of the government is to phase out oil boilers by 2030. Since 2013 it has not been permitted to install oil or natural gas boilers in most new buildings, and by 2016 it will be illegal to replace an existing oil boiler with a new one if there is access to district heating or natural gas.

The Danish Building Regulations include requirements for a wide range of TBS.

There are specific energy-related requirements for boilers based on gas, oil, coal, biomass and similar fuels. The requirements for boilers operating on gas or oil, means that only condensing boilers can be used in Denmark, both for new buildings and new installations in existing buildings. Boilers operating on coal, biofuels and biomass should, as a minimum, meet the energy requirements of boiler class 5 in EN 303-5.

Ventilation is included in the regulations, and requirements for mechanical ventilation units include heat recovery rate and energy used for transport of air (limits on the Specific Fan Power (SFP) value – Table 4).

In addition to this, there are requirements for heat pumps, elevators and cooling systems.

II.ii. Regulation of system performance, distinct from product or whole building performance

There is a general requirement in the Danish Building Regulations that services have to be built in a manner that prevents unnecessary energy consumption. This means, e.g., that heating systems must be designed and built for energy-efficient operation, including the components, which must be compatible with each other and suited to the intended use of the building and building systems.

Heating systems must be designed according to Danish Standard DS 469, which has different functional requirements for the commissioning of heating systems as well as additional requirements for use, operation and maintenance.

All technical systems in the building must be insulated as required in Danish Standard DS 452.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

The above mentioned requirements are applicable to all new and existing buildings, when a system or component is replaced, or a new system is installed. This means that the heat recovery rate and the specific electricity use for air transport have to meet the requirements in the Danish Building Regulations.

If only parts of a system are replaced or a new part of a system is added to an existing system, the requirement only applies to the new part of the system.

II.iv. Provisions for installation, dimensioning, adjustment and control

When technical systems like ventilation, heating and cooling systems are designed, adjusted and installed, it is mandatory to meet the requirements described in the following standards:

> DS 452 Code of practise for thermal insulation and technical service and supply systems in buildings

> DS 469 Heating systems with water as the heating medium

> DS 447 Code of practise for mechanical ventilation installations

These standards ensure the quality level of TBSs in Denmark.

II.v. Encouragement of intelligent metering

Technical systems with significant energy consumption must have meters installed if energy consumption exceeds a certain level (Table 5).

	Heat recovery rate [%]	SFP system [J/m³]
Exhaust ventilation	-	800
Ventilation units for single-family homes	80	1,000
Ventilation units for multi-family homes and other types of buildings	70	1,800/2,100*

* For constant air volume (CAV) and variable air volume (VAV), respectively

Table 4: Requirements for mechanical ventilation systems.

II.vi. Encouragement of active energy-saving control (automation, control and monitoring)

A new standard for commissioning of buildings in Denmark (DS 3090:14) was published during 2014. The aim of the standard is to encourage the Danish building industry to include a systematic commissioning process between construction and operation of the building. An analysis is under way to investigate how large a potential for energy-saving there is in the commissioning process.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

In Denmark, the responsibility of implementing the EPC lies with the Danish Energy Agency. The agency is also handling the daily operations, including supervision and future development of the scheme. Quality Assurance (QA) is partly performed by a private body.

It is mandatory that a valid EPC is supplied to a new owner or tenant of a building before a sale or rental contract is signed. Large buildings (1,000 m² or larger, not being public buildings) must always have a valid EPC, even if the owner/tenant has not changed. Furthermore, it is mandatory to display the label of the EPC if a building (of any type) is advertised for rent or sale in commercial media.

Table 5: Maximum annual energy use triggering metering for TBS.

System	Maximum annual energy use triggering metering
Heat pumps / cooling plants	3,000 kWh electricity
Server rooms	Always
Ventilation units	3,000 kWh electricity for air transport
Heating coils	3,000 kWh electricity or 10,000 kWh heat
Domestic hot water	10,000 kWh heat for heating and circulation of DHW

Figure 8: The energy scale of the EPC.

Table 6: Scale and numerical criteria for primary energy use in the Danish EPC.

Energy efficiency rating	Numerical criteria for each class [kWh/m².year]	
	Residential	Non-residential
A2020	20.0	25.0
A2015	≤ 30.0 + 1,000/A	≤ 41 + 1,000/A
A2010	≤ 52.5 + 1,650/A	≤ 71.3 + 1,650/A
B	≤ 70.0 + 2,200/A	≤ 95.0 + 2,200/A
C	≤ 110 + 3,200/A	≤ 135 + 3,200/A
D	≤ 150 + 4,200/A	≤ 175 + 4,200/A
E	≤ 190 + 5,200/A	≤ 215 + 5,200/A
F	≤ 240 + 6,500/A	≤ 265 + 6,500/A
G	> 240 + 6,500/A	> 265 + 6,500/A

A=conditioned area in m².

All EPCs are registered in a central database administered by the Danish Energy Agency and are displayed on the public website SparEnergi.dk.

The operation of the scheme is financed by fees paid by the certified companies as annual fees, as well as a fee per issued EPC.

How flats are certified in apartment buildings

When certifying apartments in apartment buildings, the whole building has to be included in the EPC so that all apartments in the building are covered by the certification. This is to ensure that all relevant energy-saving suggestions for the building, including the roof and the entire envelope, are considered by the energy expert.

The owner of an apartment building has the obligation to provide an EPC to a new tenant. If the apartment building consists of owner-occupied flats, the obligation lies collectively with the owners through a mandatory association among them. The association has the obligation to order and pay for an EPC at the request of an owner who wants to put an apartment up for sale.

Format and content of the EPC

The EPC assigns an energy rating to nearly all types of buildings and lists cost-effective measures for improving the building's energy performance. The requirements of the EPC are stated in Act 636 of 19 June 2012, in the Ministerial Order 673 of 25 June 2012, and the Ministerial Order 203 of 6 March 2014 (Handbook for EPC experts).

The EPC rates buildings on an energy efficiency scale (Figure 8 and Table 6) ranging from A (high energy efficiency) to G (poor energy efficiency). Class A is divided into three sub-categories, A2020, A2015 and A2010.

The EPC for existing buildings contains, among others, the following information:

- > the basic data of the building;
- > the energy efficiency rating;
- > the calculated energy consumption;
- > the calculated CO_2 emissions;
- > the measured total energy consumption, if available;
- > a precise description of the building;
- > recommendations for energy improvements.

The suggested improvements include a brief description, an assessment of the estimated cost, savings and paybacks, as well as the impact on the energy efficiency rating if all the measures are implemented. The recommendations made must refer to the specific building.

There are several elements which can lead to energy-saving suggestions in the EPC, including upgrading and replacement of:

1. old roofs and attics;
2. old windows, doors, and overhead lighting;
3. heating systems;
4. insulation of various building components and building envelope;
5. all installations that have an impact when calculating the energy consumption, including automation.

In addition, the expert always has to consider RES.

The calculation methodology is the same as the one used for proof of compliance for new buildings according to BR10. The methodology is defined in the calculation engine of SBi Direction 213.

Energy certification of single-family houses constructed less than 25 years prior to the certification can take place without an on-site visit to the building. Energy certification of selected rental buildings can be based on the calculated or measured energy consumption. Buildings that can be certified by measured energy consumption include non-residential buildings, as well as multi-family buildings with a detailed and updated operational log. However, for office buildings and buildings used for administration, the EPC has to be based on the calculated energy consumption if the rental represents more than 25% of the total heated area of the building. An EPC based on measured energy consumption is not valid for sales.

The validity of the EPC is 10 years. However, the validity will be reduced to 7 years if the EPC identifies major energy savings with a simple payback time of less than 10 years and with total savings above 5% of the energy consumption.

EPC activity levels

The distribution of the certification classes for Danish residential buildings as registered in the current EPC scheme since 2006 is shown in Figure 9.

In the current EPC scheme, from September 2006 until August 2014, the number of EPCs issued is about 445,000. The Danish Energy Agency registers about 55,000 new EPCs every year, with a total of more than 1.2 million EPCs issued in Denmark since the initiation of the certification in 1997.

The evolution of the classes for residential buildings is shown in Figure 10. Note that one EPC can contain several apartments, which is why the number of apartments is higher than the total number of issued EPCs.

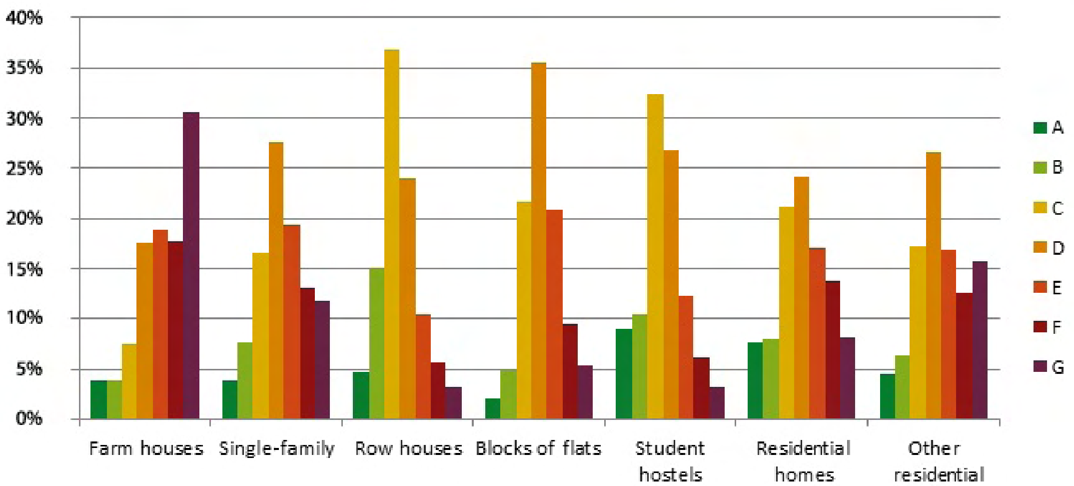


Figure 9: The distribution of the certification classes for Danish residential buildings as registered in the current EPC scheme since 2006.

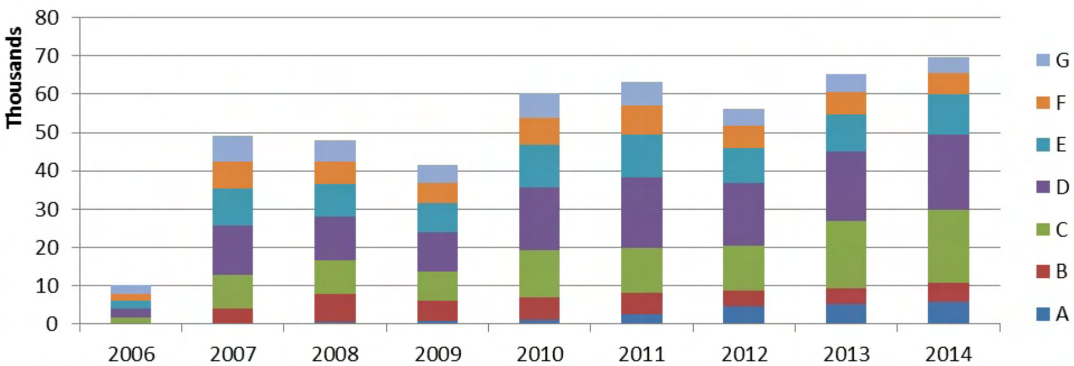


Figure 10: The evolution of the classes for residential buildings.

Comparing the number of EPCs issued for single-family houses with the existing building stock shows that approximately 29% of all single-family houses already have a certificate.

Table 7 shows the number of issued EPCs in private buildings each year from 2010 to 2014.

Typical EPC costs

The cost of an EPC is regulated by Order 60 of 27 January 2011. In 2014 the maximum price of an EPC for small buildings varies from 5,824 DKK to 6,988 DKK, incl. VAT (approximately 781 – 937 €), depending on the size of the building (up to 299 m^2). The price of an EPC for buildings larger than 299 m^2 is not regulated. However, prices usually range between 0.5 €/m^2 and 2 €/m^2 per EPC.

Assessor corps

Only certified companies can issue EPCs. A certified company must implement an ISO 9001 QA scheme for its building energy certification system. There are currently approximately 255 certified companies to be found at www.sparenergi.dk. There are two kinds of energy certification experts:

1. energy experts covering single- and two-family houses of less than 500 m^2;
2. energy experts covering multi-family houses, public buildings, as well as the trade and service sectors.

The education for energy experts has undergone a revision. As of 1 October 2014, energy experts must attend training that consists of obligatory courses, online tests and practical tests. No prior education is required. The education corresponds to level 6 of the European Qualifications Framework.

Compliance levels by sector

In Denmark it is not possible to collect data in order to check if an owner provides the buyer/tenant with an EPC when selling or renting. The Danish Energy Agency has only received one complaint from a tenant, so it estimates that the compliance level is high due to the owner's/real estate agent's obligation to display the EPC along with the advertisement for the building. Self-regulation within the real estate industry also has a positive effect on the compliance level.

Enforcement with building owners and real estate actors

If the rules regarding the EPC are not adhered to, the building owner, real estate agent, etc., may face fines and further liability. The amount of a fine for not having an EPC or for violating the EPC rules, depends on the size of the building and ranges from 2,000 DKK (268 €) to 45,000 DKK (6,036 €). For example, the owner of a building of 200 m^2 may face a fine of 5,000 DKK (670 €) for not having an EPC. If the EPC of a public building is not on display, the owner may face a fine of 2,000 DKK (268 €).

Along with the fine, the owner may also face an injunction from the Danish Energy Agency to display the EPC or to have an EPC issued.

At the end of 2014 four fines are being processed for not displaying the EPC in advertisements.

Quality Assurance (QA) of EPCs

The Danish Energy Agency carries out quality checks of EPCs on a regular basis, but they may also be carried out on the basis of a complaint. The Agency has set up a mandatory QA scheme in which EPCs are randomly selected from a central database for a quality check. A technical revision, which includes a re-certification by a specially appointed expert, must be carried out for 0.25% of all issued EPCs. Furthermore, an electronic analysis of all EPCs in the database is carried out to identify outliers, etc. Around 300 EPCs of all kinds of buildings have been checked between 2013 and 2014.

There are three levels of sanctions if errors are detected. Certified companies must correct the EPC and, if the errors are substantial, the company may also receive a first or second degree notification by the Danish Energy Agency. For grave or repeated errors and/or numerous notifications, the company will face a warning. The warning will be sent to the accreditation agency that certified the company. In addition, a warning will be displayed in connection with the online register of experts. In the worst case, the certified company may have its certification suspended. So far, the Danish Energy Agency has issued 45 warnings.

Table 7: The number of issued EPCs for private buildings each year from 2010 to 2014.

Owner: Private	2010	2011	2012	2013	2014
Single-family	50,215	54,786	44,953	47,990	48,357
Multi-family	8,008	6,297	4,357	4,616	4,318
Non-residential	2,133	2,090	1,738	3,108	2,631
Holiday houses	4,468	607	388	-	645

Certified companies must carry out their own quality checks according to DS/EN ISO 9001.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

All public buildings with more than 250 m^2 of useful floor area are required to have and display a valid EPC even if the owner/tenant has not changed. Since July 2012 this affects all buildings owned or used by the public. In Denmark, the definition of public buildings includes:

1. buildings used for public administration;
2. institutions, companies, associations, etc., if more than 50% of their expenses are covered by public funds; and
3. publicly-owned companies, or companies where a public body has the final say on decisions.

As of 1 January 2013, all other buildings in which an area of over 600 m^2 is frequently visited by the public are required to display their EPC in a place visible to the public. Only the actual rating of the EPC is required on physical display. All other key information of the certificate is publicly available on the central web-based information server www.boligejer.dk. Through this server it is possible to view the calculated consumption, as well as the name of the energy expert and the certified company who issued the certificate.

In 2013, the Danish Energy Agency has carried out 102 random checks on buildings larger than 1,000 m^2, which is 0.5% of all buildings in this category. It was found that about 24% of the checked buildings did not have the mandatory EPC. The owners of these buildings were given a warning and a deadline for complying with the rules, which they all did and thus no fines have been given yet. The random check did not distinguish between public and privately owned buildings, or whether the buildings were visited by the public.

It is not possible to extract the specific number of issued EPCs for buildings that are visited by the public from the database.

Format and content of the EPC

An EPC for a public building or a large building often visited by the public has the same format, content and validity as EPCs for other buildings.

III.iii. Implementation of mandatory advertising requirement

In July 2012 a new act and a new order came into force implementing Directive 2010/31/EU. The main rules of this act were applied on 1 January 2013 and concern mandatory advertising requirements and sanctions.

When a building is sold, rented or otherwise handed over to a new party and it is advertised in the commercial media, the advertisement must display the label of the EPC. If a real estate agent is involved in the sale, the seller must provide the agent with the EPC before advertising the building for sale. If the advertising requirement is not adhered to, the seller may face a fine of 2,000 DKK (268 €).

Regarding the advertising requirement for private sales on the internet, the Danish Energy Agency has, so far in 2014, performed a small random check which showed a compliance rate of 60%. Furthermore, an initiative has been launched concerning sales where the owner does not involve a real estate agent. These advertisements are often published on the web. In collaboration with the owners of these websites, the Danish Energy Agency is looking into technical solutions to block advertisements without an EPC.

At the end of 2015, four fines for not displaying the EPC in advertisements are being processed.

III.iv. Information campaigns

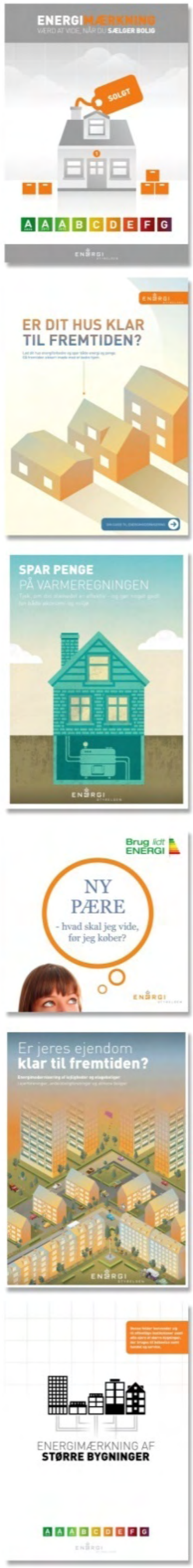
Information initiatives to reduce the energy consumption in the existing building stock are one of the key elements in the Danish Energy Agreement of 22 March 2012. Previous and current activities (Figure 11) aim at producing cost-efficient information material in cooperation with relevant actors that deal with energy saving. The importance of the local perspective and private ownership is a significant part of the activities.

The Danish Energy Agency hosts websites containing both general and specific information on energy saving as well as on the EPC.

The main website of the information campaign, www.SparEnergi.dk, contains a variety of tools, information and knowledge that supports energy saving. A selection of the content is briefly described below.

Furthermore, a number of initiatives have been launched to promote the EPC and reduce energy consumption in buildings:

Figure 11: Guides and EPC information.



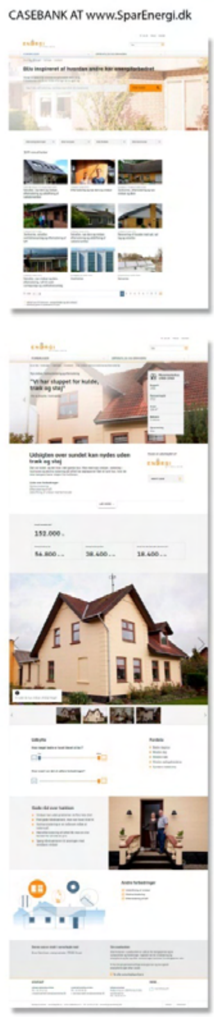
Better homes

A government-funded campaign has been launched to help building owners to choose the best solutions for their renovation projects (Figure 12). The campaign is called ‘*BedreBolig*’[4] (Better Home) and aims at accelerating energy renovation of private homes. The scheme is also part of the Danish government’s growth plan and introduces a one-stop-shop for private home owners who target an energy renovation of their homes. No direct funding to the building owners has been granted.

Figure 12: BedreBolig campaign (www.BedreBolig.dk).

Figure 13: The digital EPC (www.SparEnergi.dk).

Figure 14: Casebank (www.SparEnergi.dk).



Digital EPC

The Danish Energy Agency has developed a digital EPC[5] that was launched in June 2014, which displays the EPC in a user-friendly manner and highlights the suggested energy-related improvements (Figure 13). Together with a new EPC benchmarking-tool and a financing calculator, the digital EPC makes the EPC easily accessible and usable. Now there is only one click between the sales advertisement and the digital EPC. Further improvements are in the pipeline.

Related to this, the Danish Energy Agency has produced three leaflets with information about the EPC; one addressed to sellers of buildings, one addressed to buyers, and finally one explaining in more detail how to use the EPC.

Casebank

The Danish Energy Agency has developed a casebank[6] which contains a large number of examples of how other homeowners have renovated their home (Figure 14).

List of craftsmen

A list of relevant craftsmen[6] is published in order to make it easy for homeowners to contact craftsmen specialised in energy solutions. In essence, all craftsmen can get on the list. The better trained the craftsmen, the higher their ranking on the list.

Films and guides

A number of short films[7] have been produced, showing relevant energy solutions in households. The films present energy solutions and make them attractive to ordinary homeowners and some target at helping with the training of craftsmen. These films can also be used as marketing material by craftsmen with expertise in energy solutions.

A number of guides (see footnote 8) have been published describing the process that homeowners must go through in connection with the renovation of their homes and they include an overview of the market players, a mapping of the savings potential, and a description of case studies where energy upgrading will pay off.

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[4] *www.BedreBolig.dk*

[5] *www.SparEnergi.dk/forbruger/vaerktoejer/det-digitale-energimaerke*

[6] *www.SparEnergi.dk/forbruger/vaerktoejer/casebank*

[7] *www.SparEnergi.dk/forbruger/vaerktoejer/haandvaerkerlisten*

[8] *www.Sparenergi.dk/forbruger/boligen/renovering*

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Regarding Article 14 of the EPBD on inspection of heating systems, Denmark has adopted the alternative approach (advice). Regarding Article 15 on AC inspections, Denmark has adopted mandatory inspections until January 2016. From 2016 onwards, the alternative approach will be implemented.

IV.i. Report on equivalence

Until 2011 Denmark was implementing Article 14 through mandatory regular inspections of heating systems. However, it was considered that the use of regular inspections was not cost-effective within the Danish legislative framework. Therefore the Danish implementation of Article 14 is done through a number of activities that each contributes to increasing the efficiency or phasing out of oil and natural gas boilers, such as advisory service, tax benefits and requirements to use RES for building heating. The Danish implementation of Article 14 should be seen as part of a long term political goal to phase out fossil fuels. Thus, the initiatives for oil fired boilers are mainly focused on replacement of the oil boilers with other heating sources, e.g., heat pumps, district heating, or solar energy. The development of the share of different types of heating systems in the residential sector in the period 1981-2014 is presented in Figure 15.

To ensure maintenance of heating systems which are not phased out, a number of initiatives has been launched in order to support a general increase of the energy efficiency of buildings. Specifically, there are a number of measures, with the same goal as the boiler inspection scheme, which will contribute either to the efficiency or the phasing out of oil and natural gas boilers. These measures include campaigns to increase building owners´ awareness of the potential value of service checks, as well as the promotion of qualified service providers.

Though there are some uncertainties in accurately determining their impacts, it is expected that the alternative initiatives will have a substantially higher impact than boiler inspections alone.

There has been no integration between the implementation of Articles 14 and 15 of the EPBD and the EED.

IV.ii. Progress and current status on heating systems

As alternatives to inspections, the following initiatives have been implemented to help ensure a higher energy efficiency of heating systems in Denmark:

> Advisory services for craftsmen and building owners (i.e., "*Videncenter for Energibesparelser i Bygninger*"). This service targets craftsmen and provides information and guidelines about how, e.g., to improve heating systems.

> Tax deduction for craftsmen's fees related to renovation of buildings ("*Bolig-job-ordning*"). The tax deduction allowed building owners to include the cost of labour for renovations in their tax return forms, thereby giving them incentives to undertake renovation works such as replacement of the heating system.

> Obligations for energy service companies to implement energy savings for their customers.

> Reduced energy taxes for heat pump owners compared with owners of other kinds of heating systems. The tax reduction makes electricity-based heating such as heat pumps more economical compared to, e.g., oil.

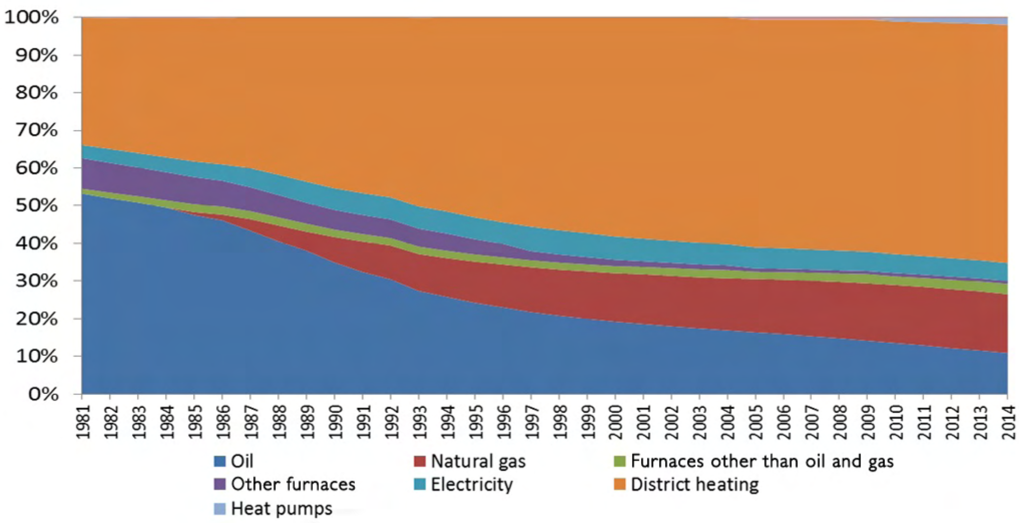

Figure 15: Residential units by type of heating, 1981-2014.

> Requirements for the use of renewable energy in some buildings and efficiency requirements for boilers. In new buildings, heating with oil or gas is no longer allowed, which means that district heating, heat pumps and other heating systems with high efficiency are promoted. In existing buildings, old heating systems must be replaced with district heating, natural gas boilers or renewable energy if the building is placed within a district heating or natural gas grid. Finally, in Denmark, the efficiency requirements for newly installed boilers are higher than those required by the ECO-design Directive (2009/125/EC).

IV.iii. Progress and current status on AC systems

Overview, technical method and administration system

Denmark has adopted regular inspections for the implementation of Article 15 of the EPBD. The scope of the inspection scheme has been expanded to include all AC and ventilation systems with an effective rated output of more than 5 kW. Certain AC systems for industrial, not personal use, as well as systems operating less than 500 hours/year are excluded. The AC and ventilation systems must undergo an inspection every 5 years. Promotion of these inspections is made via the website of the Danish Energy Agency.

The inspection consists of a basic recording of data, e.g., type of system, effective rate and composition, as well as indication of the condition of the system. Moreover, the functioning and efficiency of the system are examined during the inspection. Finally, the Danish Energy Agency recommendations on energy efficiency with respect to retrofitting, maintenance and adjustment of the system are given to the owner in a report.

Data from the inspections is submitted to a database in the Danish Energy Agency.

However it has proven difficult to ensure a high degree of compliance with the mandatory inspections since there is no common Danish register of ventilation systems, and no obvious way to establish such a register in a cost-effective way. In addition, the companies that perform the required inspections have indicated that it is their impression that the mandatory inspection to only a limited extent has triggered actual energy savings in the covered ventilation systems. Therefore it has been decided that the mandatory inspection scheme will be terminated as of January 2016 and replaced by alternative measures. These are envisaged to include integration with the EPC of large buildings, information campaigns and enhanced opportunities for energy companies to realise energy savings in ventilation systems as a part of their obligation to realise overall energy savings.

Arrangements for assurance, registration and promotion of competent persons

Inspections of AC and ventilation systems must be conducted by certified companies approved by the Danish Accreditation and Metrology Fund, or a similar accreditation organisation. To obtain a certification, companies must employ specially qualified personnel with experience within the field, as well as a QA system for the work carried out. Companies that are certified to carry out inspections are promoted via the website of the Danish Energy Agency.

Enforcement and penalties

It is the responsibility of the owner of an AC to get the required inspections to confirm whether conditions are met. If the mandatory energy measurement or inspections are not carried out, the owner of the AC may face fines. There have been no systematic compliance checks by energy authorities due to the lack of a common register of ventilation systems in Danish buildings and no fines have been imposed.

Quality control of inspection reports

In 2013, 131 inspections of AC and ventilation systems were carried out and reported. Of those, 27 inspection reports where controlled by the Danish Accreditation and Metrology Fund.

Impact assessment

Currently, no impact assessment has been made.

Costs and benefits

It is estimated that an inspection of an AC and ventilation system costs 2,300 DKK (310 €) paid to the inspection company, and that the inspection requires on average one hour of participation of the building owner per visit, at a cost of 500 DKK (70 €). In total, the cost for an inspection of an AC and ventilation system is estimated at 2,800 DKK (375 €). Currently there has been no estimate of the benefits from the mandatory inspections of AC and ventilation systems. Based on feedback received from the inspection companies, it is estimated that only a fraction of the inspections results in measures to lower the energy consumption.

3. A success story in EPBD implementation

The Danish Building Regulations incorporate definitions of future low-energy classes for many years to come and this has been a great success. BR10 contains definitions of 'Low-energy Class 2015' and 'Building Class 2020' preparing the Danish industry for future requirements almost 10 years in advance of the coming requirements, making them able to adapt their products to the new demands. This is one of the reasons why new very energy-efficient components are main stream today on the market, e.g., windows, fans and heat pumps. In general, it is voluntary to build in accordance with the future low-energy classes, but several local authorities have rules stipulating that a certain low-energy class should be applied in their municipality.

A study from 2014[9] demonstrates that building owners have a positive experience of moving into and living in their new low-energy houses, as 93% of building owners recommended to others to live in a low-energy house. Good indoor climate, and low energy and operational costs are emphasised as reasons. The study included a questionnaire distributed to 885 low-energy households, 370 of which answered. The building owners had moved into their houses between 2010 and 2013. The most important factors for the building owners with respect to their choosing to live in a low-energy house are shown in Figure 16. More than half (59%) of the inhabitants found that their heating consumption was as low as they expected before they moved into the house, while 7% found that their heating consumption was not as low as they had expected. One third (34%) did not know as they had not lived for very long in their houses. More than 90% of building owners found their indoor climate to be satisfactory during summer (93%) and winter (94%), while only 4% and 2% expressed their dissatisfaction with the indoor climate in summer and winter, respectively.

Another success is that only one calculation method was developed and used both for the management of construction projects and the energy certification scheme. The user interface of the tools was developed individually for each purpose as the use of the method is both for existing and new buildings, but the calculation engine is the same for all the tools. Hence, results from the tools will be the same for identical building models, and switching between tools is easy.

In Denmark, an energy certification scheme has been mandatory since 1997. All data from the certification scheme is gathered in a common database so a very wide range of information is available with respect to the building stock. The certification scheme has an impact on the price of buildings. A study made in 2013[10] showed that sales prices of single-family houses increase in line with improved EPC ratings. The result is reached by statistically comparing the energy certificate and the price of all single-family houses sold in 2011 and 2012. By doing the same with the sales of houses between 2006 and 2012, it became clear that, over time, the energy certificate has had a growing and strong effect on sales prices. Countrywide, the energy certificate has the greatest effect outside the capital area. The market turn can also be related to the EU statement that, from 2011, EPC labels should be published as part of house transactions.

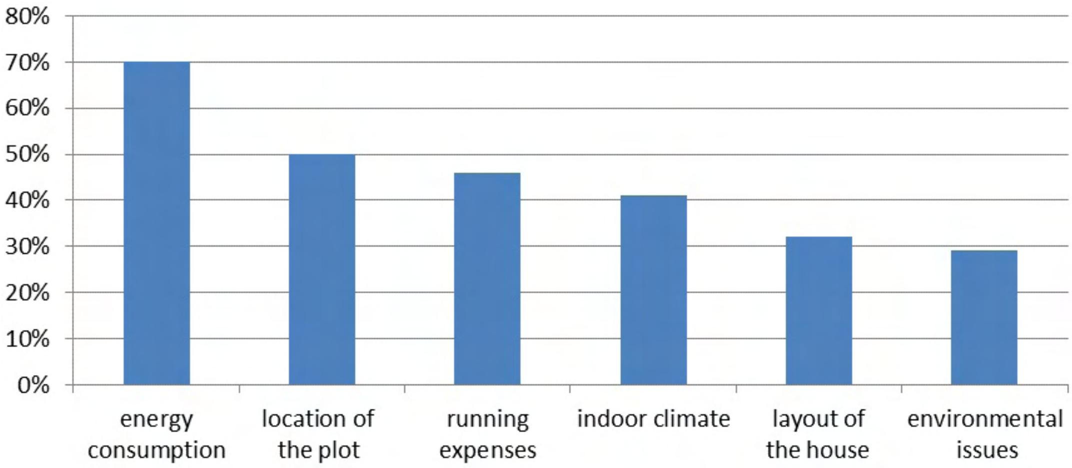

Figure 16: Most important factors for choosing a low-energy house.

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[9] *Knudsen, H.N. & Kragh J., 2015 House owners' experience and satisfaction with Danish low-energy houses. In conference proceedings of Healthy Buildings 2015, Eindhoven, The Netherlands.*

[10] *Jensen, O.M., Kragh J. & Hansen A.R., 2013. Energy label and sales price (In Danish: "Energimærke og salgspris"). Danish Building Research Institute, Aalborg University.*

4. Conclusions, future plans

The transposition of the Energy Performance of Buildings Directive (Directive 2010/31/EU – EPBD) was completed in Denmark in June 2012. The energy requirements in the Danish Building Regulation for new buildings have been tightened by using a step-by-step approach and introducing the new requirements as voluntary energy classes before they become mandatory, as it is the tradition in the Danish Building Regulation. The Building Class 2020, which was introduced in 2011, meets the obligations laid down in the EPBD regarding Nearly Zero-Energy Buildings (NZEBs). The Danish National Plan for NZEBs includes a number of initiatives and policies which will increase the number of NZEBs, including energy saving initiatives for the energy supply companies, strategy for the energy renovation of the existing building stock, changeover to renewable energy, information campaigns and public action.

In May 2014 the Danish government launched a comprehensive strategy for energy renovation of the existing building stock, compiling initiatives to promote and improve energy renovation of buildings. The strategy is based on extensive analysis and includes 21 initiatives targeting specific building types, from single-family houses to multi-apartment buildings, office buildings and public buildings. Initiatives include, among others, an upgrade of the energy requirements for buildings and building parts, reinforcing of information activities, enhancement of data availability, financing, compliance, and steps to making the energy performance certificates more robust and ensure the further support of the energy renovation of buildings. Furthermore, the strategy includes a number of initiatives targeting training, education and innovation.

Since the transposition of the Directive 2010/31/EU in 2012, a large effort has been made by the Danish Energy Agency and others to raise public awareness on energy use. Information campaigns, web-based interactive tools regarding energy saving measures, etc., have been widely initiated and public awareness has risen considerably. Denmark has succeeded in making the EPC visible, rendering it a clear sales parameter in the market. It still remains to ensure that certificates are homogenous and of high quality, which is why this also is an important initiative in the Danish strategy for renovation of buildings.

An interesting initiative targeting single-family houses is the *"Bedre Bolig"* initiative which aims at accelerating energy renovation of private homes. The scheme is also part of the Danish government's growth plan and introduces a one-stop-shop for private home owners who aim for an energy renovation of their homes.

As for initiatives targeting energy efficiency in public buildings, Denmark has committed to reduce the energy consumption in buildings owned and used by the government by 14% by 2020, with 2006 as base year. The initiative is a continuation of a long term Danish effort since 2006. In parallel, existing voluntary agreements between the government and local/regional authorities to enhance energy efficiency in buildings used by these authorities, will be revised to reflect the Energy Efficiency Directive (EED). The commitment of 14% energy reduction by 2020 will at the same time complete the Danish implementation of Article 5 in the EED.

Implementation of the EPBD in Estonia

STATUS IN DECEMBER **2014**

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1. Introduction

In Estonia, the implementation of the Energy Performance of Buildings Directive (EPBD) is the overall responsibility of the Ministry of Economic Affairs and Communications. Improving the energy efficiency of buildings has been one of the priorities of the governmental energy and housing policy in Estonia. The amendments of the Building Act[1], which transposed the main elements of Directive 2002/91/EC, came into force in October 2006. However, the regulations transposing all the EPBD requirements were finalised in January 2009, and the main regulations, in compliance with Directive 2010/31/EC, came into force in January 2013. The Ministry of Economic Affairs and Communications plans to adopt even more strict energy performance requirements after 2016, but the existing legal acts do not yet foresee the application of more strict requirements. Before the EPBD requirements, there were no specific legal obligations, e.g., thermal transmittance values, or requirements for Technical Building Systems (TBS).

During 2010-2014, almost 200 M€ was spent on renovating public and apartment buildings to achieve higher energy efficiency, using different green investment schemes for each building category (subsidies amounted to about 30 M€ for apartment buildings, and 147 M€ for public buildings, respectively). Energy efficiency has been introduced as a new selling point in cases of sale or rental of property.

This report presents an overview of the current status of implementing and improving the EPBD in Estonia. It addresses certification, minimum requirements and inspection systems, as well as quality control mechanisms, training of Qualified Experts (QE), information campaigns, etc.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

The minimum energy performance requirements were launched in 2007 and came into force in January 2008. The energy performance requirements are mandatory for all new buildings (including residential, non-residential and public buildings) and for existing buildings undergoing major renovations, and include the methodology for proving compliance. Compared to the simple measured energy-based methodology used for certifying existing buildings, the calculation methodology for new buildings

NATIONAL WEBSITES

www.mkm.ee/en/objectives-activities/construction-and-housing-sector

www.kredex.ee/energy-efficiency

[1] *Amendments to the Building Act, the Building Association Act, Apartment Ownership Act and Equipment Energy Efficiency Act. 22.10.2006. RT I 2006, 43, 326.*

and also for major renovations is relatively complex, as it is mainly based on dynamic energy simulations.

The minimum energy performance requirements are expressed as a primary energy performance indicator calculated for the building according to its standardised use, and applied to the building as a whole. Data for standardised use includes a description of occupants, small power equipment and lighting usage profiles, operation times, as well as indoor climate requirements. The energy performance calculation takes into account the energy needs for space heating, Domestic Hot Water (DHW), cooling, lighting, ventilation, and electrical appliances. The minimum energy performance value characterises the primary energy use of the building; in other words, the delivered energy is multiplied by the primary energy factors of the energy carriers, and the exported energy multiplied by the same factors can be deducted. The maximum primary energy values are listed in Table 1.

Estonia has not set minimum requirements for U-values. The building has to meet the minimum energy performance requirements as a whole.

Requirements are also set for summer thermal comfort in buildings. For residential buildings, this requirement is defined as the hourly mean indoor temperature in excess of the maximum limit of 150 degree-hours (°C.h) over +27°C during the summertime period (from 1 June to 31 August). For compliance assessment, detailed procedures are described in regulation *"Methodology for calculating the energy performance of buildings"* [2]. Temperature calculations are needed for typical living rooms and bedrooms that are most likely to encounter overheating. The verification is to be conducted considering rooms as single zones and by using dynamic simulation software.

Table 1: Minimum energy performance requirements.

No.	Building type	Energy performance requirements (kWh/m²) (primary energy)	
		New building	Existing building (major renovations)
1	Detached houses	160	210
2	Apartment buildings	150	180
3	Office buildings and libraries	160	210
4	Commercial buildings	210	270
5	Public buildings	200	250
6	Shopping malls and terminals	230	280
7	Schools, universities	160	200
8	Kindergartens	190	240
9	Hospitals and other medical buildings	380	460

Compliance with the minimum energy performance requirements should be proven through an energy calculation of the building, using the prescribed methodology. Energy calculations for non-residential buildings must be executed by a dynamic energy simulation. For residential buildings, the monthly methodology is also accepted. All the input data, including requirements for the calculation tool, are specified in the Act of Minimum Requirements. As major renovations are defined any renovations involving more than 25% of the construction cost of a similar new building.

Primary energy requirements do not apply to renovations that do not fall under the definition of 'major renovations'. For non-major renovations, also no minimum requirements for building envelope elements apply and only the requirements set for TBS, i.e., when a system is replaced or a new system is installed, must these system performance requirements (for heating, DHW, cooling, ventilation and lighting systems) be followed.

For detached and terraced houses, compliance with the minimum energy performance requirements can be demonstrated by a simplified calculation of the specific heat loss through the building envelope. This method requires only envelope heat transfer coefficients (U) to be subjected to heat loss calculations for conduction and infiltration losses, and can be used if a mechanical supply and exhaust ventilation system with specified heat recovery and Specific Fan Power (SFP) is used. Depending on the heat source, tabulated specific heat loss values are set, so that they should comply with minimum energy performance requirements. With this method, no further energy calculation is required. For example, in the case of a ground source heat pump serving as the heat source, the tabulated maximum specific heat loss value to be fulfilled is 1.0 W/m².K, and in the case of a gas boiler, 0.6 W/m².K. It is important to note that these values are not U-values, but specific conduction and infiltration heat loss values calculated per heated floor area.

[2] *Ministry of Economic Affairs and Communications, Ordinance No. 58. RT I, 09.06.2015, 21 www.riigiteataja.ee/akt/109062015021*

I.i. Format of national transposition and implementation of existing regulations

The energy performance requirements for new buildings and major renovations of existing buildings are regulated by three acts:

> The 'Minimum Energy Performance Requirements' Act[3]. This act applies for new buildings and buildings undergoing major renovations, and includes the main requirements, e.g., maximum allowable primary energy consumption, general requirements for building envelope elements and TBS, and requirements for energy calculation tools. General requirements include a thermal comfort-based U-value requirement (0.5 W/m^2.K, building leakage rate requirements and some requirements for TBS, e.g., for mechanical ventilation and some individual metering requirements. In addition to these, there are no specific component-based requirements for new buildings and for buildings undergoing major renovations. Numeric energy performance requirements are set only for the building's primary energy consumption. Some recommendations for building envelope elements and TBS are given in the regulation, to be used as initial values in the design in order to help the designer achieve the requirements for primary energy consumption, while clearly stating that the final values depend on design solutions. Besides that, the regulation gives the definition and primary energy performance value for low-energy buildings and Nearly Zero-Energy Buildings (NZEBs). This act also includes primary energy factors of different energy carriers, shown in Table 2.

> The 'Calculation Methodology for Building Energy Performance Calculations' Act[4]. This act includes all the necessary information about the calculation of the energy performance, e.g., efficiencies of heating and ventilation systems, infiltration airflows, tabulated values of thermal bridges and standardised patterns of use of the 9 different building types and other energy calculation input data, as well as detailed calculation formulas and guidelines for energy calculations. Basically, this act provides guidance on how to run dynamic energy simulation that results in energy needs, as well as calculation rules and methods from energy needs to energy usage for delivered, exported and primary energy.

> The 'Requirements for Technical Building Systems' Act[5]. This act applies for buildings where smaller, rather than major, renovations will be done. It specifies system performance requirements for building service systems that will be installed or replaced (heating, DHW, ventilation, cooling and lighting).

I.ii. Cost-optimal procedure for setting energy performance requirements

In Estonia, the cost-optimal calculations were executed in 2011 following the guidelines of the Federation of European Heating, Ventilation and Air-Conditioning Associations (REHVA). The detailed report is available in English[6].

Cost-optimal calculations were executed for six building types: detached building, apartment building, nursing home, day-care centre, school building and office building. Those buildings were selected as the most commonly built new buildings. All the selected buildings were set as reference buildings. The cost-optimal calculation followed a 7-step procedure:

1. selection of the reference building/buildings;
2. definition of construction concepts based on the building envelope optimisation for four fixed specific heat loss levels (from business-as-usual constructions to highly insulated building envelopes);
3. specification of TBS;
4. energy simulations for specified construction concepts, from business-as-usual constructions to highly insulated building envelopes;
5. post-processing of the simulation results to calculate delivered, exported and primary energy;
6. economic calculations for construction cost and net present value calculations;
7. sensitivity analyses for the interest rate, the escalation of energy prices and other parameters.

In the selection process, different professional associations, universities and government agencies were involved, among others the Union of Estonian Architects, the Estonian Heating and Ventilation Association, and the Tallinn University of

Table 2: Primary energy factors.

Renewable energy (wood, biofuel)	0.75
District heating	0.9
Fossil fuels	1.0
Electricity	2.0

[3] www.riigiteataja.ee/akt/105092012004
[4] www.riigiteataja.ee/akt/118102012001
[5] www.riigiteataja.ee/akt/109112012012
[6] www.mkm.ee/sites/default/files/cost_optimal_and_nzeb_energy_performance_levels_for_buildings.pdf

Technology. The new energy performance requirements implemented in 2013 are based on the results of this cost-optimal study and improved minimum requirements for buildings energy efficiency (primary energy usage) are in cost-optimal range.

The current Estonian requirements also include the definition of a cost-optimal building (following REHVA definitions, where a cost-optimal building must ensure the lowest lifecycle cost over a period of 30 years for residential, and 20 years for non-residential buildings). In the new version of the requirements, the system boundaries have been modified so that the locally produced energy by Renewable Energy Sources (RES) has an effect on the energy performance ratio (Figure 1).

I.iii. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The current energy performance legislation includes the definition of NZEBs (nearly zero-energy) and net zero energy buildings. A NZEB is a building that is characterised by sound engineering solutions, considering the current best practices, on-site energy production by RES (the share of energy by RES is not fixed) and meets the set primary energy performance requirements shown in Table 3. The regulation also defines a net zero-energy building as a building whose

Figure 1: System boundary of minimum energy performance requirements.

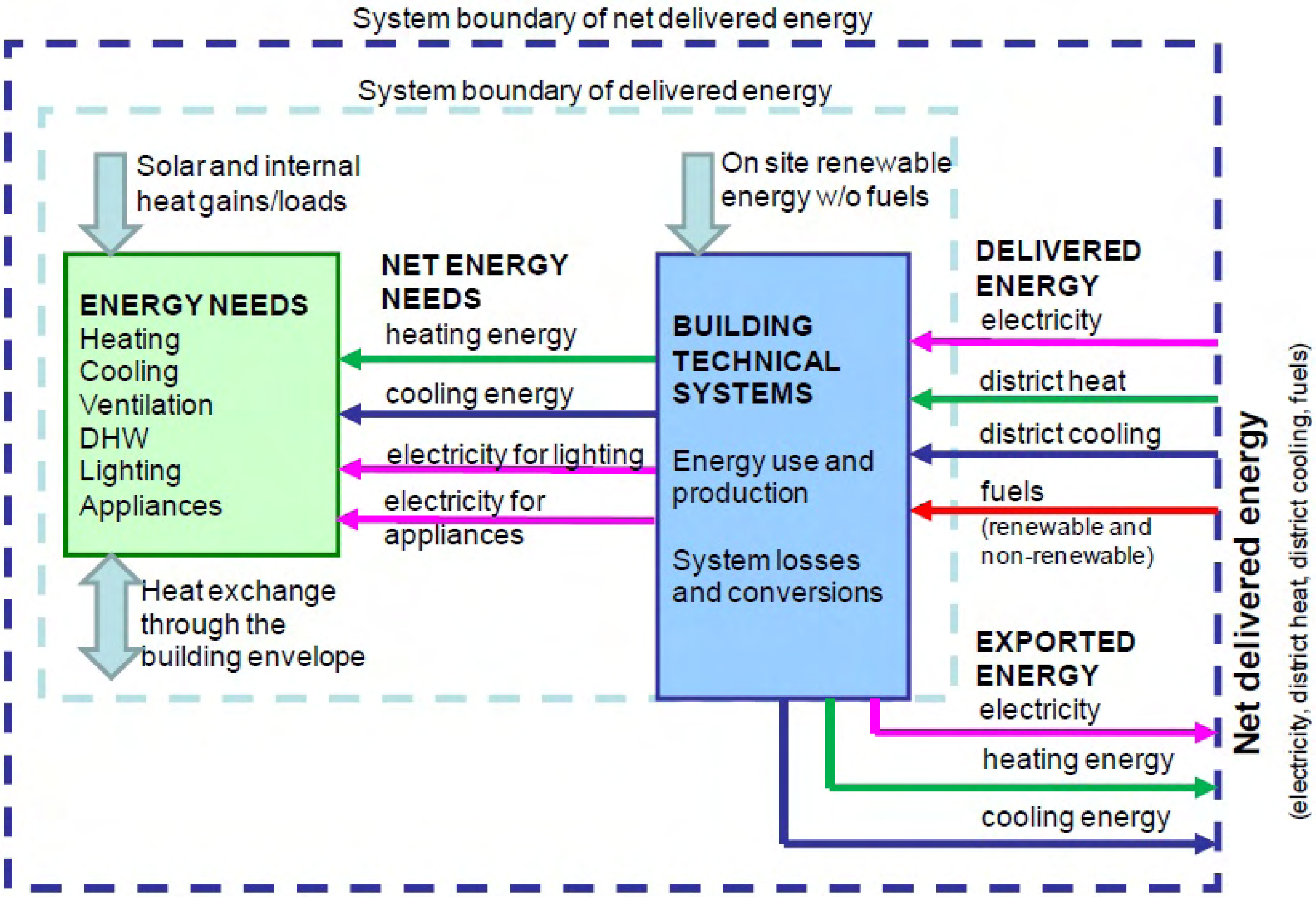


Table 3: Energy performance requirements for nearly zero-energy buildings and low-energy buildings.

No.	Building type	Energy performance requirements (kWh/m²) (primary energy)	
		NZEB	Low-energy building
1	Detached houses	50	120
2	Apartment buildings	100	120
3	Office buildings and libraries	100	130
4	Commercial buildings	130	160
5	Public buildings	120	150
6	Shopping malls and terminals	130	160
7	Schools, universities	90	120
8	Kindergartens	100	140
9	Hospitals and other medical buildings	270	300

primary energy performance indicator is 0 kWh/m^2.year. Delivered energy may be imported to a net zero-energy building if this is offset by energy fed into energy networks. Requirements for the NZEB and net zero-energy building are fully based on the primary energy indicator. There are no component-based requirements.

The action plan for the coming years will provide the next update of the energy performance requirements in 2016, and then a final update before the main objective in 2018-2019. After 31 December 2018, all new public buildings should be NZEB, and after 31 December 2020, all new buildings must be NZEB.

Figures and statistics on existing NZEBs

At the moment, there are no measured, documented and proven NZEBs in Estonia. There are projects in the design phase and under construction, but not in active use.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The regulation 'Requirements for Technical Building Systems' establishes requirements for improving the energy efficiency of existing TBS or part of the TBS, when a new technical system is being installed, or an existing technical system, or parts of it, are being replaced. Performance requirements are set for the heating, hot water, cooling, ventilation, and lighting systems.

Requirements do not apply to major renovations of existing buildings. Technical system requirements for major renovations are established in minimum energy performance requirements.

II.ii. Regulation of system performance, distinct from product or whole building performance

Performance requirements are set for installing or replacing the heating and the hot water system's heat source, cooling systems, AC and ventilation systems, and air-handling units.

For the heating and hot water systems, the requirement is that the heat source's primary energy efficiency (the efficiency or performance coefficient of the heat source divided by the primary energy factor of the energy carrier) must be at least 0.8.

For the cooling system, the performance requirement is that the air conditioner to be installed must have a SEER[7] with at least 5.1.

For the ventilation system, the requirement is that the performance efficiency of the heat recovery must be at least 70%. If the ventilation system requires the use of a liquid-coupled heat exchanger, then the efficiency of the heat recovery must be at least 50%. Specific fan power of the air-handling unit may not exceed 2.5 kW/(m^3/s).

II.iii. Provisions for installation, dimensioning, adjustment and control

TBS must be installed in accordance with good construction practices, including the adherence to relevant standards and installation instructions. Systems must be configured to the optimal level to serve the function of the specific space. If possible, automatically controlled systems should be preferred, and a centralised automation system, enabling centralised control and monitoring, is recommended. It is up to the owner and energy efficiency expert to choose the best technical solution for the specific case.

This is enforceable through the owner's supervision of the construction work. An expert can be hired on his behalf if the owner lacks the relevant skills and knowledge. Good construction practices are a key principle of the building code. If there is a difference of opinion as to whether this principle was followed, the matter can be settled in court.

II.iv. Encouragement of intelligent metering

In new buildings or existing buildings undergoing major renovations, and in which a separate part or parts of the building may have different owners, metering equipment must be installed in the heating system to determine the use of heating energy in the different parts of the building. Intelligent metering does not factor into the energy efficiency calculations or requirements.

II.v. Encouragement of active energy-saving control (automation, control and monitoring)

Active energy-saving control is used for lighting requirements. In case of new

[7] *SEER – Seasonal Energy Efficiency Ratio*

lighting installation or replacement of existing lighting in office buildings, educational buildings and research buildings in areas where lighting does not exceed 500 lux, the lighting may not exceed a specific power of 10 W/m^2. These buildings should also use lighting control that takes space usage and daylight level into account.

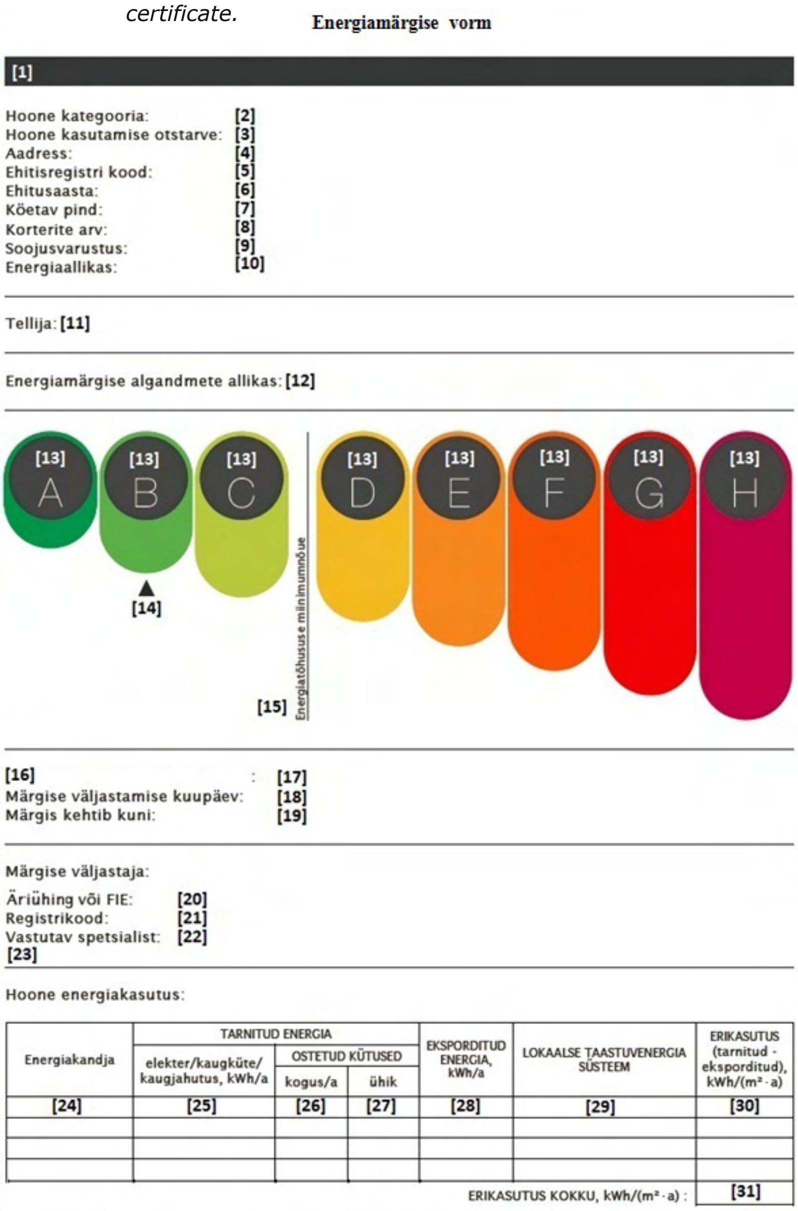
III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

Estonia has a public building register, named ‘Register of Construction Works’ (www.ehr.ee), through which experts issue Energy Performance Certificates (EPCs). This is the only way to issue an EPC. Information, as well as the EPCs that are issued through the register, are made publicly available to all citizens. Issuing EPCs through one register guarantees that all the EPCs are compiled in one database with all the related data and calculations.

Figure 2: Cover page of the energy performance certificate.



How flats are certified in apartment buildings

The EPC may be issued for a building, or for part of a building. However, an independent EPC is only provided to a part of the building if there is no central heating system in the building. So, for a building with a common central heating system, only one certificate can be issued for the whole building.

Format and content of the EPC

The EPC template was updated in 2013. The main changes, concerned the appearance of the certificate and were implemented to make the EPC more appealing and more easily readable.

The EPC includes a page with the energy label prominently visible. This page is meant for public display. The next pages form the main part of the EPC, and include the energy performance scale, minimum requirement level and other relevant information. If necessary, an additional page is added that contains a standardised list of recommendations, from which the certifier chooses the most relevant recommendations for the specific building. The recommendations include, e.g., Heating, Ventilation and Air-Conditioning (HVAC) systems, electricity use, and envelope elements. The EPC issuer marks the specific building elements and gives a statement about what type of works have to be performed and how it impacts the energy efficiency of the whole building. The new updated legislation includes a more detailed recommendations page for TBS.

For now, the EPC, both for new and existing buildings, is valid for 10 years. But, after 1 July 2015, EPCs for new buildings will be valid for just 2 years after the completion of the building. EPCs for existing buildings will still be valid for 10 years (Figure 2).

EPC activity levels

EPCs are required in Estonia since January 2009. As of the end of 2014, approximately 12,000 EPCs were issued (the total for new and existing buildings - see Figures 3 and 4).The number of EPCs issued by type is shown in Table 4.

A new version of the regulation for the energy certification of buildings ('The template of energy certificate and issuing procedure') came into force in

May 2013[8]. This regulation sets a procedure to determine the energy rating of buildings and the template of the EPC. The calculation methodology of the energy rating is the same for all buildings: residential, non-residential and public. There are two types of certificates: one for existing buildings, where the calculation methodology is based on the actual used primary energy, and one for new buildings, where the calculation is executed on the basis of standardised use.

Typical EPC costs

Certification of existing buildings is a relatively simple service. It typically costs from 100 € to 200 € per building, depending on its size. For a more in-depth analysis, an energy audit of the building should be conducted.

The cost of the certification of the new building depends on the building type. Non-residential buildings (e.g., offices) require use of a dynamic simulation tool. Certification of residential buildings that do not have cooling systems can be based on a degree-days calculation method. Therefore, the typical cost is difficult to forecast.

Assessor corps

The EPC is produced by an energy auditor. In order to obtain the necessary qualification, candidates must attend special courses and pass an exam. Higher technical education is needed in order to attend the courses. In Estonia, there is a public list of all energy auditors.

Compliance levels by sector

Analysis about compliance levels of EPCs is not yet performed, as the number of checked EPCs is relatively small at the moment.

Enforcement with building owners and real estate actors

An EPC is mandatory for renting or selling property. From May 2013, it is mandatory to add information about the EPC to the sale or rental advertisement. The Estonian Technical Surveillance Authority is in charge of checking the use of EPCs in case of selling or renting property.

Quality Assurance (QA) of EPCs

The Estonian Technical Surveillance Authority makes random checks on EPCs and deals with complaints. This Authority has the power to impose penalties for deviations from the building act. A total of 10 EPCs for existing buildings were checked in 2013, as it was the launch year for the EPC central database and the new regulations. In 2014, the number of EPCs checked rose to 115. Out of the ones inspected, 11 EPCs contained different types of small mistakes (i.e., mistakes in the calculation of degree days, or an EPC issued on a wrong form, etc.). The energy auditors who issued these EPCs were informed of the shortcomings by letter and, as a result, all the mistakes have been corrected. The number of EPCs checked by the Technical Surveillance Authority will increase in the coming years.

Figure 3:
Number of certificates issued for existing buildings from 2009 to March 2015.

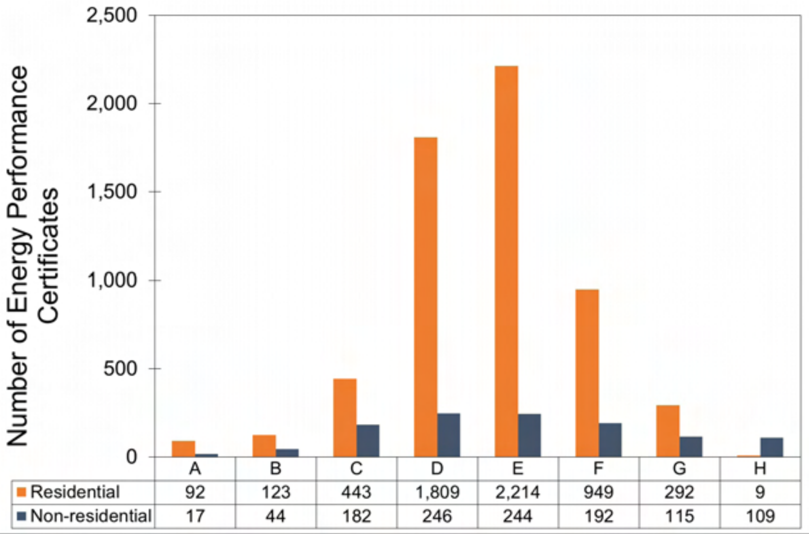
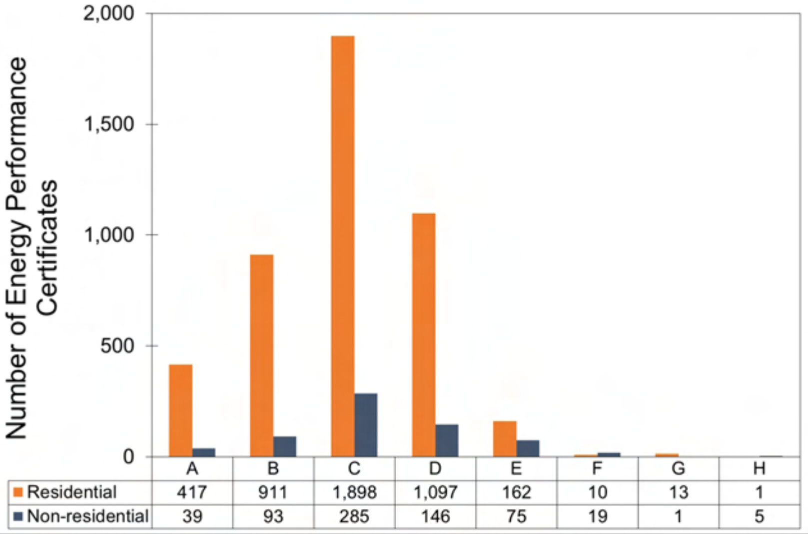


Figure 4:
Number of certificates issued for new buildings from 2009 to March 2015.



Residential buildings (new and renovated)	4,509
Residential buildings (existing)	5,931
Non-residential buildings (new and renovated)	663
Non-residential buildings (existing)	1,149

Table 4: Number of EPCs issued by type.

[8] www.riigiteataja.ee/akt/122012014005

The EPCs for new buildings are checked before issuing a building permit and form the basis of evaluation as to whether or not a building meets the minimum requirements for energy performance. The building permits are issued by the local government authority. This is why the EPCs for new buildings are submitted to the local government authority for inspection. A building permit is given only in the case that the energy performance requirements are met.

III.ii.Progress and current status on public and large buildings visited by the public

Overview

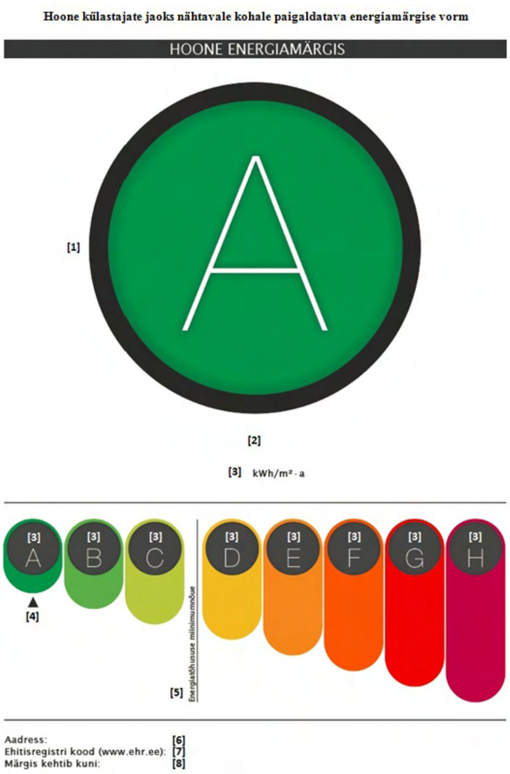
Current legislation requires an EPC for every public building used by the government that has a floor area larger than 500 m². The EPC must be placed in a location visible to visitors. After 9 July 2015, the requirements will be stricter and the display of the EPC in a visible place will be mandatory for all public buildings with a used area larger than 250 m².

Public buildings with the requirement to have and display an EPC are the focus of attention of the Technical Surveillance Authority in 2015. Letters in reminder of this requirement have been sent out during 2014, informing that inspections would commence in the second half of 2015.

Format and content of the EPC

The content of the EPC for public and large buildings is the same as of all other EPCs, whereas the format of the publicly displayed EPC is slightly different (Figure 5).

Figure 5: The energy performance certificate, which must be displayed in a visible area of a public building.



Frequency of updating

The EPC for public buildings is also valid for 10 years (the old EPC expires after a new one is issued), except for new buildings that are granted a building permit after 1 July 2015, in which case they are valid for only 2 years after the completion of the building.

Activity levels

The number of EPCs issued for public buildings in not known.

III.iii. Implementation of mandatory advertising requirement

Current regulations require an EPC for the renting and/or selling of buildings since January 2013. The National Building Act also requires advertisements to include at least the building energy class and the primary energy consumption per heated area. The compliance rate for advertisements has risen from 3% in 2013 to 10% by the end of 2014. The possible penalty for selling and renting real estate without an EPC is 600 € for natural persons and 1,600 € for corporations. By the end of 2014, the Technical Regulatory Authority, who is responsible for the enforcement of this obligation, had not issued any fines for missing EPC information in advertisements. Based on previous experiences of fines not working due to a systematic disregard for meeting legislation requirements, the Technical Regulatory Authority is of the opinion that alternative measures of imposing this obligation must be developed.

III.iv. Information campaigns

Public awareness for energy efficiency and energy certification systems is at a quite good level in the case of renting or buying buildings. People generally ask for the EPC, and the building law states that, in a case where a buyer or tenant enquires about the EPC, the seller has to provide the EPC.

Fund KredEx and the Ministry of Economic Affairs and Communications, together with the Tartu Regional Energy Agency organise a national energy week once a year. Fund KredEx has also carried out several other information campaigns, mostly targeted at apartment buildings, as their share is roughly 70% of the total residential building stock. These campaigns have been organised on an annual basis, to inform tenants of apartment buildings about energy saving measures and the potential magnitude of the savings, to give expert advice and to inform them about support provided by the state. Several methods have been used in these campaigns. Information has been distributed through TV, radio, print media, internet, street advertisements, training courses for persons responsible for building maintenance, etc. As a result of these campaigns, energy saving activities have taken off.

The Estonian Technical Surveillance Authority holds an information campaign[9] about the requirement to add information about the EPC to the property rental or sale advertisement (Figure 6).

Figure 6: Information campaign on adding information about the energy performance certificate to the property rental or sale advertisement.

III.v. Coverage of the national building stock

It is mandatory to have EPCs for new buildings built after July 2009. For existing buildings, it is mandatory to have an EPC for renting or selling property. In Estonia there are approximately 263,000 residential buildings and 43,000 non-residential buildings. Of these, 5,931 existing residential buildings have EPCs (2.3%) and 1,149 non-residential buildings have EPCs (2.7%).

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Estonia has adopted the alternative approach instead of mandatory inspections for heating and Air-Conditioning (AC) systems.

IV.i. Report on equivalence

The role of on-site heat generation in water-based heating systems is significantly lower than the heat supply from district heating. At the same time, the data of on-site heat generation devices that are being used, or even data of companies that are selling and installing the devices, was incomplete and unreliable. This type of data had not been recorded with much precision. With these restrictions in place, it was obvious that at the time of the inspection scheme's scheduled implementation, the requirement would have been unenforceable. Therefore, for boilers, Estonia adopted alternative measures for implementing Article 14 of the EPBD. Instead of implementing the inspection scheme, three specific measures were developed:

> Requirements were set in legislation for conducting energy audits of residential buildings. Energy audits have been conducted voluntarily, but at the same time, conducting an audit is one of the reconstruction activities subsidised by KredEx as a part of the reconstruction grant. KredEx also has had different versions of grants in place for small residential houses for the renewal of the heating system.

> The building act includes a requirement for boiler sellers to provide advice on demand to consumers whenever a new boiler is installed, or an existing boiler is replaced. Provision of advice on demand may include an on-site inspection of the system. If such an inspection is carried out, the inspection report should include information on options for boiler replacement, on other modifications to the heating systems, as well as on alternative solutions that would enable the energy-efficient operation of the system.

> In order to gain a better overview of the heating devices that are being used, the boiler must be registered when it is sold, and its rated output, efficiency and type of fuel must be recorded. The selling company must register the boiler in the National Building Register if its output is higher than 20 kW.

IV.ii. Progress and current status on AC systems

Detailing of activities to improve energy performance of air-conditioning systems

The use of AC systems is not widespread in buildings, due to the prevailing cold climate in Estonia. In cases where an AC

[9] *www.tja.ee/public/documents/Toostuohutus/Energiatohusus/Hoone_energiamargis_RUS_EST_koos_09_2014.pdf*

system is installed, it usually concerns small devices (heat pumps) with a rated output lower than 12 kW. Larger systems are usually installed in new buildings that must fulfil the minimum energy performance requirements in the current regulations. The Estonian Building Act establishes similar rules for AC systems as those for boilers when their rated power is above 12 kW.

3. A success story in EPBD implementation

Input data needs a clear procedure and format to be documented. For that purpose, Estonia has developed a special input data table, which is incorporated into the regulation. From January 2013, new updated minimum requirements and procedures for calculating an EPC came into force in Estonia. This legislation includes two acts: one is the 'Minimum requirements for energy performance' Act, which establishes maximum allowable primary energy consumption, and the second is the 'Methodology for calculating the energy performance of buildings' Act, which provides the methodology and instructions for energy calculations. In a similar fashion, the EPC calculation results have to be reported using a mandatory format within a results data form. Input and results data tables make EPC calculations transparent and enable the checking and reproduction of energy simulations, if necessary. Implementation of clear input data and results tables and the provision for easy control has raised the quality of EPC calculations and the reliability of the EPCs (Figure 7).

4. Conclusions, future plans

The Energy Performance of Building Directive (EPBD), Directive 2010/31/EC, has already been fully transposed into the national legislation. Updated requirements and new acts came into force in January 2013. Estonia will continue conducting information campaigns to improve the level of knowledge of building owners, designers, architects, as well as specialists working in the municipalities. The next update of the energy performance requirements will start in 2016, which will provide the final update before the main Nearly Zero-Energy Buildings (NZEBs) objective in 2018-2019.

Figure 7: Mandatory form that presents the results of energy calculations in Estonia.

Presentation of the results of the energy calculation

Information regarding the building			
Address			☐ New building
Year of completion of construction			☐ Major renovations
Heated area		m²	☐ Renovations
Net area		m²	☐ Existing building
Energy performance indicator		**kWh/(m² a)** (kWh per square meter of heated area)	

Summary of energy use	Purchased fuels amount/y	Purchased fuels unit of mass or volume	Delivered energy kWh/y	Delivered energy kWh/(a m²)	Exported energy kWh/y	Exported energy kWh/(a m²)	Energy carrier conversion factor -	Weighted energy consumption kWh/(a m²)
Electricity	-	-					2	
District heating								
Fuel 1								
Fuel 2								
...								
Total	-	-					-	

Total energy use	Electricity kWh/y	Heat kWh/y	Electricity kWh/(a m²)	Heat kWh/(a m²)
Heating system	-	-	-	-
Space heating				
Heating of ventilation air				
Heating of household water				
Ventilation system[1]		-		-
Cooling system				
Lighting		-		-
Appliances		-		-
Total (energy use of technical building systems)				

[1] The heating of ventilation air is regarded as part of the heating system

Local renewable and exported energy	Local renewable kWh/y	Local renewable kWh/(a m²)	Exported kWh/y	Exported kWh/(a m²)
Heat from solar energy				
Electricity from solar energy				

Net energy need	kWh/y	kWh/(a m²)
Space heating [2]		
Heating of ventilation air[3]		
Heating of household water		
Cooling		

Implementation of the EPBD in Finland

STATUS IN DECEMBER **2014**

1. Introduction

The Ministry of the Environment is responsible for the transposition and implementation of the Energy Performance of Buildings Directive (EPBD). Finland has had building energy efficiency regulations in the National Building Code since 1976. These regulations have been tightened several times, among others due to implementing the EPBD. Energy Performance Certificates (EPC) were introduced at the beginning of 2008, based on the Energy Certification of Buildings Act.

Due to Directive 2010/31/EU, minimum energy performance requirements for the construction of new buildings have been revised and minimum requirements for existing buildings undergoing renovation and retrofitting have been developed. The revised regulations for new buildings came into force in July 2012, whereas regulations for existing buildings on 1 June 2013, together with the revised legislation on energy performance certification for buildings.

For boiler and air-conditioning (AC) system inspections, Finland's parliament chose to use alternative measures (instead of compulsory inspection) in response to Articles 14 and 15 of Directive 2010/31/EU.

In April 2014, the advice programme 'Kutteri', which pertains to biofuel-fired heating, was started. This programme is implemented in cooperation with the Ministry of the Environment and organisations in the field.

Finally, the decree of the Ministry of the Environment on Nearly Zero-Energy Building (NZEB) measures was issued in August 2014. This decree laid out the basis for the national definitions on NZEB. The detailed definition will be finalised during the course of 2015 and the aim is to give the legislative proposal to the parliament in autumn 2016.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

Energy performance regulations are valid for new buildings under the regulations of the National Building Code of Finland. In February 2013, energy performance regulations were also given for the renovation and retrofitting of existing buildings.

I.i. Progress and current status

Finland's National Building Code has set minimum requirements for the thermal insulation and ventilation of new buildings since 1976. These requirements have been amended and enhanced several times to improve energy efficiency in buildings. Amendments were made in 2003, when the requirements were tightened by 25 – 30%, and in 2007, when the requirements were amended due to implementing the EPBD. During the most recent update (in December 2008), the minimum requirements for thermal insulation and ventilation were further tightened (by 30% in total) and came into force at the beginning of 2010.

The requirements for the overall energy consumption of a building were set with the new building code that came into force in July 2012. The overall energy consumption is calculated using standard user profiles and primary energy factors for different energy sources (Table 1). The aim of the new requirements is to reduce the energy consumption of all new buildings by 20% compared to previous requirements. The development of minimum requirements is shown in Table 2.

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Minimum energy performance requirements have also been developed for existing buildings undergoing renovation and/or retrofitting that is subject to a building permit, or when the use of a building is altered, or technical systems are repaired. It is also important that actions to improve the energy performance are taken in consideration of special features and intended uses of the building. The approach to improving energy efficiency is chosen in the planning phase of the renovation or retrofitting project, and it dictates the calculation methods, as well as minimum energy requirements to be used. The three approach options are depicted in Figure 1.

The energy performance regulations for existing buildings are part of the National Building Code. The decree came into force in June 2013 for public buildings and in September 2013 for other buildings.

Figure 1: Approaches to improving energy efficiency in a building project for renovation and retrofitting or altering the use of a building.

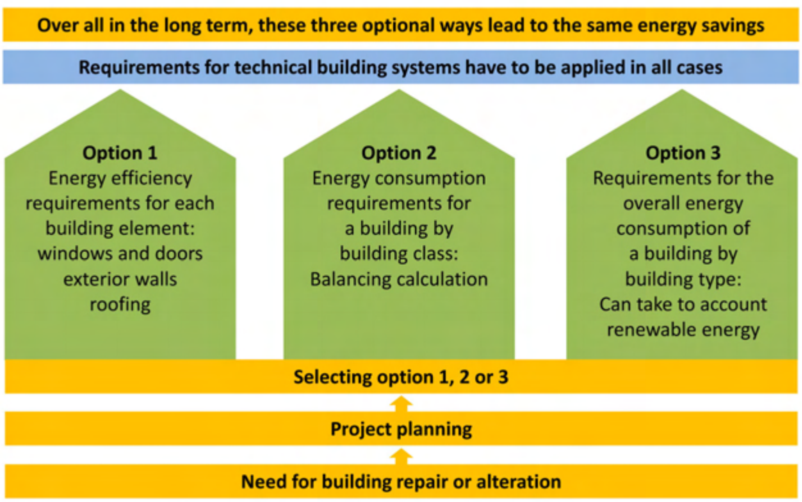

Table 1: Primary energy factors.

	Weighting factor for energy source in the new building code of 2012
Fossil fuels	1.0
Electricity	1.7
District heating	0.7
District cooling	0.4
Renewable fuels	0.5

Regulations for existing buildings, as well as all other relevant legislation referring to buildings, are being reviewed as a whole, as part of the ongoing work on NZEB legislation, leading to a legislative proposal to the parliament in autumn 2016.

I.ii. Format of national transposition and implementation of existing regulations

Energy requirements for new buildings

The minimum energy performance requirements have been revised for the construction of new buildings due to Directive 2010/31/EU. The approach, as set in the National Building Code of 2012, is based on overall energy consumption, which takes the energy source (primary energy factor) into account.

The current minimum performance calculations for new buildings are based on a national calculation method that follows the main principles of CEN standards. Both CEN standards, as well as other, more detailed calculation and simulation methods, can be used.

Requirements are given as a fixed value (kWh_E/m^2 - primary energy). Calculations include thermal comfort requirements, indoor-air quality requirements and infiltration, thermal bridges and shading devices. Evaluation of infiltration is either based on a site test, a quality audit, or an accepted building industry quality control method.

The National Building Code of 2012 sets maximum values for overall energy consumption (E-values) calculated using the primary energy factor (Table 3). The maximum values depend on the building type and, for single-family houses, also on the area of the building. The new building code does not exclude any heating sources. However, the code encourages the use of renewable energy sources and district heating, which have better primary energy

Table 2: Development of minimum requirements for new buildings (all building types).

U-values for building components $W/(m^2.K)$	1976	1978	1985	2003	2007	2010	2012
Walls	0.4	0.29	0.28	0.25	0.24	0.17 0.40 logwall	0.17 0.40 logwall
Roof	0.35	0.23	0.22	0.16	0.15	0.09	0.09
Floor	0.40	0.40	0.36	0.25	0.24	0.09/0.16/0.17 (1)	0.09/0.16/0.17 (2)
Windows	2.1	2.1	2.1	1.4	1.4	1.0	1.0
Doors	0.7	0.7	0.7	1.4	1.4	1.0	1.0
Other base values							
n_{50}-value	6	6	6	4	4	2	q_{50} (3) =4
Annual efficiency for heat recovery systems	0	0	0	30%	30%	45%	45%
Maximum values for energy consumption kWh_E/m^2.year E-value							Based on building type (4)

(1), (2) Base floor bordering on outside air = 0.09 $W/(m^2.K)$, building component against the ground = 0.16 $W/(m^2.K)$, base floor bordering on crawl space = 0.17 $W/(m^2.K)$.

(3) q_{50} is the air leakage value of the building envelope, measured in m^3 per building area. Before 2012, the n_{50}-value used was measured in m^3 per building volume.

(4) See Table 3.

Type of building	Maximum value for energy consumption per year, primary energy (calculated with weight factors of energy source)	
Single-family houses	Heated net area, A_{net}	E-value
	m^2	kWh_E/m^2.year
	A_{net}< 120 m^2	204
	120 m^2 ≤ A_{net} ≤ 150 m^2	372 - 1.4 · A_{net}
	150 m^2<A_{net} ≤ 600 m^2	173 - 0.07 · A_{net}
	A_{net}> 600 m^2	130
Single-family houses (log houses)	A_{net}< 120 m^2	229
	120 m^2 ≤ A_{net} ≤ 150 m^2	397 - 1.4 · A_{net}
	150 m^2<A_{net} ≤ 600 m^2	198 - 0.07 · A_{net}
	A_{net}>600 m^2	155
Row houses	150 kWh_E/m^2 per year	
Apartment buildings	130 kWh_E/m^2 per year	
Offices	170 kWh_E/m^2 per year	
Shops etc.	240 kWh_E/m^2 per year	
Hotels, motels etc.	240 kWh_E/m^2 per year	
Schools and day care centres	170 kWh_E/m^2 per year	
Sports halls	170 kWh_E/m^2 per year	
Hospitals	450 kWh_E/m^2 per year	
Other buildings	Energy consumption has to be calculated but no limit values	

Table 3: Maximum values for primary energy consumption (E-value) in different building types.

Minimum energy requirements by building element		
Building element	**Calculated requirement for a building built in late 1970s***	**Limit**
Exterior walls		
In renovation	Original U-value 0.40 W/(m^2.K) x 0.5 = 0.20	No more than 0.17 W/(m^2.K)
In changing use of building	Original U-value 0.40 W/(m2.K) x 0.5 = 0.20	At least 0.6 W/(m^2.K), or better
Roof		
In renovation	Original U-value 0.35 W/(m^2.K) x 0.5 = 0,175	No more than 0.09 W/(m^2.K)
In changing use of building	Original U-value 0.35 W/(m^2.K) x 0.5 =0.175	At least 0.6 W/(m^2.K), or better
Base floor	No set requirement, energy efficiency to be improved if possible	
Windows and doors		
New windows and doors	U-value 1.0 W/(m^2.K), or better	
Renovated windows and doors	No set requirement, heat retention to be improved when possible	

**Original U-values according to Building Code 1976.*

Table 4: Example of minimum energy requirements by building element for energy efficiency improvements in a late 1970s building.

factors than other energy sources. Other renewables (e.g., solar heat and power) are taken into account when calculating a building's primary energy needs.

Energy requirements for existing buildings

The feasibility of measures to improve the energy efficiency of an existing building are assessed on the basis of technical, operational and financial considerations. Energy efficiency improvements can be done using three alternative ways:

1) energy efficiency requirements for each building element;
2) energy consumption requirements for a building by building class; or
3) E-value requirements of a building by building type (as shown in Figure 1).

In the long term, these three options lead to the same overall energy savings. An example of the energy efficiency requirements for each building element is depicted in Table 4.

Building inspection authorities

An applicant for a building permit has to ensure that the construction will fulfil the requirements. This is done through calculations whereby the results must be shown to the municipal building inspection authorities responsible for inspecting the compliance of building permit applications.

Information to consumers and professionals

The new energy regulations have been disseminated to both professionals and consumers through various means, e.g., seminars, building fair events, presentations and articles. An information brochure on the new regulations for new buildings was published in 2012 (Figure 2). The brochure has been distributed to the municipal authorities working with building permits and they have been encouraged to further disseminate the information to their customers. The Ministry of the Environment provided training for the municipal building inspection authorities, and training and information are also available via several different training organisations all over the country.

The regulations were put in the spotlight during the annual National Housing Fair, held in July-August of 2012, 2013 and 2014, with approximately 120,000 – 140,000 visitors during each year. The regulations were also presented at the Helsinki Own Home Fair (held annually in April), in 2013 and 2014, with approximately 50,000 visitors per year.

Figure 2: Brochure on National Building Code.

Figure 3: FInZEB programme website.

I.iii. Cost-optimal procedure for setting energy performance requirements

In the national report submitted to the Commission in 2013, the average cost-optimal level of energy efficiency of buildings and building components for new buildings is 7% more efficient than the National Building Code regulations (Ministry of the Environment Decree 2/11). For renovations and retrofitting of existing buildings, the cost-optimal level of energy efficiency for buildings and building components is 8% more efficient than the National Building Code regulations (Ministry of the Environment Decree 4/13). The calculations were conducted for single-family homes, apartment buildings, office buildings, and commercial buildings.

Table 5 presents the variation range between the cost-optimal level and energy regulations. The difference is calculated by weighting the result with the number of new and renovated buildings. The cost-optimal level is slightly more efficient than the regulations demand for both new buildings and renovated buildings. Differences are within the set 15% tolerance margin.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

In 2012, the Ministry of the Environment launched an intensive process to gather the necessary input for the preparation of the national plan for NZEBs. The national plan for increasing the number of NZEBs was drawn up and submitted to the European Commission in October 2012. As the cost-optimal levels for NZEBs have been calculated, the aim is to give technical recommendations for NZEBs in 2015. For this, an extensive collaborative and consultative effort, the FInZEB programme, was launched in March 2014, with major industry and non-profit stakeholders contributing to a detailed, national definition of NZEB (Figure 3).

Table 5: Summary of cost-optimal tolerances in reference buildings, according to primary energy.

Reference building	**Cost-optimal tolerance** (E-value) kWh_E/m^2	**Regulations in force for reference buildings** (E-value) kWh_E/m^2	**Difference** (weighted by numbers of buildings)
New construction	114–211	119–247	-7%
Renovation and retrofitting	122–289	136–335	-8%

In August 2014, the decree of the Ministry of the Environment on NZEB measures was given, laying the basis for the national definitions on NZEB. In autumn 2014, the ministry started the legislative work in order to set the national definitions on NZEB. The aim is that NZEB requirements could be determined in early 2017 and come into force at the beginning of 2018.

To encourage construction of very energy efficient houses, e.g., low-energy, or Nearly Zero-Energy single-family houses, the Ministry of the Environment finances the national "Energy Efficient Home" information campaign (EEH campaign), coordinated by Motiva, a state-owned company promoting energy and material efficiency. The EEH campaign monitors, for several single-family homes, the actual energy use during a 12 to 24 months long period, from construction phase to completion. The campaign is well linked to organisations and companies operating in the field. Its core element is the website www.energiatehokaskoti.fi, which provides comprehensive information, follow-up statistics on the monitored houses, best practices based on case buildings, tools and practical guidance towards achieving energy efficiency and NZEBs (Figure 4).

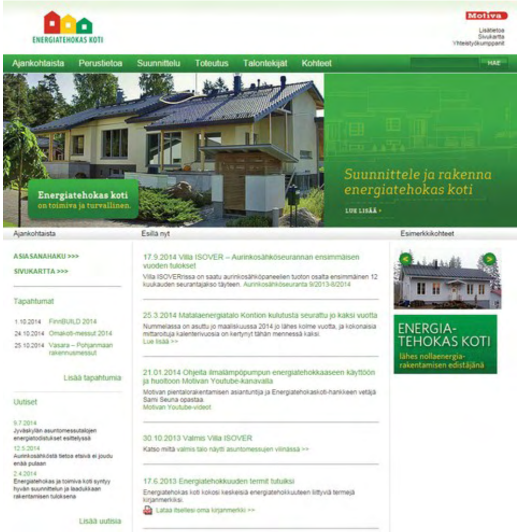

Figure 4: EEH campaign website.

Figures and statistics on existing NZEBs

Very energy efficient pilot buildings of different types – blocks of flats, offices, single-family houses – have been built in various areas in Finland. As no definition for NZEBs is yet available, these buildings are used as examples by the building industry to develop possible solutions and definitions for NZEBs. As part of the EEH campaign, more detailed statistics will be gathered during 2015.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The Finnish national strategy on renovation of buildings, based on Article 4 of Directive 2012/27/EU, focuses less on developing a set of requirements and instead seeks ways to initiate energy efficiency improvements in public and private residential and commercial buildings, to be implemented during both planned and corrective maintenance. This involves innovative means related to decision making, services and financing of renovations, which are initiated through communication measures, as well as training and improving the know-how of building professionals.

Finland has chosen to implement voluntary measures instead of the 3% renovation requirement set by the central government in Directive 2012/27/EU, Article 5. These measures are calculated to achieve similar savings as the set requirement. The types of measures include projects for reducing tenant electricity use, premium/sanction contracts for building management, energy repairs in building maintenance, user support for energy efficiency, energy efficiency measures included in renovation projects, as well as improving space efficiency. For other public services, e.g., municipalities, the demands set by Directive 2012/27/EU are met by the voluntary energy efficiency agreement (EEA) scheme for municipalities. EEAs have no direct link to the EPBD, but they contain many measures that enhance the energy efficiency of buildings, e.g., energy audits and consumption monitoring.

II. REQUIREMENTS ON TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The Finnish National Building Code states that, when the technical systems of any type of existing buildings are renovated, modernised or replaced, the following requirements must be met:

1) The minimum annual efficiency of heat recovery must be at least 45%;
2) The maximum specific fan power (SFP) of a mechanical supply and exhaust system is 2.0 kW/(m³/s);

3) The maximum specific fan power of a mechanical exhaust air system is 1.0 kW/(m^3/s);
4) The maximum specific fan power of an air-conditioning system is 2.5 kW/(m^3/s);
5) The efficiency of heating systems must be improved where possible when the related equipment and systems are renewed.

Minimum requirements have also been set for oil- and gas-fired boilers. These will be superseded by the ecodesign requirements set for boilers. There are also requirements set for other technical building systems, e.g., for different temperature levels of Domestic Hot Water (DHW) systems or for apartment-specific water meters.

For new buildings, the calculation method is based on the E-value (primary energy demand), which takes the building as a whole into account.

II.ii. Provisions for installation, dimensioning, adjustment and control

For renovation or retrofitting works that require a building permit, the party engaged in the building project is responsible of ensuring the proper and energy efficient use and functioning of heating and ventilation systems[1]. This party is also responsible (strongly encouraged, but not required) for implementing the balancing and adjusting of the building technical systems in case one or more of the following measures have been conducted: improvement of insulation or tightness of the building envelope; renewal or improvement of the energy efficiency of windows; improvement of ventilation.

The information on conducted measures is presented to the building inspector during the final review. The same applies for new buildings; the required documentation has to be made available for inspection during the final review.

II.iii. Encouragement of intelligent metering

Intelligent metering (hourly-based metering) has been introduced almost completely in Finland following the introduction of legislation on the energy markets in 2009. This legislation sets requirements for companies operating in the production and distribution of energy to offer end-users up-to-date information on energy consumption as well as services to improve end-user energy efficiency. There is also a standing recommendation for energy metering (electricity) existing in the energy production industry. From the beginning of 2014, over 96% of metering points are hourly metered and remotely read (automatic meter reading, AMR). By law, individual meters for cold and warm water must be installed in new buildings since 2011. It is not mandatory to use the readings as a basis for billing. The same applies to the renovation of buildings. Intelligent metering enables the collection of more useful data to be presented in EPCs. Meters relate to the building as a whole and do not target individual heating, ventilation and air-conditioning (HVAC) systems.

II.iv. Encouragement of active energy-saving control (automation, control and monitoring)

Requirements (for e.g., cooling and ventilation systems, electricity or AC metering) enable active energy-savings control.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

Legislation to implement the requirements of Directive 2010/31/EU was adopted at the beginning of 2013 and came into force in June 2013. All requirements apply to private and public buildings.

Energy Performance Certificates (EPCs) are needed for all new buildings along with a building permit application.

For existing buildings, an EPC is needed when the building (or a part of a building, e.g., an apartment) is sold or rented. For residential apartment buildings and single-family houses built on or after 1980, the requirement took effect in June 2013 whereas for row-houses, offices and commercial buildings in July 2014. EPCs for institutional care, assembly and educational buildings are required after July 2015. For single-family homes built before 1980, the new requirement takes

[1] *The building permit process set in the Building Code demands that the proper and energy efficient use and functioning of those systems must be recorded and shown at the final review/inspection.*

effect on July 2017. The requirement is the same for private and public buildings.

The Ministry of the Environment is responsible for legislation and guidelines regarding EPCs, EPCs templates and other instructions concerning the issuance of certificates.

The EPC is produced by a Qualified Expert (QE). The Housing Finance and Development Centre of Finland (ARA) is the administrative authority ensuring the quality of certificates and QEs and the appropriate preparation and use of the certificates. As the responsible authority, it can also make compliance checks of issued certificates. Additionally, the ARA can initiate enforcement measures in case of negligence on the part of the building owner or the QE. Measures are administrative, not penal, and include requests, warnings, orders, conditional fines, and suspension of the QE. Quality procedures of the energy performance certification system were launched by the ARA in the beginning of June 2013.

According to the new legislation, the ARA is responsible for developing the new EPC database. The database will list all EPCs and act as a registry for the QEs. Legislation concerning the uptake of the developed database was approved and came into force in spring 2015. Data on EPCs on new buildings has been collected since 2009. Before the current phase, the database collected only statistical data (energy class, building type, geographical distribution) on the total number of certificates, provided by the local building authorities approving the building permits.

How flats are certified in apartment buildings

Energy performance certification extends to the whole building or a significant portion of the building if the building has multiple usage areas. Single flats are not certified separately.

Format and content of the EPC

The legislation adopted in February 2013 changed energy certification procedures and the layout of EPCs. The new EPC layout is shown in Figure 5. Certification requirements, as well as the format and content of the EPC, are the same for residential, non-residential and public buildings.

The energy label classifies buildings on an efficiency scale, ranging from A (high energy efficiency) to G (poor energy efficiency). As an example, the efficiency scale for apartment buildings is shown in Table 6.

Energy performance is based on overall primary energy consumption (kWh_E/m^2.year), taking the energy source (primary resource factor) into account. Primary energy factors for energy sources are fixed in the National Building Code as described previously in Table 2. The energy certificate is always based on calculated energy consumption, which makes it possible to compare different buildings, instead of different users.

For existing buildings, information on the available actual energy consumption has to be reported. A QE must inspect the renovated building and assess the energy efficiency of the building elements and components, as well as the technical systems (external walls, doors, windows, heating and DHW systems, ventilation systems, lighting and other electrical systems, e.g., electrical heating systems). An on-site inspection for renovated buildings is required.

The QE must suggest cost-effective energy-saving measures to be included in the EPC. Because there are no general lists of recommended energy-saving measures, these recommendations depend on the expert's skills and knowledge. Savings in

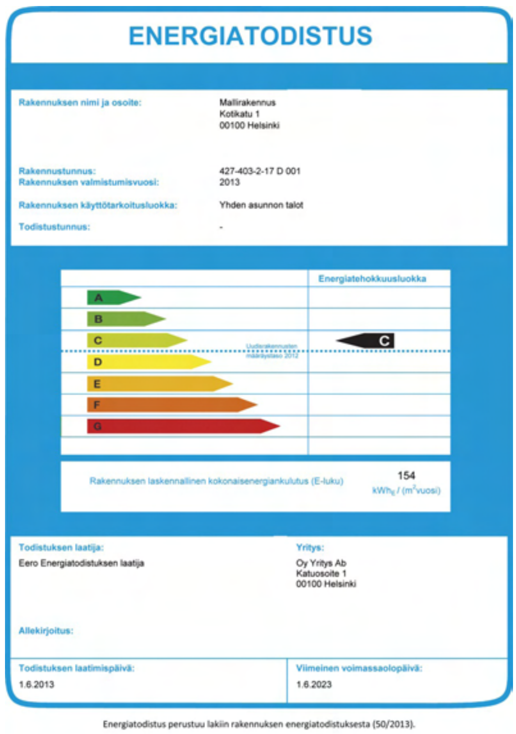

Figure 5: New format of the EPC.

Table 6: Efficiency scale for apartment buildings.

Energy efficiency class	Total energy consumption, E-value (kWh_E/m^2.year)
A	E-value ≤ 75
B	76 ≤ E-value ≤ 100
C	101 ≤ E-value ≤ 130
D	131 ≤ E-value ≤ 160
E	161 ≤ E-value ≤ 190
F	191 ≤ E-value ≤ 240
G	241 ≤ E-value

kWh_E/year must be calculated in detail for each measure for every building.

The EPC is valid for 10 years. However, it is recommended, though not required, that the certificate is updated following major reconstruction of the building envelope or the technical systems, even if the works take place before the expiry date.

EPC activity levels

Since the legislation changed in June 2013, about 62,672 EPCs have been sent to the ARA, of which 34,034 have been produced in 2015. After the new EPC database came into use, statistics on the distribution of the EPCs by building type or by building ownership (public/private) have become available.

Typical EPC costs

The cost of the EPC depends on the building type and size. For example, in 2013, as the new law came into force, the price of an EPC was 275 - 345 € for a new single-family house (EPC issued with the building permit application), 495 - 520 € for an existing single-family house, 600 - 780 € for an existing apartment building, and 500 - 655 € for an existing row house. Since 2013, prices have gone down, and the price of an EPC for a new single-family house is about 150 - 200 €, and for an existing single-family house 300 - 360 €. Price updates for larger residential buildings are not yet available. Costs of EPCs for buildings other than residential are not monitored because they were only made mandatory after July 2014.

Assessor corps

According to the new legislation from June 2013, the EPC is always issued by a QE. The Ministry of the Environment has designated two accreditation bodies – *'FISE ry'* and *'Kiinteistöalan Koulutussäätiö ry'* – to approve QEs. There are two levels of QEs, with the higher level needed for buildings requiring dynamic simulations (e.g., for new buildings with cooling facilities). To apply for accreditation, the expert must have suitable training and education background (e.g., a degree in building technology or architecture or, for the higher level, a master's degree in building technology or related field), the lack of which can be compensated with work experience. The qualification has to be approved by a test administered by the accreditation bodies, and is valid for seven years, after which it needs to be renewed. There currently are over 2,182 QEs altogether, with 238 experts possessing higher level qualifications, though not all are active. Qualification and accreditation for QEs is the same for all building types, public and private.

As of 1 May 2015, the QEs must be registered with the ARA EPC database to be able to produce and sign EPCs. There are altogether 757 registered QEs, of which 566 with base level qualifications, and 191 with higher level qualifications.

Enforcement with building owners and real estate actors

The building owner is responsible for ensuring that an EPC is issued for the building. As the administrative authority, the ARA can initiate enforcement measures in case of negligence on the part of the building owner. Measures are administrative, not penal, and include orders, warnings, prohibitions and conditional fines. The ARA also has the right to have the EPC made, in case it is missing.

Real estate agents are controlled by the Regional State Administrative Agencies, and are required to ensure that the energy class of a building that is being sold or rented is posted with advertisements and other marketing materials, and that the EPC can be viewed by potential buyers or tenants during the transaction process. Until the end of 2014, no penalties were yet issued to building owners nor real estate agents.

The mandatory requirement to display the energy class of the building in commercial advertisements is included in the new legislation on energy performance of buildings that came into force on 1 June 2013 and it applies to different building types in accordance with the calendar set by the legislation.

Quality Assurance (QA) of EPCs

The ARA controls EPCs based on Directive 2010/31/EU, Article 18, Appendix II, and partly checks the data input of building information, the accuracy of the presented calculations, and the appropriateness of suggestions given for improving energy efficiency. As the national database is under development, the checks are performed based on documentation requested from the QE.

In 2013, altogether 120 EPCs – mainly EPCs for single-family homes and a few apartment buildings – were checked (about 2% of EPCs issued). Based on the checks of the EPCs, the ARA issued warnings to some QEs (e.g., poor quality/miscalculation of EPC).

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The administration system and the enforcement system, both are the same for all types of buildings, private and public alike.

Activity levels

The energy certification of public buildings is followed through the voluntary energy efficiency agreement (EEA) scheme for municipalities since 2009. Information is gathered yearly from participating municipalities, towns and cities to be used in a comprehensive monitoring and reporting system. According to the monitoring, over 3,000 EPCs altogether have been issued for buildings owned by the public sector since 2008. The total number of EPCs in the public sector is listed in Figure 6 by building type.

According to the new legislation, per 1 July 2014, the energy certificate must be displayed so as to be visible to the public in buildings where over 500 m^2 of total useful floor area is occupied by public authorities and visited by the public. In addition, the energy certificate must be displayed so as to be visible to the public in all buildings that already have an energy certificate and that have over 500 m^2 of total useful floor area visited by the public. Previously, the requirement for the useful floor area was 1,000 m^2. After 1 July 2015, the floor area is reduced to 250 m^2. The display rule is controlled by the ARA. However, there have not been any controls yet, as the requirement came into force in July 2014. According to the EEA scheme, monitoring is based on information from 2013 and EPCs are made visible in 44 municipalities altogether, but the number of buildings is not monitored. Respectively, these municipalities represent over 20% of the Finnish population, and the EEA scheme coverage in the public sector is close to 80% of the population.

Costs

As new legislation on EPCs comes into force in stages and regulation for public and large buildings takes effect from 1 July 2014 and 1 July 2015 onwards, there are no statistics as of yet on the costs for the new type of certification for public and large buildings.

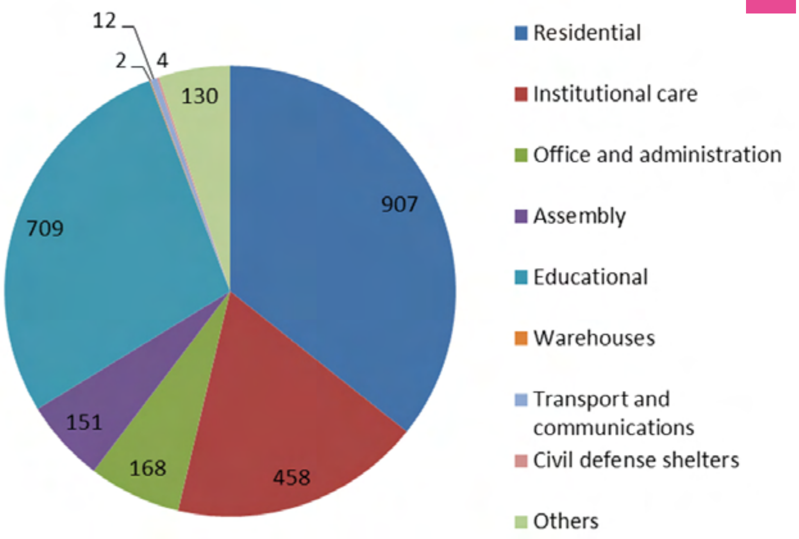

Figure 6: Public buildings, EPCs by building type, 2008-2013.

III.iii. Information campaigns

The ministry has assigned Motiva the coordination of a national information campaign on energy certificates since 2008. The key information source of the campaign is a web portal (www.motiva.fi/energiatodistus) with detailed information on the certification procedures and a FAQ section, links to certification models, materials and guidebooks, as well as other relevant information (Figure 7). Motiva also maintains a help desk (Figure 8) and service centre that answers questions put forth by consumers, homeowners and professionals, including QEs. According to help desk statistics, the need for information is steady, and the number of calls, questions and visits to the website increased in abundance as the new legislation came into force.

Motiva has been encouraging networking between QEs through annual workshops since 2009. Motiva has also arranged other seminars and workshops for both professionals and consumers. Seminars have been well attended, with 100 - 200 participants each.

Consumers and homeowners have been informed through many channels: news and press articles, press releases, as well as annually held popular events such as the Own Home Fair and the National Housing Fair (Figure 9), which are the largest events.

III.iv. Coverage of the national building stock

There were 1,483,990 buildings altogether in Finland (455 million m^2) at the end of 2013. Residential buildings comprise 85% of all buildings (1,265,547). Of all residential buildings, 1,128,366 are single-family homes. The building stock has grown by over 9,000 buildings in 2013. The 17,600 EPCs issued thus represent 1.2% of the building stock.

Figure 7:
EPC Brochure.

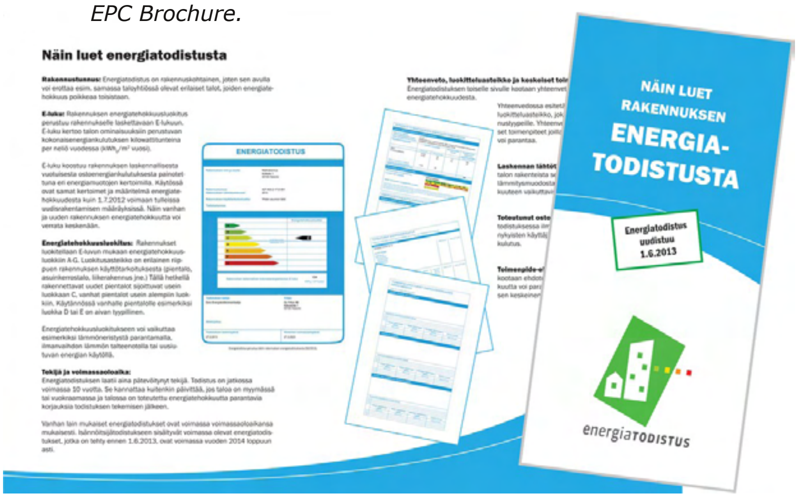

Figure 8:
EPC helpdesk website.

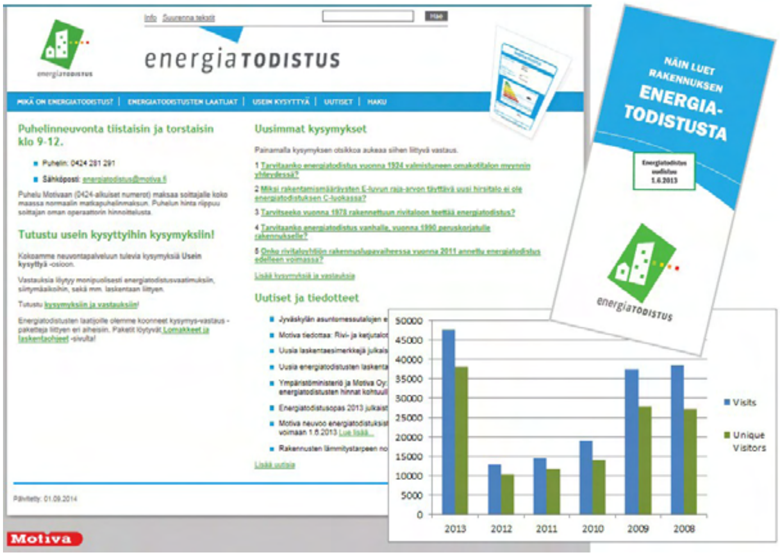

Figure 9:
EPC (current form 2014) shown at the National Housing Fair.

Energy performance certification is estimated to be quite common in blocks of flats as well as in row houses, with requirements in force since 2008. However, it is estimated that energy performance certification is not very common for existing small houses, with requirements in force since 2013, neither for older homes (built before 1980), with requirements coming into force in 2017. Although there are many small houses in Finland, only less than 20,000 are sold annually; this means that the uptake of certification in existing small houses is slow. EPCs are mandatory for all new buildings.

As the national energy performance certification database is in use as of 1 May 2015, the statistics on certification coverage become more accurate.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Finland has adopted the alternative approach for enhancing the efficiency of boiler-based heating systems (oil-, biofuel and biomass- and gas-fired) since the implementation of the EPBD in 2007. Upon implementing Directive 2010/31/EU in 2013, the alternative approach has also been adopted for air-conditioning (AC) systems.

IV.i. Report on equivalence

Since the implementation of Directive 2002/91/EC, Finland has adopted the alternative approach (model B) for enhancing the efficiency of boiler-based heating systems. In estimating the equivalence with actual inspections, estimates from experts, statistics as well as various preliminary studies were used in addition to the information gathered in the oil-sector voluntary energy efficiency agreement scheme '*Höylä*'. The equivalence was estimated for oil, biofuel, biomass and gas-fired heating boilers for the period 2013 - 2015.

With the implementation of Directive 2010/31/EU, the alternative model was also adopted for AC systems, with the annual savings through this approach estimated at 6.5 - 17.8 GWh compared to the annual 5.2 - 15.7 GWh achieved through mandatory inspections. The alternative approach covers AC systems of over 12 kWh, systems of under 12 kWh (mostly air-to-air heat pumps), as well as systems using district cooling.

IV.ii. Progress and current status on heating systems

Detailing of activities to improve energy performance of heating systems

The activities in improving energy performance of heating systems are divided by system type: measures have been planned for oil-, biofuel and biomass- and gas-fired boilers. Activities are centred on voluntary energy efficiency agreements in the oil sector '*Höylä*', the bioenergy sector '*Kutteri*' and the gas sector. Through the agreement schemes, information and advice on selecting and using boilers, as well as encouraging regular maintenance measures, is passed on through leaflets, articles and guides aimed at both consumers, as well as professionals working in the field (Figure 10). Savings are based on measures (numbers of actions per year) reported in the EEAs, with examples listed in Table 7.

In the oil sector, a voluntary efficiency inspection method for oil-fired boilers is available, as well as recommendations for a heating system condition survey for small family homes. The main advocates are the Finnish Petroleum Federation and '*Lämmitysenergiayhdistys ry*'.

In the bioenergy sector, information and advice on selecting and using wood-fired boilers is available through a guidebook and a website produced by Motiva Oy (Figure 11). An inspection method comparable to the one in the oil sector is being planned.

Gas-fired boilers are a distinct minority in Finland, amounting to only 5% of heating energy consumption of single-family homes. Information on gas heating, as well as guides on gas heating systems is available through the Finnish Gas Association.

Impact and equivalence assessment

Based on calculations for 2013 - 2015, the total estimated energy savings from mandatory inspections of heating systems account 260 – 540 GWh, whereas from the alternative approach, 330 – 650 GWh. Calculations are based on information described in the equivalence reports, relying on national statistics, expert estimates and studies, as well as data gathered on measures performed, e.g., in the '*Höylä*' programme (as in Table 7).

Of the 1.1 million small single-family homes in Finland, 208,000 are heated with oil, 171,000 with wood and other biofuels, and only 4,000 with gas. The rest are heated mainly with electricity or district heat and other means (heat pumps, solar, etc.). Of all building types, 40.5% are heated with oil, bioenergy or gas, 38.5% are heated with electricity, and 11.7% are heated with district heat. The rest (9.5%) are listed as other (solar, various types of heat pumps, coal, etc.).

Costs and benefits

In comparison with the mandatory inspections, the alternative approach proved to be more cost-effective. The costs were estimated comparing the overall costs of

Figure 10: Information on 'Höylä' is distributed to consumers via the magazine 'Lämmöllä' ('with warmth').

Table 7: Measures (numbers of actions per year) reported in the 'Höylä' energy efficiency agreement (EEA).

Measures	2012	2011	2010
Overhaul, EPBD-advice given	63,525	83,260	78,200
Repairs suggested	19,727	13,950	19,300
Boiler replacement	2,600	3,430	3,600
Burner replacement	5,920	7,578	8,000
Regulator replacement	4,499	7,030	5,900
Other repairs	4,961	17,260	6,700
Repairs planned	1,155	1,820	2,100

Figure 11: Brochure on wood-fired boilers.

the systems, including fuel prices. The cost effects of the mandatory inspections for oil-fired boilers were positive because of higher fuel prices, but the cost effects on biofuel, biomass and gas-fired boilers were negative. Also, the annual costs for the consumers would be higher if mandatory inspections were required.

IV.iii. Progress and current status on AC systems

Detailing of activities to improve energy performance of air-conditioning systems

The alternative approach to enhance the energy efficiency of AC systems was implemented in 2013 (1 June 2013).

The alternative approach consists of specific advisory measures, the uptake of the voluntary energy efficiency inspection of ventilation systems, as well as many other measures that support the enhancement of energy efficiency of AC systems, e.g., building codes, tax reductions, voluntary energy efficiency agreements, energy audits and energy performance certificates.

The Ministry of the Environment commissioned a preliminary study on the implementation of the alternative approach for AC systems in 2013. In conclusion of the study, the Ministry of the Environment appointed Motiva Oy as coordinator for implementing the alternative approach, starting from autumn 2014. Motiva acts as the coordinator implementing the various measures, initiating communication and gathering necessary monitoring information.

In 2013 and 2014, information on the energy efficiency of cooling, in both households and offices, was distributed in various ways. For households, videos on the proper use of air-to-air heat pumps, a guidebook for vacation homes, as well as advice on summertime cooling (including use of ventilation in cooling, as well as proper use of fans) were produced (Figure 12).

The development of the voluntary inspection method for ventilation and AC systems continues, the inspection method was piloted in several buildings (blocks of flats, school buildings and in multi-user office buildings) and the methods will be published as technical guides for building professionals.

Figure 12: Brochure for vacation homes on energy efficient use of ventilation and cooling.

Impact and equivalence assessment

The scope of the alternative approach covers all AC systems: systems over 12 kW, systems under 12 kW (air-to-air heat pumps), and district cooling systems. The targeted energy use of cooling electricity is 377 GWh/year, due to the wider target group. This is over 100 GWh more than the 279 GWh/year that was covered by the mandatory inspections approach. The annual savings of the alternative approach are estimated to be 6.5 - 17.8 GWh compared to the 5.22 - 15.7 GWh achieved through mandatory inspections. The savings for the alternative approach were based on estimates calculated for different types of buildings of different ages in a combination of preliminary studies and expert evaluations on the effects of different measures (such as changing the base temperature, night-time cooling, anticipatory maintenance, etc.), as well as simulations on energy use in cooling systems. The estimated yearly energy use in cooling systems is approximately 377 GWh, which is about 0.4% of all electricity use in Finland, and about 0.9% of electricity use in buildings. There are about 37,000 cooling systems with a cooling area of 23 million m^2.

The alternative approach has been in full operation since the end of 2014.

Costs and benefits

As the alternative approach to improving the energy efficiency of AC systems was selected in Finland, the cost-effectiveness was deemed as one major contributor. For the government, the costs of the mandatory inspections and the alternative approach did not vary significantly, but since the costs of the mandatory inspections for consumers and companies were significantly higher than the costs of the alternative approach, the alternative approach was deemed more cost-effective. The mandatory inspections approach would also have demanded the production and maintenance of costly monitoring and control systems.

3. A success story in EPBD implementation

There has been a major trend in Finland to develop and implement the many aspects of the Directive 2002/91/EC into Finnish legislation and building culture, in close cooperation with the significant parties in the construction and building maintenance fields.

As the Finnish National Building Codes are developed, professionals and major organisations in the field are consulted and take an active part in the work, through preliminary studies and consultation forums.

The proposals for national definitions and guidelines for NZEBs are being developed in the FInZEB programme with active involvement of professional organisations from the construction industry, the building design and planning fields. Through many workshops and studies, the optimal levels for planning and constructing NZEBs are being developed by the very professionals that will be implementing the regulations and methods in their own work.

The involvement of professionals is also visible in the implementation of the EPCs. Organisations in both the building ownership as well as building maintenance sectors are involved in both developing the national transposition and disseminating EPCs. Through workshops and networking forums, the Finnish authorities are in constant communication with the professionals to ensure compliance and quality of energy performance certification.

As Finland has developed a widely used and very comprehensive system of the voluntary energy efficiency agreements scheme (EEA scheme), the many aspects of the EPBD are built into the aims and goals of the voluntary agreements. The EEAs play a key role in implementing the Energy Efficiency Directive in Finland. The major organisations and companies in the building sector are involved and actively participate in both building sector agreements and have been able to achieve significant energy savings.

Cooperation with the building and construction sectors and active involvement of field professionals has ensured that there is a high degree of compliance with the legislation – laws, decrees and building codes. Their early involvement also ensures increased acceptance of jointly developed measures.

4. Conclusions, future plans

Energy use in buildings covers approximately 40% of Finnish energy end-use. This means that all possible measures must be taken to achieve the energy efficiency objectives. Following the adoption of new legislation transposing

Directive 2002/91/EC in February 2013, the preconditions for successful implementation have been set.

After all measures are introduced, access to information and tools necessary to be able to comply with the legislation must be ensured. This means extensive and continuous work also in the future and especially to disseminating information to professionals and consumers. Detailed guidebooks, practical examples and comprehensive training are still essential for different professionals to ensure smooth implementation of the directive.

Well-tried practices, such as energy efficiency agreement schemes and existing web portals, have proved to be an excellent basis for providing information on, e.g., training programmes and advisory services, as well as on monitoring and reporting, and will continue to be so in the future.

The implementation process, the effectiveness of the measures and the quality of work will be monitored to ensure that the challenging objectives will be achieved and that relevant resources are proportionate.

Implementation of the EPBD in France

STATUS IN DECEMBER **2014**

1. Introduction

The implementation of the Energy Performance of Buildings Directive (EPBD) is the responsibility of the French Ministries of Ecology and Housing. In order to replicate the successful transposition of Directive 91/2002/EC, France has been working on implementing the Directive 2010/31/EU since its publication. Law 2010/788 of 12 July 2010 and the regulation that followed have significantly improved the Energy Performance Certificate (EPC) process, while the new thermal regulation, RT 2012, has brought energy efficiency of new buildings to the level of Nearly Zero-Energy Buildings (NZEB).

This report is structured around four main parts, each one giving an overview of the EPBD current status of implementation on a certain topic. These four parts concern requirements on buildings' energy performance, Technical Building Systems (TBS), EPCs and inspection for heating and Air-Conditioning (AC) systems. There is one last additional part highlighting a specific point considered in France successful within the EPBD implementation: the positive effect of mandatory advertising requirements of EPCs.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

New residential and non-residential buildings

The first thermal regulation in response to the EPBD was the RT 2005 *(Réglementation Thermique 2005)*, introduced in 2006. It concerned all new buildings, both residential and non-residential (including public buildings), and set maximum energy consumption along with minimum requirements on some elements such as envelope insulation, and Heating Ventilation and Air-Conditioning (HVAC) systems. It has since been replaced by a new regulation, the RT 2012 *(Réglementation Thermique 2012)*, mandatory only for some public buildings since the end of 2011, and for all new constructions since 2013. This regulation is the result of a two year-long dialogue with all stakeholders, including seven consultative conferences where the work in progress was presented. The next thermal regulation is planned for 2018 and it will present even more ambitious objectives, since all new buildings would then be "positive energy buildings". These requirements will first be applied during the year 2016 to public buildings.

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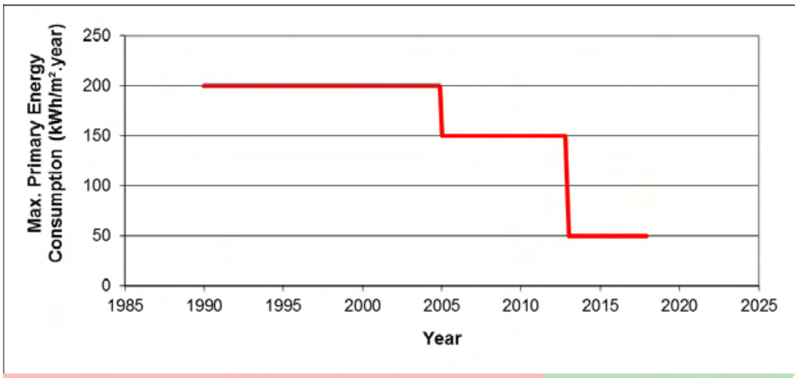
NATIONAL WEBSITES

www.developpement-durable.gouv.fr, www.rt-batiment.fr, www.ademe.fr

Figure 1: Evolution of requirements (new buildings).



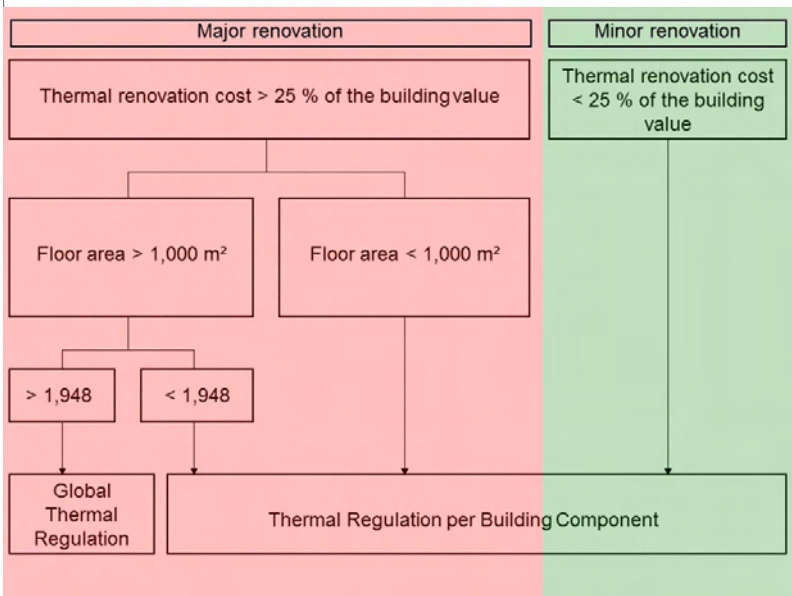


Figure 2: Thermal Regulations for existing buildings.

Existing residential and non-residential buildings

Following the publication of RT 2005, two regulations were introduced for existing buildings. The first one, called *"RT par élément"* (Regulation by Building Component), was published in late 2007 and the second one, called *"RT globale"* (Global Thermal Regulation), was introduced in April 2008. Figure 2 shows how to determine the relevant regulation, depending on the renovation type (major or minor).

I.ii. Format of national transposition and implementation of existing regulations

New residential and non-residential buildings

The RT 2012 is structured around three performance requirements:

> the requirement for minimum energy efficiency of buildings, which imposes a limitation on energy demand (heating, cooling and lighting) based on the bioclimatic conception (B_{bio}) of the project, whereby the B_{bio} value has to be lower than a maximum value called B_{biomax};

> the requirements for primary energy consumption, which impose a limitation on primary energy consumed (C_{pe}) for the combined use of heating, cooling, Domestic Hot Water (DHW), lighting and auxiliaries (pumps and fans), whereby the C_{pe} has to be lower than a maximum value called C_{pemax};

> the requirement for summer comfort, where the ambient indoor temperature of the building, reached after the 5 hottest days of the year (T_{ic}), cannot exceed a reference level calculated for each project, whereby T_{ic} has to be lower than a maximum reference value called T_{icref}.

These three coefficients are calculated through TH-BCE, a dynamic hourly methodology (calculations are run every hour of a full year), which describes each component of the building envelope, as well as its energy systems[1].

The values of B_{biomax} and C_{pemax} are absolute values, based on standard benchmarks depending on the building type (Table 1) and are modulated by local climate, altitude and immediate environment factors.

Additionally, in order to ensure that residential structures are correctly built, upon completion of the building, Qualified Experts (QEs) have to check their airtightness which cannot exceed 0.6 (m³/h)/m² for single-family houses and 1 (m³/h)/m² for apartment buildings.

Finally, the RT 2012 includes requirements for renewable energy use. It takes different forms depending on the energy type (for example a minimum of 2 m² for solar panels), but it should amount to at least 5 kWh_{EP}/m².year.

Existing residential and non-residential buildings

As previously described, there are two regulations for existing buildings. Which of the two applies depends on the building size and the extent of the renovation (Figure 2). The Regulation by Building Component is based on minimum requirements for the different components of the building (envelope and systems) (Table 2). Shading devices are mandatory only if they already existed before the renovation. There are no minimum requirements for thermal bridges.

The Global Thermal Regulation is based on overall consumption with minimum requirements for each component of the building (envelope and technical systems). Energy performance is assessed using a complex hourly methodology, called TH-CE ex, based on the new buildings' methodology[2].

[1] *Th-BCE calculation core: www.rt-batiment.fr/batiments-neufs/reglementation-thermique-2012/logiciels-dapplication.html*

[2] *Table 2: Some requirements for existing buildings in the Regulation by Building Components.*

I.iii. Cost-optimal procedure for setting energy performance requirements

Cost-optimality of the French thermal regulations has been analysed in compliance with the EPBD. The conclusions drawn are summarised below.

New residential buildings

Based on a representative sample of newly constructed residential buildings (3 individual houses and 3 apartment buildings), the mean value of maximum primary energy consumption (C_{pemax}) has been calculated to 54 kWh/m².year. In order to determine the cost-optimal level, approximately 140 calculations were done for 4 construction packages in 3 areas with differing climates and the costs were calculated from both the macroeconomic and the financial perspective. Figure 3 shows the plots for one type of individual house. The cost-optimal level determined is between 59.4 kWh/m².year and 84.1 kWh/m².year, which represent a 6.5% improvement beyond the cost-optimal level.

Existing residential buildings

This study is based on a representative sample of existing buildings (4 individual houses and 6 apartment buildings) and the results depend on which regulation is applied. The calculation procedure was similar to the one for new buildings, except that there were 6 different improvement packages, which bring the calculation number to 260. For both regulation cases, mean values have been weighted by representative reference buildings.

The Global Thermal Regulation presents a mean maximum consumption of 134.2 kWh/m².year whereas the cost-optimal level is between 118.2 kWh/m².year and 130.1 kWh/m².year. The mean deviation calculated is just 3.1% below cost-optimal.

The Regulation by Building Component has also been evaluated for major renovations. Its mean maximum consumption is 133.1 kWh/m².year whereas the cost-optimal level is between 105.5 kWh/m².year and 124.6 kWh/m².year. This is 6.8% better than cost-optimal.

New and existing non-residential buildings

The methodology was the same for non-residential buildings. The sample contained 4 new buildings (an office, a school, a large shop and a hospital) and 8 existing ones (two office buildings, two schools, a hotel, a shop, a gymnasium and a hospital), with 4 and 6 improvement packages respectively. However, the plots did not consistently show a visible cost-optimal level. When visible (as on Figure 4), the difference between cost-optimal level and regulation was less than 15%.

Table 1: B_{biomax} and C_{pemax} for various new buildings' typologies.

		B_{biomax}	C_{pemax} (kWh/m².year)
Individual House	EC1	60	50
	EC2	80	60
Apartment Building	EC1	60	90
	EC2	90	105
Office Building	EC1	70	70
	EC2	140	110
Secondary Education (Day Time)	EC1	40	55
	EC2	50	70
Secondary Education (Night Time)	EC1	60	90
	EC2	90	105
Shop	EC1	140	320
	EC2	250	520
Catering 2 meals/day 6 days a week	EC1	75	110
	EC2	85	125
Hospital (Day Time)	EC1	230	270
	EC2	270	330
Hospital (Night Time)	EC1	120	130
	EC2	180	190

EC1 : Air-Conditioning not required
EC2 : Air-Conditioning required
B_{biomax} : Maximum Bioclimatic need (without unity)
C_{pemax} : Maximum primary energy consumption

Table 2: Some requirements for existing buildings in the Regulation by Building Components.

Component	Climatic zone	Minimum requirement
Insulation materials of external opaque walls	H1, H2	U = 0.435 W/m².K
	H3	U = 0.5 W/m².K
Glazing	H1, H2, H3	U = 2 W/m².K
Boiler	H1, H2, H3	Minimal efficiency from 89.0% to 90.9% for a nominal power from 20 to 400 kW Minimal efficiency over 90.9% for a nominal power over 400 kW

France is divided in 3 climatic zones from the colder, H1 to the warmer, H3
R - Thermal resistance
U - Thermal transmission

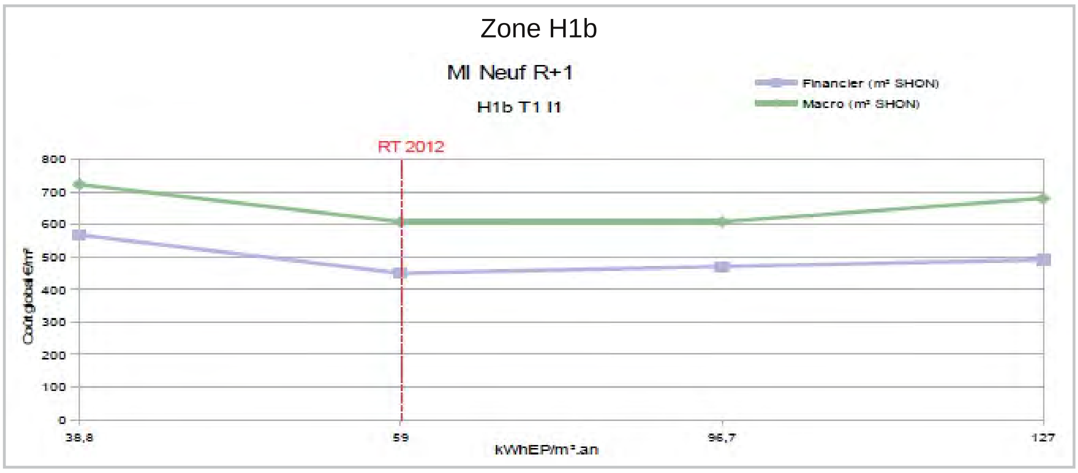


Figure 3: Cost-optimality curve for one type of new individual house - primary energy.

87 kWh EP / m²	87 kWh EP / m²

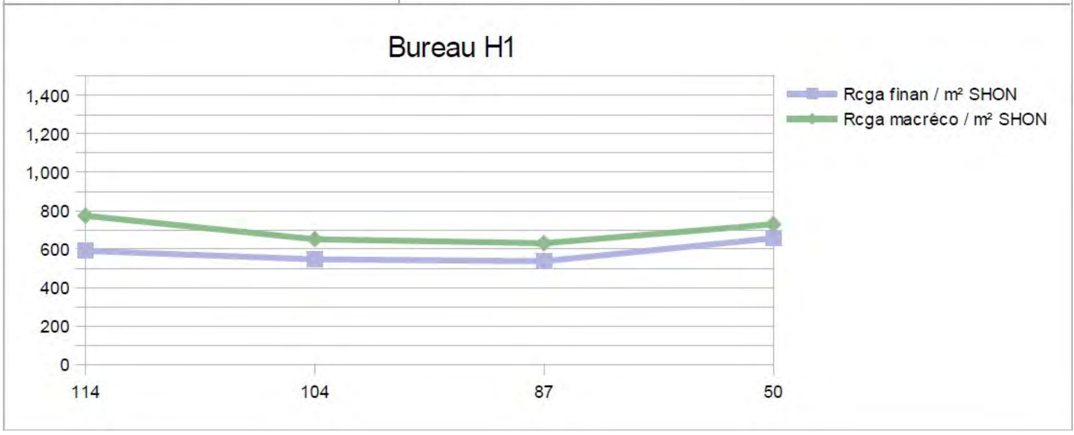


Figure 4: Cost-optimality curve for a non-residential building (office building) – primary energy.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

In France, NZEBs are called "Low Consumption Energy Buildings" (*Bâtiments Basse Consommation* - BBC), and were originally a quality seal for buildings with very low energy consumption, and in the case of individual houses, they included in particular a great proportion of Renewable Energy Sources (RES). Since 2013, all new buildings are mandatory NZEBs since requirements for Low Consumption Energy Buildings match the RT2012. Therefore, the cost-optimal level for NZEB has been evaluated along with the RT2012 one.

Although regulations for existing buildings are quite ambitious, renovated buildings do not systematically reach the NZEB level. The French Government has therefore developed several quality seals in order to encourage owners to go beyond the regulation requirements.

For existing residential buildings there are two quality seals: "High Performance Energy 2009" (HPE 2009), demanding a level of 150 kWh/m².year, and "Low Energy Consumption Renovation 2009" (BBCR 2009), demanding a level of 80 kWh/m².year.

For existing non-residential buildings there is only one quality seal also called "Low Energy Consumption Renovation 2009" (BBCR 2009). It certifies that the consumption of energy of the renovated building is at least 40% less than the reference building (the same building, with specified envelope and systems).

Figures and statistics on existing NZEBs

Three hundred thirty five thousand (335,000) new houses (300,000 apartments and 35,000 individual houses) were certified NZEBs before the RT2012 enforcement. In addition, there have been around 465,000 new houses certified since the enforcement of RT2012. Hence, the current number of new NZEB houses can be estimated to be approximately 800,000.

On the renovation side, 26,172 houses were given the Low Energy Consumption Renovation 2009 quality seal. For non-residential buildings, more than 2 million constructed m² are certified NZEBs, and about 640,000 renovated m² have been given the Low Energy Consumption Renovation 2009 quality seal.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Article 4 of the EED

In order to promote thermal renovation France has established several measures for both residential and non-residential buildings.

In 2013, the National Plan for Housing Thermal Renovation was launched. It is based on 3 pillars:

> assisting private individuals with free independent advice;
> improving financing thanks to optimised grants based on households incomes;
> raising the skills of the construction sector to handle the cost and quality of the renovation.

Concurrently with this national plan, local authorities made more than 80 project proposals in order to work closer with both private and public landlords. The best projects have been nationally promoted as good examples of local work.

Concerning non-residential buildings, a charter has been signed by the French Government and major companies, showing a commitment for energy efficiency by everyone involved.

To encourage professionals to build-up their skills, there will be some financial support to owners whose renovations are made by qualified workers.

Finally, a fund for guarantee of loans with higher risk that will reimburse banks in case of non-payment will be established, aiming to mobilise investments.

Article 5 of the EED

In order to implement Article 5 of the EED, France has chosen an alternative option. Indeed, in the *"Grenelle de l'Environnement"* laws (voted in 2009 and 2010), there is a goal for a 40% primary energy reduction until 2020 for all the buildings owned by the French Government. Based on the results of energy audits on a representative sample of the building stock, this would represent 10,131 GWh (primary energy) saved. In comparison, the 3% renovation proposed in the EED would lead to only 2,477 GWh (primary energy) saved.

Three types of action will help to reach this ambitious goal:

> renovation carried out by French authorities;
> a better use of the building;
> selling the unused buildings in order to have them renovated by a private landlord.

II. REQUIREMENTS ON TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, hot water, air-conditioning and large ventilation systems

As explained before, the thermal regulation for new buildings sets general performance objectives. Therefore, it does not include any requirements on systems' efficiency. However, such requirements exist in the two thermal regulations for existing buildings.

Both these regulations share some rules, especially for DHW, setting maximum heat loss depending on the boiler size, and giving European Norms 89 and 26 as a reference for some systems' performance.

The Regulation by Building Component gives a minimum efficiency around 90% for boilers and a coefficient of performance (COP) of 3.2 for heat pumps on heating mode. For AC units under 12 kW, the energy efficiency rating should be at least 3.0. For other AC systems the efficiency should be between 2.6 and 3.0. Ventilation unit consumption should not exceed 0.25 Wh/m^3 for residential buildings and 0.3 Wh/m^3 for non-residential buildings.

II.ii. Applicability to new, replacement and upgraded systems in existing buildings

For existing buildings, each time a new system is installed or replaces an old one, its performance has to meet the requirements of Global Thermal Regulation if the project meets the criteria of a major renovation. If it is not classified as a major renovation, it has to meet the requirements of the Regulation by Building Component.

II.iii. Provisions for installation, dimensioning, adjustment and control

Installation, dimensioning, adjustment and control are handled in the Standardised Technical Documents (*"Documents Techniques Unifiés"*), a set of rules acknowledged by the professionals, and they are not a purely regulation matter.

If the planned installation is regarded as under-sized, the TH-BCE and TH-CE ex calculation software will display an error message and may not run the calculation to the end. Over-sizing penalises the calculated energy needs, but there is no legal limit.

II.iv. Encouragement of intelligent metering

Intelligent meters for both electricity ("Linky") and gas ("Gazpar") are to be widely deployed, with a target of full national coverage by 2021. The deployment will be carried out by the Electricity Network of France (ERDF) and the Gas Network of France (GRDF). There are no requirements for intelligent metering for individual TBS.

The initial target for the number of houses with intelligent meters by 2016 is set at 3 million. As a test, by the end of 2011 Linky was already installed in 300,000 houses in two different regions, with more than 90% satisfied household users. In 2014, there have been several ERDF invitations to tender, and the second semester of 2015 will see the beginning of the wide installation of these meters.

II.v. Encouragement of active energy-saving control (automation, control and monitoring)

For each energy use, the RT2012 and the RT Global include requirements to install active energy-saving control systems:

> Heating and cooling systems have to be automatically regulated in accordance with internal temperature and offer the possibility to be switched off manually.

> For building with discontinuous occupation, the heating system must include four operating modes: comfort, reduced heating, frost-free and switched off. These four modes should be controlled by a clock-based automation, but could also be manually programmed.

> Any door giving access to an air-conditioned area must close automatically after crossing.

> For mechanical ventilation systems, air flow manual modification must be temporised.

> Artificial lighting systems must switch off automatically when the lit area is not occupied, or when natural lighting levels are sufficient.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The French EPC, called "*Diagnostic de Performance Energétique* (DPE)", was introduced in France in 2006 and is produced by a QE. For both existing and new buildings, issuing an EPC involves the QE assessing the thermal efficiency of the building following an on-site visit, where the envelope, HVAC and DHW systems are inspected. Once issued, the EPC is automatically sent to the EPC national database (mandatory since 2013), and is valid for 10 years.

How flats are certified in apartment buildings

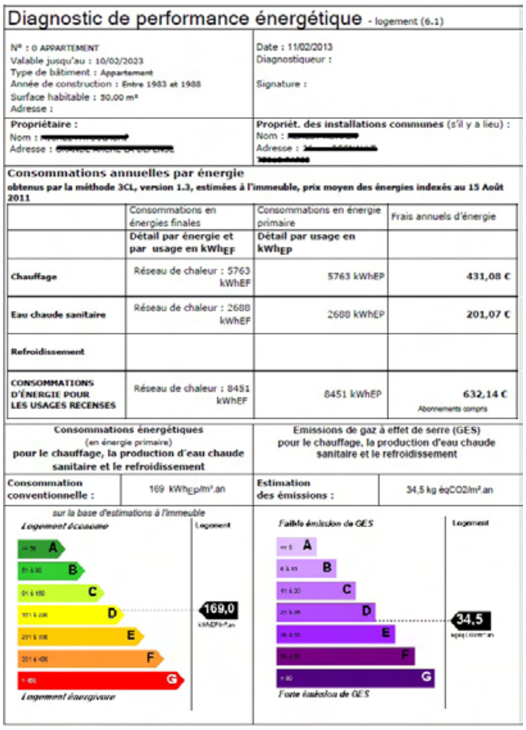
As displayed on Table 3, the energy performance can either be estimated (using a calculation methodology) or measured (using energy bills), depending on the building's nature. For buildings with a collective heating system, if an EPC is issued for the whole building, individual EPCs can be drawn for each apartment, using a factor that takes into account its floor size, the size and the direction of its windows and the size of the walls giving onto unheated premises.

Format and content of the EPC

The first page of the EPC shows the calculated or measured consumption of heating, cooling, DHW, etc., expressed in final and primary energy and the corresponding annual costs. It also displays the energy label along with the greenhouse gas emission label. Those labels classify buildings on an energy consumption (or greenhouse gas emission) scale ranging from A (< 50 kWh/m².year primary energy or < 5 kg/m².year CO_2 equivalent) to G (> 450 kWh/m².year or > 80 kg/m².year CO_2 equivalent). The second and third pages show technical information about the building and

Table 3: EPC method used.

	Residential building						**Non-residential** building
	EPC for the **whole** building or house		**Flat** with **collective heating system** when there already is an **EPC for the whole building**	EPC not concerning the whole building			
				Flat with **individual heating system**		**Flat** with **collective heating system**	
	Building built **before 1948**	Building built **after 1948**		Building built **before 1948**	Building built **after 1948**		
Performance **assessed**		X	**EPC** for the **whole building**		X		
Performance **measured**	X			X		X	X



Diagnostic de performance énergétique - logement (6.1)

N° : 0 APPARTEMENT Valable jusqu'au : 10/02/2023 Type de bâtiment : Appartement Année de construction : Entre 1983 et 1988 Surface habitable : 50.00 m² Adresse :	Date : 11/02/2013 Diagnostiqueur : Signature :
Propriétaire : Nom : [redacted] Adresse : [redacted]	Propriét. des installations communes (s'il y a lieu) : Nom : [redacted] Adresse : [redacted]

Consommations annuelles par énergie
obtenus par la méthode 3CL, version 1.3, estimées à l'immeuble, prix moyen des énergies indexés au 15 Août 2011

	Consommations en énergies finales	Consommations en énergie primaire	Frais annuels d'énergie
	Détail par énergie et par usage en kWh_{EF}	Détail par usage en kWh_{EP}	
Chauffage	Réseau de chaleur : 5763 kWhEF	5763 kWhEP	431,08 €
Eau chaude sanitaire	Réseau de chaleur : 2688 kWhEF	2688 kWhEP	201,07 €
Refroidissement			
CONSOMMATIONS D'ÉNERGIE POUR LES USAGES RECENSES	Réseau de chaleur : 8451 kWhEF	8451 kWhEP	632,14 € Abonnements compris

Consommations énergétiques (en énergie primaire) pour le chauffage, la production d'eau chaude sanitaire et le refroidissement		Emissions de gaz à effet de serre (GES) pour le chauffage, la production d'eau chaude sanitaire et le refroidissement	
Consommation conventionnelle :	169 $kWh_{EP}/m^2.an$	Estimation des émissions :	34,5 kg éqCO_2/m².an

Diagnostic de performance énergétique - logement (6.1)

Recommandations d'amélioration énergétique

Sont présentées dans le tableau suivant quelques mesures visant à réduire vos consommations d'énergie.
Les consommations, économies, efforts et retours sur investissement proposés ici sont donnés à titre indicatif et séparément les uns des autres.
Certains coûts d'investissement additionnels éventuels (travaux de finition, etc.) ne sont pas pris en compte.
Ces valeurs devront impérativement être complétées avant réalisation des travaux par des devis d'entreprises.
Enfin, il est à noter que certaines aides fiscales peuvent minimiser les coûts moyens annoncés (subventions, crédit d'impôt, etc.). La TVA est comptée au taux en vigueur.

Mesures d'amélioration	Nouvelle consommation Conventionnelle ($kWh_{EP}/m^2.an$)	Effort d'investissement	Économies	Rapidité du retour sur investissement	Crédit d'impôt
Isol. murs extérieurs par l'extérieur	127,0	€€€	★★	○	15,00
Robinets Thermostatiques	123,1	€€	★★	○○○○	15,00

légende		
Économies	Effort d'investissement	Rapidité du retour sur investissement
★ : moins de 100 € TTC/an	€ : moins de 200 € TTC	○○○○ : moins de 5ans
★★ : de 100 à 200 € TTC/an	€€ : de 200 à 1000 € TTC	○○○ : de 5 à 10 ans
★★★ : de 200 à 300 € TTC/an	€€€ : de 1000 à 5000 € TTC	○○ : de 10 à 15 ans
★★★★ : plus de 300 € TTC/an	€€€€ : plus de 5000 € TTC	○ : plus de 15 ans

Commentaires :

Les travaux sont à réaliser par un professionnel qualifié.

Pour aller plus loin, il existe des points info-énergie : http://www.ademe.fr/particuliers/PIE/liste_eie.asp

Vous pouvez peut-être bénéficier d'un crédit d'impôt pour réduire le prix d'achat des fournitures, pensez-y ! http://www.impots.gouv.fr

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(left) Figure 5: EPC cover page.

(right) Figure 6: EPC fourth page.

	EP calculated			EP based on real consumption
	Heating	Domestic Hot Water	Cooling	Any Use
Wood, Biomass	0.013	0.013	0.013	0.013
Natural gas	0.234	0.234	0.234	0.234
Fuel oil	0.3	0.3	0.3	0.3
Coal	0.384	0.384	0.384	0.384
Propane/Butane	0.274	0.274	0.274	0.274
Other fossil fuels	0.32	0.32	0.32	0.32
Electricity	0.18	0.04	0.04	0.084

Table 4: kWh final energy to CO_2 emission conversion factor (kg_{CO_2}/kWh_{FE}).

Type of Building	Individual House	Flat	Apartment Building	Non Residential	Total
Number of EPCs issued since 2013	555,000	581,000	50,000	61,000	1,247,000
New Building	53,000	94,000	14,000	1,000	162,000
Existing Building	502,000	487,000	36,000	60,000	1,085,000
Public Buildings	-	-	-	4,000	

Table 5: Total number of EPCs issued since 2013.

provide some common advice. The last page features specific recommendations given to the building owner by the QE.

EPC activity levels

Following the set up of the national EPC database, the precise EPC activity level as of April 2013 can be determined. The number of EPCs issued since that date can be seen on Table 5 with a total of 1,251,000 EPCs registered on the database. The number of EPCs before 2013 can only be estimated.

The total figure (before and after 2013) is estimated to circa 6 million EPCs for all building types, which represents a fifth of the national building stock.

Typical EPC costs

The cost of the certificate is not regulated. Average market prices are presented in Table 6.

Type	Flat			House	
	Studio	3 Room	5 Room	3 Room	5 Room
Mean Price (€)	95	110	120	120	130

Table 6: EPC average prices.

Assessor corps

Since 2006, QEs have to be certified by an accredited body. In late 2011, the minimum requirements for becoming and continuing to practice as an expert were included in the regulation in order to make the EPC more reliable. There are 2 levels of certification: QE for single residential buildings, and advanced QE for non-residential and apartment buildings. QEs with the advanced certification may also produce EPCs for single residential buildings.

The requirements for a QE in single residential buildings are:

- initial education: 2 years after the French high school diploma in the field of construction;
- ongoing training: 3 days training in the field of EPC every 5 years.

The training expert is assessed in two examinations: one theoretical and one practical. A certification cycle lasts 5 years, after which experts must be re-certified.

The requirements for an advanced QE (non-residential buildings and apartments buildings) are:

- initial education: 2, 3 or 5 years after the French high school diploma in the field of construction and respectively 3, 2 or 1 years of work experience in the field of construction;
- ongoing training: 5 days training in the field of EPC every 5 years.

As for the standard level, there are two examinations (theoretical and practical), focussing more specifically on non-residential and apartments buildings.

The list of QEs is available to the public online. In early 2014, according to the last available list, there were 9,700 QEs including 1,400 advanced QEs.

Compliance levels by sector

The EPC is part of the real estate diagnosis file, a set of documents mandatory for a sale or a rental. This way, the notary in charge of concluding the sale (or the real estate agent in case of leasing) will not act without presentation of a valid ECP. ECPs are therefore produced for 100% of the sales and for the vast majority of the rents, with the exception of private transactions (when no estate agent is involved).

As a consequence, it is the building owner's duty to have the EPC produced. Once issued, the owner has to give it to the real estate agent who then presents it to the potential buyer (or tenant), helping the latter to make a choice.

Quality Assurance (QA) of EPCs

There is a Quality Assurance (QA) system requiring the work of each QE to be checked on a continuous basis. New experts are checked 4 times during the first year, and 4 more times in the following 4 years. Following this first cycle of certification, experts are checked 4 times every 5 years. Table 7 shows the type and number of checks performed on each expert by its certifying body.

In 2013, there were 1,200 new QEs, which corresponded to 4,800 checks. A fifth of the remaining QEs were also controlled (4 EPCs checked per QE), corresponding to a further 6,800 checks. These controls represent a total amount of 11,600 EPCs checked in 2013. The certifying body must verify that each point of the regulation is abided by and it can withdraw the expert's certification temporarily or permanently in case some fields in the EPC are not correctly filled. Following this exercise in 2013, a total of 682 QE certifications were permanently withdrawn and a further 480 QEs received a suspension.

The EPC database can also be used as a QA tool, since it allows landlords to check the accuracy of their EPC.

Finally, there is a directory of QEs available, so landlords can check that the QE is certified.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

Since 2007, all buildings over 1,000 m² occupied by public authorities and frequently visited by the public must have an EPC issued. In 2013, the threshold was lowered to 500 m² and it will be lowered further to 250 m² in 2015. Once issued, the EPC must be displayed near the entrance point of the building clearly visible by the public.

Format and content of the EPC

Public buildings are mainly non-residential buildings for which the EPC format and content is generally the same as for residential buildings. The main difference relates to the thresholds between the different consumption classes on the energy label. Non-residential buildings are separated in 4 categories, shown on Table 8.

Frequency of updating

EPCs for public buildings frequently visited by the public are valid for 10 years.

Table 7: Number and types of checks.

	First Certification Cycle		Re-Certification Cycle
Number of EPC reports checked	4 (during the first year)	4 (between the second and the fourth year)	4
Number of EPC checked on-site	1		1

Table 8: Consumption range (primary energy) depending on building type.

Building Type	Class A (kWh/m².year)	Class B (kWh/m².year)	Class C (kWh/m².year)	Class D (kWh/m².year)	Class E (kWh/m².year)	Class F (kWh/m².year)	Class G (kWh/m².year)
Residential Buildings	< 50	51 to 90	91 to 150	151 to 230	231 to 330	331 to 450	> 450
Office building and schools	< 50	51 to 110	111 to 210	211 to 350	351 to 540	541 to 750	> 750
Buildings with continuous use (hospitals, hotels, retirement homes, etc)	< 100	101 to 210	211 to 370	371 to 580	581 to 830	831 to 1,130	> 1,130
Shopping centres	< 80	81 to 120	121 to 180	181 to 230	231 to 330	331 to 450	> 450
Other buildings	< 30	31 to 90	91 to 170	171 to 270	271 to 380	381 to 510	> 510

Activity levels

As for the general activity level, the exact number of EPCs issued for this type of building can be determined since April 2013. For buildings over 1,000 m², the database shows around 1,600 EPCs issued. The number of EPCs issued for buildings between 500 and 1,000 m² is around 700, although the real number is probably higher due to public bodies' pro-activeness (EPCs issued before registration in the database started in April 2013). Indeed, the database shows around 400 EPC issued for buildings between 250 and 500 m², even though the mandatory threshold is still 500 m².

Costs

For public and large buildings visited by the public, it is not possible to provide average prices because of the multiple typologies of non-residential buildings. However, the value of 1 €/m² has been used in a study to evaluate the impact of the measure on public bodies.

Assessor corps

QEs have to be certified on an advanced level to issue EPCs for public and large buildings visited by the public.

Quality Assurance (QA) of EPCs

There are no particular QA differences between EPCs issued for public and large buildings visited by the public, and other EPCs.

III.iii. Implementation of mandatory advertising requirement

Since 1 January 2011, it is mandatory for real estate agencies to include some parts of the EPC in their advertising. Every type of advertising is affected, but not in the same way. Advertisements published in newspapers should display at least the energy class letter. On the other hand, advertisements published on the internet or at the real estate office must display the full energy label. The picture of the label should be at least 180 X180 pixels on the internet and should occupy at least 5% of the advertisement displayed at the real estate office.

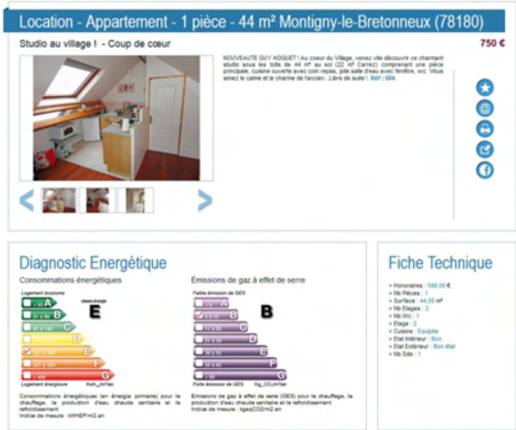


Figure 7: Example of advertising on the internet.

In case of non-compliance there are two types of sanctions: on the civil-law side the client can demand the cancellation of the sale; on the criminal-law side, the sale can be considered as fraudulent and can lead to a prison term of two years without remission and to a 37,500 € fine imposed by the General Directorate of Competition, Consumption and Fraud Repression (DGCCRF). Such penalties have never been applied. A simple call to order has always been enough to bring non-compliant parties to compliancy. Yet, the DGCCRF estimates that in 15% of the real estate dealings the EPC is not displayed.

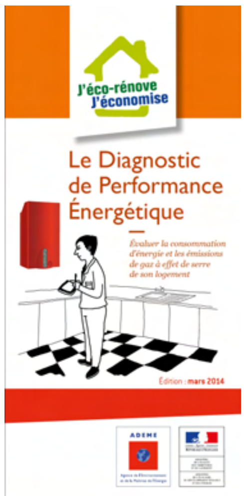
III.iv. Information campaigns

Periodically, the ministry in charge of the regulation on EPCs publishes guidebooks aiming to raise public awareness of the links between environment, energy performance and economy. They cover topics such as thermal regulation, EPC, financial incentives and renovation.

The ministry also runs several information websites, providing information to individuals as well as professionals and helping them to best understand and apply the different topics of the EPBD.

Finally, France collaborates closely with the European association of local authorities in energy transition, Energy Cities. One of their campaigns, 'Display', has pushed many French cities to issue EPCs for their public buildings, contributing in giving the EPC a good reputation and leading to numerous renovations.

Figure 8: Example of guidebook published in 2014.



	Boilers between 4 and 400 kW	Boilers of more than 400 KW	Air-Conditioning systems and reversible heat pumps of more than 12 kW
Periodicity of inspections	Annual maintenance visit	Inspection every two years	Inspection every five years

Table 9: Inspection or maintenance scheme.

III.v. Coverage of the national building stock

The total number of residential units (houses and apartments) in France is around 30 million, with a total number of 5 million EPCs issued at the end of 2012. With the addition of the 1 million EPCs issued between April 2013 and September 2014 for existing houses and apartments, we can conclude that around 20% of the national existing housing stock is covered.

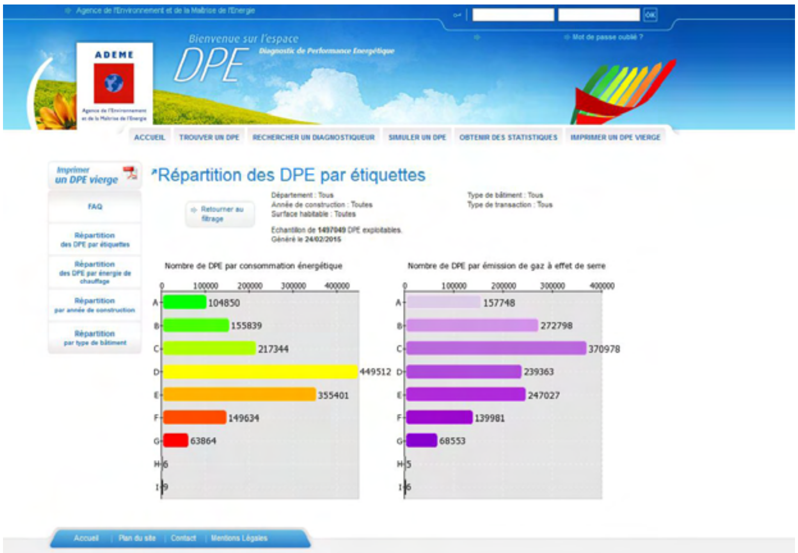
The statistics show a number of 330,000 new residential buildings, corresponding to an equal number of EPCs issued.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

To transpose Article 15 about AC systems, France has chosen to adopt the default approach, which consists of a periodic inspection scheme. For heating systems, an inspection scheme has been introduced for boilers of more than 400 kW. For boilers between 4 and 400 kW, alternative measures involving an annual maintenance visit have been taken according to Paragraph 4 of Article 14 of the EPBD. The inspection of heating systems of more than 400 kW is similar to inspections for AC systems (Table 9).

Energy saving due to the enforcement of Article 14 and 15 of EPBD is part of the French National Energy Efficiency Action Plan in order to reach the target announced in April 2013 in application of Article 3 of the EED.

Figure 9: Screenshot from the website hosting the EPC[3] database.



IV.i. Progress and current status on heating systems

Alternative measures that have been taken to improve the energy performance of heating systems are the following:

> **An annual maintenance visit** is required for systems with an output lower than 400 kW. This visit can be performed by any professional in the field of maintenance. During the maintenance visit, the professional must:

- check the boiler and, if necessary, clean it and tune it;
- measure the concentration of carbon monoxide (CO);
- evaluate the energy and environmental performance of the boiler:
  - evaluation of the energy efficiency of the boiler, which is compared to the energy efficiency of the best boilers available on the market today;
  - evaluation of the polluting emissions of the boiler, which are compared to the emissions of the best boilers available on the market today (NOx for gas and oil boilers, VOC and particulates for biomass boilers);
- provide advice on best use, improvement of the boiler and of the heating system in place and, if necessary, advice on the replacement of the installation;
- a certificate of maintenance should be issued within 15 days after the visit, containing contain the results of the measurements and evaluations listed above, and including recommendations on best use and improvement of the heating system in place, as well as, if necessary, advice on the replacement of the installation. The reports are not collected in a central database;
- the Ministry in charge of the regulation on inspections together with the French Energy Agency (ADEME), have prepared a guide for the public in order to explain the new provisions regarding the annual maintenance of boilers. It can be downloaded free of charge from the ministry's website. Also, a guide for professionals was prepared by the

[3] *In French: DPE.*

association "*Énergies et Avenir*", an association of professionals dedicated to the promotion of heating systems using hot water.

> **Financial support**: The tax benefit "Sustainable Development" is available since 2005 and its name changed to "Energy Transition (CITE)" in 2015. It is a tax benefit for the purchase of the most efficient materials and equipment in terms of energy saving and reduction of greenhouse gas emissions. The amount of the credit depends on the system type and its price. The only proof needed to get the tax benefit is the sales receipt. The expenditure amount for the tax benefit "Energy Transition" shall not exceed 8,000 € for one person, and 16,000 € for a couple.

In response to Article 7 of the EED there is also an obligation for energy suppliers to practice energy saving (or to have it practiced by their consumers). To comply with this obligation, energy suppliers, among other things, have to promote and support Energy Saving Certificates (ECS) among their clients. These Energy Saving Certificates can take the form of standardised action, or they can be more specific, and will often imply heating system based action. The overall saving goal was 54 TWh from 2006 to 2009 and 345 TWh from 2011 to 2013. Both goals were reached, and the new goal is 700 TWh from 2015 to 2017.

Since 2009, the 0% Eco-Loans (loans with a 0% interest rate) have enabled financing of work to improve the overall energy performance of buildings and in particular to improve heating systems. They are designed for property-owning individuals to finance major renovation work. This loan is addressed to the owner of a building, with a maximum amount of 30,000 € over a 15 year period.

In addition to that, the financial support of the National Agency for Housing Improvement (Anah) helped low-income households to finance renovation work if they can reduce their energy consumption by at least 25%. The level of financial support varies depending on the income of the beneficiaries, with a maximum amount of 10,000 €. A bonus "*Habiter mieux*" can also be given with a maximum amount of 2,000 €.

Finally, a reduced VAT (5.5%) applies for renovation works in residential buildings. To take advantage of this VAT reduction, materials used shall respect technical characteristics adopted by a ministerial order.

> **Information campaigns**: ADEME and the ministry in charge of the regulation on inspections conducted publicity campaigns in relation to the most efficient heating systems and to financial support for replacement. Campaigns have also covered improving the energy performance of a building as a whole and possible financial support or tax benefit (Sustainable Development Tax Benefit, zero-interest eco-loans, etc.). The "Energy Info Sites" also provide information on how to improve the efficiency of boilers and heating systems.

Equivalence of the alternative measures for systems under 400 kW output

The equivalence has been proven in two stages. First, the impact of some financial support on energy saving (Tax Benefit "Sustainable Development", 0% Eco-Loans, and energy efficiency certificates) has been assessed by making a hypothesis to avoid double-counting.

According to the French regulation, boilers of more than 400 kW are not supposed to be inspected every year. In fact, for boilers between 400 kW and 20 MW, inspections shall be carried out every two years. During the inspection visit the QE must check and measure the same elements as regard to boilers from 4 – 400 kW. But for boilers of more than 400 kW a 'boiler-room handbook' has to be kept, recording all information about the system.

There has been a comparison between the hypothetical inspection scheme (the reference scheme) and the annual maintenance visit (alternative scheme). The main differences between the two calculations were the following:

> The scope is larger for the alternative scheme (for the default approach only boilers of more than 20 kW are targeted, while maintenance concerns boilers of more than 4 kW).

> Inspections will not systematically lead to renovation work and thus energy saving, whereas a maintenance visit would, although the energy saving following maintenance would be lower than the saving following a renovation.

The assessment of the impact of alternative measures and the ones resulting from the implementation of the default approach shows that the alternative measures taken by France permit more than twice the energy saving linked to the implementation of a regular inspection scheme. Indeed, as explained in the report requested by Article 14 of the EPBD, inspections would lead to savings

Figure 10: Cover page of the guide for maintenance of boilers.

between 5.12 TWh and 13.84 TWh, whereas alternative measures savings would be between 47.68 TWh and 70.94 TWh.

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

The French regulation on AC systems[4] has been in application since 16 April 2010. France has chosen to implement Article 15 of the EPBD by enforcing the following points:

> inspection of AC systems and reversible heat pumps with an output of 12 kW or more;
> to be carried out once every 5 years;
> person responsible for the inspection is the owner or the manager of the building;
> inspectors should be certified.

A report is issued within one month after the inspection with the results and advice on best use, improvement of the AC system in place and, if necessary, advice on the replacement of the installation. Standard EN 15240 was used as a basis for the methodology, but the methodology of inspection is fully described in the decrees.

The inspection should include:

> inspection of documentation;
> assessment of system performance at the time of the on-site inspection;
> assessment of the sizing of the system in relation to the cooling requirements of the building at the time of the on-site inspection;
> provision of the necessary recommendations concerning proper use of the system in place, possible improvements to the installation as a whole, any benefit from its replacement and other potential solutions.

In total, this mechanism covers some 300,000 AC systems in France, which amounts to around 10% of installed stock, as the vast majority has a thermal power less than 12 kW.

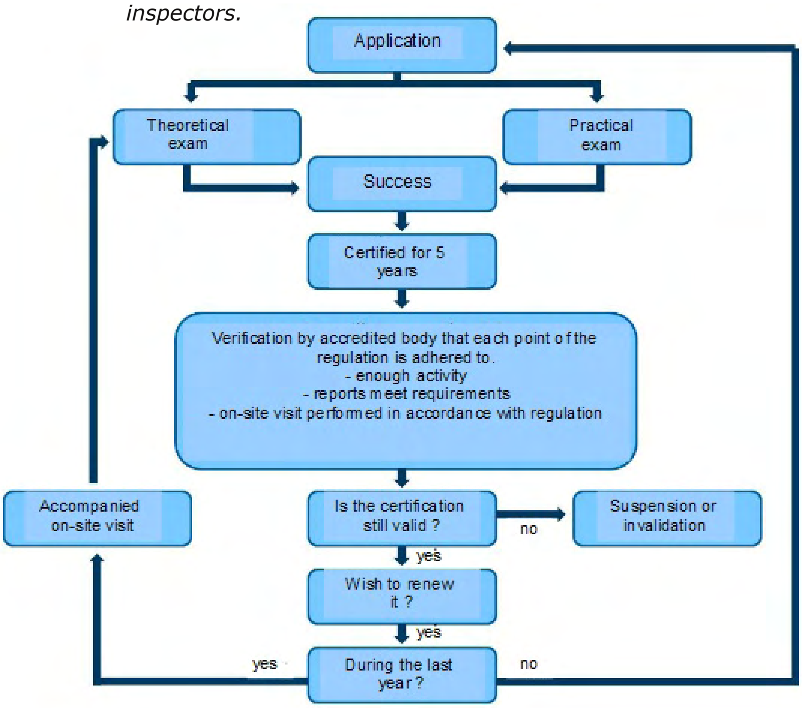
To perform an inspection of AC systems, experts have to be certified according to ISO standard 17024 'General requirements for bodies operating certification of persons' by an accredited body. This body is accredited by the French committee of accreditation (COFRAC).

There are two levels of certification:

> the 'simple systems' level, for the inspection of AC systems and reversible heat pumps with output from 12 kW to 100 kW;
> the 'all systems' level, for the inspection of all such systems, large or small.

Experts have to pass a theoretical and a practical examination and are certified for 5 years. There are currently 3 certifying bodies and around 250 inspectors (Figure 11).

Figure 11: Process of certification of inspectors.



Arrangements for assurance, registration and promotion of competent persons

Each accredited body has to make publically available the list of the experts having a valid certificate, which provides a useful source of information for the public. There are currently around 200 accredited experts.

Promotional activities

At national level, the details of the regulation are presented as much as possible at relevant conferences. There is also a relevant section on the website of the ministry. It explains the main points of the regulation and a frequently asked question section is reviewed on a regular basis.

Enforcement and penalties

Provisions on controls and penalties are set in the regulation. Control can be performed by officers of the General Directorate for Competition Policy,

[4] *"Arrêté du 16 avril 2010 relatif à l'inspection périodique des systèmes de climatisation et des pompes à chaleur"* and *"Arrêté du 16 avril 2010 définissant les critères de certification des compétences des personnes physiques réalisant l'inspection périodique des systèmes de climatisation et des pompes à chaleur"*

Consumer Affairs and Fraud Control. If the regulation has not been properly adhered to, the relevant authority can apply several types of sanctions:

> to carry out a new inspection of the AC system at the owner's expense;
> to oblige the owner to deposit the equivalent of the inspection cost with a public accountant. As soon as the inspection is carried out, the sum of money is given back;
> to oblige the owner to pay a fine;
> to force the owner to stop the AC system.

Since many public bodies can perform controls, feedback about the number of them is not available.

Quality control of inspection reports

The independent control system is included directly in the certification scheme. Experts are certified by bodies which are accredited by the COFRAC according to ISO standard 17024 "General requirements for bodies operating certification of persons" (Figure 12).

During this period the accredited body has to:

> check at least two reports per year;
> check if experts perform enough inspections;
> accompany the expert during at least one of his/her on-site inspections.

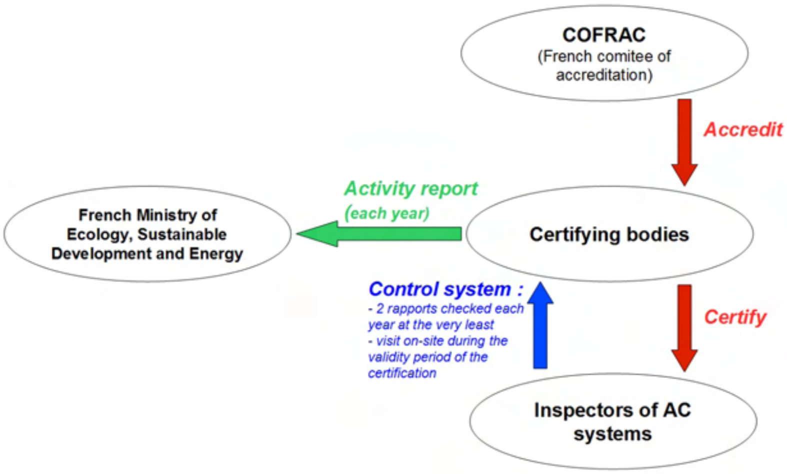
The COFRAC checks if the accredited bodies meet the requirements of the standard.

There are 4 bodies accredited by the COFRAC according to ISO standard 17024 "General requirements for bodies operating certification of persons" to certify experts. So far they have certified around 250 experts. An expert performs 8 inspections per year on average, which means that in 2013 around 2,000 inspections took place. This is only an estimate as there is no central database of reports. A total of 150 reports were controlled in 2013, corresponding to 8% of the total number of reports.

Impact assessment

The reports are not collected in a central database so it is challenging to assess precisely the impact of the inspection scheme. Energy saving is variable because inspection does not lead systematically to an action on the system. This means that energy saving depends first on the decision of the owner to do something or not, and then on the extent of the work. According to owners' feedback, saving can easily reach 20% of the energy consumption of the AC system.

Figure 12: Organisation of participants in AC inspection scheme.



Costs and benefits

Concerning cost-effectiveness of the inspections, an expert needs one day to perform an inspection and that costs 600 €. Given that inspections occur every five years, this is equivalent to 120 €/year. As said above, energy saving is closely linked to the choice of the owner after an inspection, making it very difficult to assess the impact in terms of energy saving. Indeed, when the system is not well maintained or when there is no control, the energy saving can be important enough to make the inspection cost-effective. But, if the system is relatively new or properly monitored, then the price of the inspection provides no return.

3. A success story in EPBD implementation

France's success story lies in the numerous positive effects of the mandatory advertising requirements of the EPC (see section 2.III.iii). It is clear at first glance that this measure has been successful, since 85% of the real estate agencies comply with the obligation. The EPC has consequently gained high visibility.

Looking more closely, several positive effects of these requirements can be brought out. First of all, it forces the owner to have an EPC issued, without which the estate agent will not put the building on sale (or for rental). Indeed, before the enforcement of this measure, it was very common to have the EPC issued only a few days before the sale was concluded and the new owner was given the EPC only after that. Such behaviour from owners is no longer possible.

The potential buyer can now effectively compare several buildings in terms of energy performance, which is one of the original goals of the EPC. Displaying it on advertisements has also increased the consumers' awareness of the EPC, contributing to its recognition. Furthermore, it has led consumers to establish a dialogue with real estate agents about the EPC and to take note of the full four-page EPC file.

Along with increasing consumers' awareness, this measure has also brought greater visibility to the most energy efficient buildings. In some areas this has even translated into an increase of the value of such buildings; it is important that this raise of value can be balanced out thanks to the PTZ + (*Prêt à taux zéro* +), a 0% loan intended for buyers of energy efficient buildings. On the other hand, low class building owners are now encouraged to perform thermal renovation in order to compete with efficient buildings, especially in unattractive areas. The owners can also choose to lower the sale price of their building. This second option usually leads to the new owner having a thermal renovation carried out with the help of financial incentives such as the 0% Eco-Loan and the Tax benefit 'Sustainable Development'. In the case of a major thermal renovation both incentives are granted.

In addition to official penalties for lack of an energy performance indicator in advertisements, the biggest sanction comes from the consumers themselves. Indeed, thanks to the numerous press articles published in both mainstream and specialist press along with the help of most real estate agencies to pass the information, people are well aware of this measure. The EPC has now become common practice. Consequently, an advertisement without EPC seems rather suspicious, and in non-competitive areas it is put aside by most consumers.

Displaying the EPC in advertisements has been a great success since the tool has gained in visibility, but also in understanding. More and more people think of the EPC as one of the most important tools to help them make their choice. Moreover, the recommendations are used to direct and orientate thermal renovation, leading to the increase of the national real estate efficiency.

4. Conclusions, future plans

Even though the Energy Performance of Buildings Directive (EPBD) is now fully transposed, France has the will to position itself at the forefront of energy performance in buildings, and plans to make sustainable development the driving force of national growth. This will is expressed by several measures to be taken in the short or medium term.

A new bill, called 'energy transition for a green growth', was examined by the French Parliament at the end of 2014. Among many provisions relating to energy and the environment, there are some which concern buildings' performance.

The next significant step of the French thermal regulation, set for 2018, will be energy positive buildings, since they will be at the core of the new regulation. Preliminary work for this regulation will start in early 2015. In addition and in order to promote the Government's exemplary role, a measure included in the 'energy transition' bill stipulates that all new public buildings should be energy positive whenever possible. It will also give construction professionals the opportunity to improve their skills in the construction of very high energy performance buildings and to get ready for 2018.

There is also a continuous assessment of the tools and measures by the ministry with studies evaluating the reliability of the calculation, or through constant contact with professionals, with the goal to identify and correct any dysfunctional points in the EPBD implementation.

Implementation of the EPBD in Germany

STATUS IN DECEMBER **2014**

1. Introduction

Energy efficiency of buildings in Germany has been subject to legal requirements since 1976 when, in the wake of the first energy crisis, the Energy Saving Act was adopted by the German parliament. Under this law, a series of ordinances were introduced and amended several times during the following years. At the end of the 1990s, the government issued the first Energy Saving Ordinance ('Energieeinsparverordnung' - EnEV) which came into force in 2002, combining the two ordinances on thermal insulation and heating appliances. This legal act was not only a step towards an integrated approach for the energy performance of buildings, but also a continuation of certain standard practices concerning additional requirements, inter alia, for building systems, thermal bridges, heat protection during summer. The German government took this step in full awareness of the, at that time, ongoing negotiations for the Directive 2002/91/EC, in support of the new European approach. Nevertheless, there were still minor aspects within the EPBD pending for national transposition, which was finally completed with the 2007 amendment of the Energy Saving Ordinance.

The Directive 2010/31/EU (Energy Performance of Buildings Directive - EPBD) brought up some issues for further amendment of the national transposition, mainly concerning Nearly Zero-Energy Buildings (NZEBs), certain aspects of Energy Performance Certificates (EPCs), and additional obligations to include energy efficiency indicators in property sale or rental advertisements. The preparations started in time to meet the time schedule given by the Directive 2010/31/EU. In the aftermath of the Fukushima accident in 2011, the German government decided on the 'Energiewende', which included a further strengthening of energy performance requirements. This new development had to be taken into account within the context of the EnEV amendment, and thus the changes and additional formal steps caused a certain delay. The "second Ordinance amending the Energy Saving Ordinance" was finally decreed in November 2013. Nearly all the provisions of the ordinance came into force on 1 May 2014, however the further reinforcement of requirements for new buildings (towards NZEB level) shall enter into force on 1 January 2016, and the penalties for indicators missing in property sale or rental advertisements are suspended until 31 April 2015.

Overall, the EnEV stipulates the minimum energy performance requirements, whereas the Renewable Energies Heat Act sets quotas of renewable energy for new buildings and refurbished public buildings. A set of DIN standards serves as a compulsory calculation methodology in order to ensure non-ambiguity of the calculated values and requirements.

In Germany, the issue of energy saving in buildings is subject to federal legislation, whereas the building codes fall under regional legislation. In general, the enforcement of federal and regional legal provisions of any kind is the sole responsibility of the regional governments. This should therefore ensure that every enforcement decision takes into account the requirements deriving from different regulations. Regional governments are prominently involved in the energy-saving legislation primarily due to their principal role in enforcement issues, but also because of the overlaps with regional law. In practice, they have the 'last word' whenever an ordinance is issued or amended, given that the consent of the (weighted) majority of the Bundesrat (chamber of parliament representing the regional governments) is required.

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NATIONAL WEBSITE www.bbsr-energieeinsparung.de/EnEVPortal/DE (German)
www.bbsr-energieeinsparung.de/EnEVPortal/EN (English)

For further important websites, please see footnote 1 on page 2.

2. Current status of implementation of the EPBD

The most important instrument of the legal framework for energy efficiency in the German national legislation is the Energy Saving Act. First introduced in 1976 in the aftermath of two energy supply crises and pre-dating the EPBD, this act has been amended several times in order to meet the current political needs – the last amendment dated June 2013 responding to some aspects of the EPBD implementation. The Energy Saving Act does not contain any detailed requirements, but serves as the basis for governmental ordinances dealing with such provisions. Therefore, the law mainly determines the issues of energy performance requirements that shall be governed by respective ordinances. The law also sets a number of restrictions that the government must take into account and provides the legal basis for the enforcement of the requirements.

The main restriction that will apply to technical requirements is the so called '*Wirtschaftlichkeitsgebot*', which is equivalent to the 'cost effectiveness' provision in Article 4 of the EPBD. In Germany, any financial investment aimed at meeting a certain requirement must repay itself through the energy savings achieved within the lifetime of the investment. This has to be proven from a general point of view, not considering whether, or to what extent, the investor benefits from energy saving. The requirements concerning energy certificates and the inclusion of energy performance indicators in advertisements are not subject to the '*Wirtschaftlichkeitsgebot*'.

In order to implement the NZEB provisions of the EPBD, the current Energy Saving Act contains verbal requirements in accordance with the Directive 2010/31/EU, leaving specifications to be set out by an ordinance that is expected before 2017. This next amendment of the Energy Saving Ordinance is currently under preparation. Furthermore, studies were commissioned to support the government in determining the basis for a proper description of the NZEB level, in consideration of the EPBD and all additional national issues.

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Since 2002, energy performance requirements for buildings are subject to the Energy Saving Ordinance (EnEV), which is issued by the German Federal Government with authorisation of the Energy Saving Act. The EnEV was amended in 2004, 2007, 2009 and more recently, in 2013. The amendments of 2009 and 2013 provide for significant reinforcement of requirements, the latter entering into force by 1 January 2016.

The Federal Government has opted for a stepwise approach towards the intended NZEB level. As a result, stakeholders have the time to adapt to the tightened requirements while the financial burden may also be reduced by allowing in the interim new technologies to enter the market.

The most recent amendment (issued in November 2013) foresees as a first step from 1 May 2014 onwards, a methodical adoption of recent technical procedures and developments concerning climate and primary energy factors. As a consequence, there will be minor changes in the calculation of results and requirements, although this is not the primary purpose. As before, the calculation procedures take into account thermal bridges (default values or detailed calculation), infiltration (default values or detailed calculation with respect to blower-door test), shading (mostly via default values) and several different sets of indoor conditions including thermal comfort, lighting comfort (applicable only to non-residential buildings) and air exchange-rates, to be applied according to usage.

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[1] *NATIONAL WEBSITES:*

Federal Ministry for Economic Affairs and Energy:

> *www.bmwi.de/DE/Themen/Energie/Energiewende-im-Gebaeudebereich/energieeinsparrecht.html (German)*

> *www.bmwi.de/EN/Topics/Energy/Buildings/energy-conservation-legislation,did=667990.html (English)*

Special Site about the Renewable Energies Heat Act:

> *www.erneuerbare-energien.de/EE/Redaktion/DE/Standardartikel/waermegesetz_eewaermeg.html (German only)*

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety:

> *www.bmub.bund.de/themen/klima-energie/energieeffizienz/gebaeude/ (German)*

> *www.bmub.bund.de/en/topics/climate-energy/energy-efficiency/buildings/ (English)*

As a further step towards the NZEB level, the current EnEV introduces tighter requirements, which will be effective from 1 January 2016. For building permit applications submitted after the said date, the buildings' primary energy demand may not exceed 75% of the reference building's demand (Table 1). The reinforcement of requirements from January 2016 onwards applies to all new residential and most new non-residential buildings.

Since 2009, the Renewable Energy Heat Act has added an additional requirement for new buildings, i.e., a quota of renewables. The 2011 amendment, introduced also provisions for the use of energy from renewable sources in the case of major renovations of public buildings.

The entire concept shall be subject to evaluation. The *Bundesrat* issued a resolution to merge the Renewable Energy Heat Act and the EnEV. This is the subject of a study to be delivered by mid-2015. Furthermore, the government envisages an evaluation of the EnEV in order to improve its acceptance in practice. The time schedule of this evaluation has not yet been determined.

I.ii. Format of national transposition and implementation of existing regulations

New residential buildings

In Germany, requirements for new buildings are not expressed by a fixed value, but by comparing the building in question with its corresponding reference building. The reference building is identical to the individual building in terms of geometry, size, orientation and use, but constructed with components and technical systems presented in the annex of the ordinance (Table 1). The energy performance is calculated twice: once with the features of the reference building, and once using the real construction features and real system performance. The maximum primary energy demand of the building in question may not exceed the primary energy demand of the reference building (Figure 1).

For residential buildings, the EnEV provides a choice between two different calculation methods (DIN V 4108-6 combined with DIN V 4701-10, or the more recent DIN V 18599). However, the same method must be applied to both the real building and the reference building. Both methods are steady-state calculation models and generally in accordance with European and ISO standards. Thermal bridges are taken into account, either using two different default levels, or by detailed calculation. Infiltration is also included for new buildings by two different default levels, one with successful on-site airtightness check and the other without.

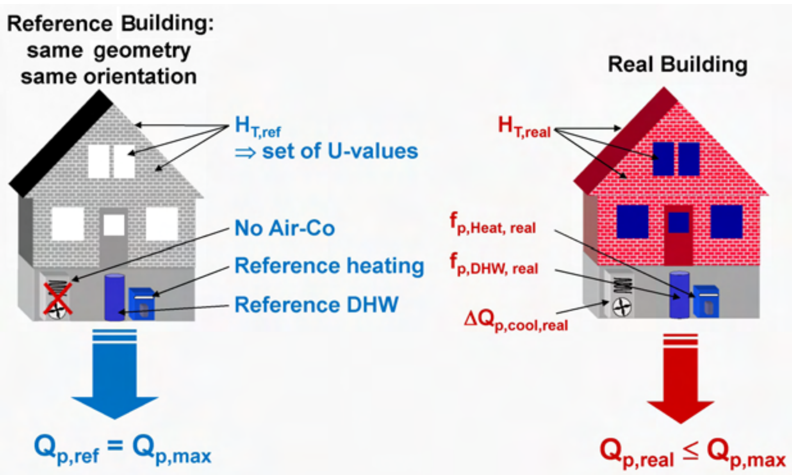
In addition to the above mentioned overall performance requirement for the primary energy level, new residential buildings must meet several additional specifications:

Table 1: Technical characteristics of the reference residential buildings

Component	Reference design / value	2nd requirement
Strengthening factor January 2016	$Q_{p,max,2016} = 0.75 \cdot Q_{p,ref,2009}$	$H'_{T,max,2016} = 1.0 \cdot H'_{T,ref,2009}$
	Reference 2009	
External walls, Floors	U = 0.28 W/m².K	$H'_{T,max,2009} \cong 1.25 \cdot H'_{T,ref,2009}$
Floor, basement structural element	U = 0.35 W/m².K	[requirement 2009 is legally defined by tabled values according to situation and size of the building]
Roof, upper ceiling	U = 0.20 W/m².K	
Windows incl. French windows	U = 1.3 W/m².K (Skylight U = 1.4 W/m².K)	
Entrance doors	U = 1.8 W/m².K	
Boilers	Condensing boilers	Requirements for pipe insulation and controls
Hot water	Central, with solar system	
Cooling	None	Thermal protection in summer
Ventilation	Central exhaust fan, demand-controlled	large systems: SFP_{max}, heat recovery

Note: The current requirement on boiler efficiency is linked to the previous boiler-efficiency Directive 92/42/ECC, which allows all gas and oil-fired low-temperature and condensing boilers, as well as all biomass-boilers, even with lower efficiency. In practice, it is not relevant for new buildings because even the installation of a low-temperature boiler in a new building would not be economically reasonable. This requirement has to be abandoned by September 2015 because of the new EU legislation.

Figure 1:
The reference building as a way to define the maximum primary energy demand ($Q_{p,max}$).



> a requirement which limits the average specific heat transmission coefficient (EN ISO 13789 and EN ISO 13370) to ensure a proper thermal quality, even in the case of very low primary energy factors;
> several additional requirements for technical buildings systems (heating, Domestic Hot Water – DHW, ventilation, air-conditioning);
> a requirement for summer comfort provisions to avoid energy use for cooling of buildings.

Table 2: Minimum required U-values for building elements ($W/m^2.K$).

Energy carrier [1]		Primary Energy Factor	
		total	non-renewable fraction
Fossil fuels	Light fuel oil	1.1	1.1
	Natural gas (grid)	1.1	1.1
	Liquid gas	1.1	1.1
	Coal	1.1	1.1
	Brown coal	1.2	1.2
Bio fuels	Biogas [2]	1.5	0.5
	Liquid bio fuel [2]	1.5	0.5
	Wood	1.2	0.2
District heat from CHP [3 4]	Fossil fuel (default)	0.7	0.7
	Renewable fuel (default)	0.7	0.0
District heat from heating plant [4]	Fossil fuel (default)	1.3	1.3
	Renewable fuel (default)	1.3	0.1
Electricity	Grid-Mix (2014)	2.8	2.4 [5]
	Grid-Mix (2016)	2.8	1.8 [5]
	Substitution mix [6]	2.8	2.8
Environmental energy	Solar energy	1.0	0.0
	Ground heat, geothermal energy	1.0	0.0
	Ambient heat	1.0	0.0
	Ambient cooling	1.0	0.0
Waste heat	from (industrial) processes on-site	1.0	0.0

[1] Reference: calorific value
[2] restricted to on-site / nearby generation
[3] default values for CHP ≥ 70 %
[4] calculation of local PE-factors foreseen
[5] Values given by the Energy Saving Ordinance (deviation from standard)
[6] used for electricity delivered by CHP-plants to the public grid

The calculation method, as well as the primary energy factors (Table 2) and applicable boundary, use and climate conditions, are subject to the DIN calculation methods stated above. With regard to certain aspects, the EnEV includes differentiated provisions, or allows simplifications exceeding those prescribed by standards. The thermal conditions provided are mandatory for the calculations and reflect the comfort needs for residential use. Minimum requirements for indoor air quality, temperatures and minimum daylight are, however, subject to other legal provisions relating to health, workplace environment and safety issues.

New non-residential buildings including public buildings

The requirements for new non-residential buildings follow an approach which is similar to the one for residential buildings, but with some minor differences. As lighting is an additional aspect in non-residential buildings, and a significant number of these buildings are equipped with sophisticated ventilation systems and air-conditioning, the description of the reference building is quite extensive. Furthermore, there are some differences related to the use patterns and the height of the rooms. The requirement for the minimum performance of the building envelope is expressed differently, i.e. a set of maximum average U-values (Table 3) is determined instead of a maximum average heat transmission coefficient (as for residential buildings).

With regard to non-residential buildings, DIN V 18599 is the mandatory calculation method. Different from the method for residential buildings, the method foresees zoning of the building, primarily according

Table 3: Maximum average U-values for new residential buildings.

Row	Components of thermal surface	Average U-Value [W/m².K]			Remarks
		Zones with internal set-point temperature ≥ 19 °C until 31st Dec. 2015	Zones with internal set-point temperature ≥ 19 °C from 1st Jan. 2016	Zones with internal set-point temperature < 19 °C	
1	Opaque elements (if not included in rows 3 and 4)	≤ 0.35	≤ 0.28	≤ 0.50	Ground floor weighted (0.5) and only considered up to 5 m from outer margin
2	Transparent elements (if not included in rows 3 and 4)	≤ 1.9	≤ 1.5	≤ 2.8	Doors and gates not considered
3	Curtain walls	≤ 1.9	≤ 1.5	≤ 3.0	
4	Transparent roofs, roof-integrated window-strips, rooflight-domes	≤ 3.1	≤ 2.5	≤ 3.1	

to different use patterns (partitioning; Figure 2). The zoning of the reference building has to reflect the zoning of the real building including the conditions of use. Most use patterns are provided in this standard and reflect accepted comfort needs. For other, not so common use patterns, rules for creating a customised set of conditions are also included in the standard. In order to simplify the effort of calculation, the EnEV allows skipping partitioning for some frequently constructed building types, e.g., office buildings, standard retail buildings and schools. In these cases, a primary use pattern may be applied to the building as a whole without respect to zoning (single-zone-model). Nevertheless, calculating these buildings with detailed zoning is also allowed.

Share of energy from renewable sources for new buildings and major refurbishment of public buildings

Aside to the requirements on energy performance established by the EnEV, the Renewable Energies Heat Act, in force since 2009 and amended in 2011, demands a quota of energy from renewable sources. For all new buildings, a certain share of Renewable Energy Sources (RES) to cover the building's net demand for heating, DHW, significant hot water supply (in non-residential buildings) and cooling (if applicable) is mandatory. The exact ratio depends on the chosen energy source; the given default solutions vary in share from 15%, e.g., in the case of solar thermal power, to 50% in the case of geothermal heat (Table 4). As surrogate options, the Renewable Energy Heat Act allows either an energy performance of 15% higher than required by the EnEV, or the use of district heating and Combined Heat and Power (CHP) instead of RES.

For public buildings, the Renewable Energies Heat Act (amendment in 2011) also sets requirements in the case of major refurbishment. This takes into account the leading role of the public in this field. A major refurbishment is defined as the combination of a renovation of more than 20% of the building envelope with an exchange of the boiler, or an exchange of energy source supplying the building. The mandatory share of renewables in these cases is roughly the same, but the surrogate option 'enhanced energy performance' is defined differently.

Existing residential buildings

As far as existing buildings are concerned, there are two different types of requirements: some are mandatory only in the case of major renovation ('*Bedingte Anforderungen*' = conditional

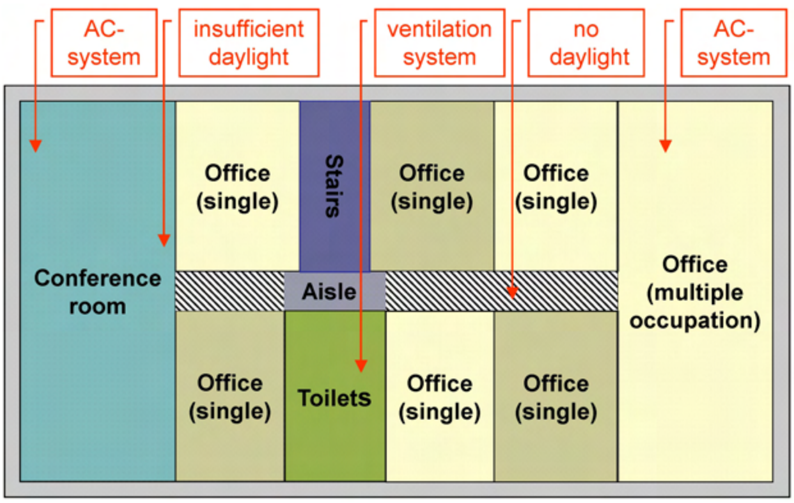


Figure 2: Example for zoning an office building floor according to DIN V 18599: the zoning follows the use pattern of individual rooms. In addition, daylight and the connection to several other systems (red) is considered within the zones.

	Option according to annex		Minimum share
Renewable Energies	Energy from **solar radiation** (collectors)		15 %
	or default collector size for residential buildings (m² collector aperture area per m² living space)	≤ 2 dwellings > 2 dwellings	0.04 [m²/m²] 0.03 [m²/m²]
	Geothermic energy or **ambient heat** by heat-pumps (performance requirements given for heat-pumps)		50 %
	Biomass from sustainable sources (proof by bills required)		
	• **Gaseous** (mostly restricted to use in CHP-appliances only)		30 %
	• **Fluid** (best affordable boiler technology)		50 %
	• **Solid** (minimum efficiency values given for boilers)		50 %
Substitute measures	Heat from **waste combustion**		50 %
	CHP plants		50 %
	District heat with substantial share of RES / waste / CHP		100 %
	Measures to save energy in buildings		EnEV req. - 15 %
	Combinations of several measures		$\sum_i \frac{share_i}{share_{min,i}} \geq 1$

Table 4: Options to comply with the Renewable Energies Heat Act.

requirements) and some are mandatory even without any renovation (*'Nachrüstpflichten'* = retrofitting obligations). Conditional requirements must be complied within defined cases, either of first-time installation or of certain refurbishment measures applied to a share of more than 10% of a building component (e.g., 10% of all outer walls of a building); see Table 5. In either case, the requirements extend exclusively to those parts of the building elements that are the subject of the specific measure. Typical measures leading to conditional requirements are, e.g., replacement of roof tiles, new layers of plaster or sheathings on outer walls, as well as the replacement of windows or glazing. As an alternative for proving conformity with component requirements, building owners are also allowed to fulfil a certain whole building requirement, which is 140% of the energy performance level for new buildings (this still relates to the 2009 level).

Only one retrofitting requirement applies to components of the building envelope: the upper ceiling has to be insulated if the roof above and the upper ceiling itself are not yet insulated to a given minimum value. The deadline is 31 December 2015. Certain exemptions apply to small owner-occupied residential buildings. Further compulsory retrofitting measures apply to systems as described in section 2.II.

Existing non-residential buildings including public buildings

Requirements concerning measures on existing non-residential buildings are not very different from those applying to residential buildings (see above). There are certain provisions and exemptions that are not exclusively addressed to non-residential buildings, but are normally not relevant to residential buildings (e.g., provisions for refurbishment of curtain walls, exemption for revolving doors).

Table 5: U-values in case of refurbishment (component requirement).

Refurbished external structural element	Maximum heat transmission coefficient U (normal internal temperatures) [W/m².K]
External walls	0.24
Windows	1.3
Windows with special glazing	2.0
Glazing	1.1
Curtain walls	1.5
Curtain walls with special glazing	2.3
Top floor ceilings,	0.24
steep roofs	0.24 [1]
Flat roofs	0.20
Ground floors, cellar ceilings	0.30 [2]
Ground floors towards outside air	0.24 [2]
Ground-covered walls	0.30 [2]
Floor screeds	0.50

[1] alternative: space between rafters completely filled with insulation with a conductivity of $\lambda \leq 0.35$ W/m.K

[2] measures on cold side

I.iii. Cost-optimal procedure for setting energy performance requirements

The German report on cost-optimal calculation for new buildings shows that the current requirements (or at least the requirements introduced for 2016) for all types of new buildings meet or exceed the cost-optimal level (see, e.g., Table 1). The cost-optimal level was calculated using a set of 6 representative model buildings where a number of different solutions were applied. This approach acknowledges the fact that the costs required to meet a certain primary energy requirement may differ widely from the individual construction and heat supply of a given model building. The solutions were different in terms of the components used (thermal envelope, as well as technical systems) and some typical solutions from current funding schemes were included. Thus, about 30 different cases for each model building were examined to detect the cost-optimal levels.

The cost-optimality of minimum requirements in the case of refurbishment of components depends on the costs of heat and therefore on the heating system and energy carrier. In consequence, the German report on cost-optimality was carried out with packages of a certain refurbishment measure (defined by a variation of 3 to 4 U-values) applied to a building component in connection with the choice of 3 typical and generally applicable heating systems. This results in 9 to 12 variants for each of the 4 major component-requirements. These 'packages' were applied to six model buildings. The heat generators were assumed to be installed roughly at the same time as the refurbishment measure, but independent thereof (Table 6). As a result, using only a few model buildings with only a few heating systems, the cost-optimal level proved to be only slightly stricter than the current level. The government stated in the related report that a differentiation concerning the heating system or building type was not in favour of clarity and enforceability of the requirements, therefore the current level should be considered as 'cost-optimal' from a general point of view and open to any technology. Furthermore, it was concluded that a unique level of requirements for all buildings and heating systems lead to lower prices for the applied technical solutions.

Table 6 presents several examples of cost-optimal levels for refurbishment of components.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

Germany delivered the NZEB Action Plan in January 2013. Upon request of the European Commission, additional information was provided in July 2014.

According to the action plan, the numerical definition of NZEB in Germany is still under elaboration (see also section 4). Nevertheless, we can safely predict that this future level will derive from Germany's vast experience in funding energy efficient buildings through the KfW programmes. The current programmes do refer — and have done so for more than 10 years now — to a certain percentage of the current requirement for new buildings (maximum of primary energy demand, maximum transmission heat loss).

For new buildings, these 'KfW-Efficiency houses' are defined by 'efficiency house 70', 'efficiency house 55' and 'efficiency house 40', requiring a maximum of 70%, 55% or 40% of the requirements for new buildings respectively.

As a guideline, it can be indicated that the well-known *'Passive Houses'* mostly meet the requirement 'efficiency house 40'.

For major refurbishment of existing residential buildings, funding levels are currently established as 'efficiency house 115', 'efficiency house 100' and 'efficiency house 85', requiring a maximum of 115%, 100% or 85% of the requirements for new buildings respectively.

For listed monuments, an additional level is set at 'efficiency house 160' by special regulations. Since 2011, the funding programmes also apply to all kinds of municipal buildings.

Since a significant portion (about 23%) of all new residential buildings nowadays consists of 'efficiency buildings 40 or 55', the future NZEB requirement will most probably be defined around these levels. The definition will be legally introduced with an amendment of the energy saving ordinance due for 2017, which for buildings owned and used by public authorities shall enter into force by January 2019 and for other buildings shall be effective by January 2021. The amendment is currently under preparation.

Figures and statistics on existing NZEBs

There are no detailed statistics available about the current total number of NZEBs (considering the most probable future definition). The above mentioned schemes have generated a significant number of efficient buildings in Germany. The report points out that about 463,000 apartments or homes were funded as new 'efficiency buildings' as well as 1,090,000 apartments in refurbished residential efficiency buildings (status June 2012). As the funding of municipal projects in this sector started much later, the total number of buildings funded under the efficiency house schemes was 1,350 until June 2012.

Table 6:
Example (semi-detached residential building) for the determination of the cost-optimal level for component requirement (outer walls) dependent on a choice of combinations with heat generators ('packages').

Requirements for refurbished outer walls (example: semi-detached residential building)				
Heat generator	u-value	overall costs	Primary energy demand	
			calculation result	+15%*
	[W/m².K]	[€/m²]	[kWh/m².year]	
Condensing boiler	**0.24****	**275**	**106**	**122**
	0.20	276	105	
	0.16	277	104	
	0.12	282	102	
Heat pump (air – water)	0.24	357	99	
	0.20	356	98	
	0.16	355	96	110
	0.12	358	95	
Wood pellet boiler	**0.24****	**221**	**28**	**32**
	0.20	222	28	
	0.16	224	27	
	0.12	229	27	

(shaded) cost-optimal level
* margin for relevant deviations according to recital 14 EPBD
** cost optimal level considering technology-open heat supply

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The German Federal Government submitted to the Commission a report according to Article 4 of the Energy Efficiency Directive (EED) on 16 April 2014. This report contains the first approach concerning the strategy provided in Article 4, including the overview of the national building stock based on statistics, as well as the evidence-based estimate of expected energy savings and wider benefits. Table 7 shows the results from the National Energy Efficiency Action Plan (NEEAP) calculations. The underlying calculations by experts on behalf of the Federal Ministry of Economic Affairs and Energy include the effects of the major funding schemes and the legal provisions of the EnEV. One of the funding schemes has been established in order to provide energy consultation for building owners.

The strategy to improve the building stock in Germany is based on three pillars to enhance market power: requirements - funding - information. As mentioned above, the effect of the requirements and the effect of funding are calculated in detail for different time periods. The calculation of the impact of information campaigns is more difficult as the reason a building owner decides to refurbish a building cannot be easily determined. Nevertheless, it is obvious that campaigns add a value to both other pillars. Therefore, the federal government invests in such campaigns, e.g., by funding activities of the German Energy Agency. The current activities are 'branded' with the headline '*Die Hauswende*', with reference to the commonly used term '*Energiewende*'.

In the residential sector, the strategy has to address a high quota of rented property, with the typical ensuing difficulties due to conflicting interests of landlords and tenants. Furthermore, the report emphasises the obstacles arising from the fact that the majority of heat transmitting surface elements have already been modernised in the past and have considerable residual lifetimes.

Statistics concerning heated and/or cooled buildings owned and occupied by the German Federal Government are also included. The total floor area of such buildings was reported to be 3 million m^2, including buildings that already fulfil the national requirements due to previous refurbishment. An amendment of the national renovation strategy for these buildings according to EED Article 5 ('*Energetischer Sanierungsfahrplan Bundesliegenschaften — ESB*') is still under preparation at the end of 2014.

Table 7: From German report to EED Article 4: Evidence-based estimate of expected energy savings (in accordance with the German NEEAP).

Timeframe	1995-2007	2008-2010	2008-2013	2008-2016	2008-2020
Measure	(Cumulated) Savings of annual Energy demand [PJ/year]				
Energy Saving Ordinance (residential)	128	27	67	108	**162**
Energy Saving Ordinance (non residential)	63	9	25	35	**53**
KfW-Funding Programs					
CO_2-building renovation	17	7	7	7	**7**
Energy-efficient renovation	-	16	32	50	**70**
Eco-Plus	-	4	4	4	**4**
Energy-efficient construction	-	2	4	6	**9**
Eco-construction	1	1	1	1	**1**
BAFA-Funding Programs					
Market incentives for RES ("MAP")	10	8	11	14	**21**
En. Consulting (*"Vor-Ort Beratung"*)	1	1	1	2	**3**
Activities of the Regions (*"Länder"*)	1	2	3	5	**7**
Total	**228**	**77**	**153**	**232**	**337**

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

In Germany, requirements for heating and DHW systems have a history of 36 years. Such obligations were first introduced with the Heating Appliances Ordinance in 1978. These requirements, focusing on pipe insulation, as well as centralised and de-centralised controls, were broadened and strengthened in various steps. In several cases requirements nowadays involve the compulsory update of existing systems, including boilers, insulation, etc. In 2002, these requirements were integrated in the EnEV and then amended as follows:

> in 2007, when requirements for air-conditioning (AC) and ventilation systems were added;

> in 2009, when additional requirements for AC and ventilation systems were introduced;

> in 2013, when the mandatory replacement of boilers older than 30 years was introduced. The range of the former requirement for replacement of gas-and oil-fired boilers installed before 1978 and which set the deadline at the end of 2006 or 2008 in most cases, was considerably expanded by this regulation, maintaining, however, the exemption for low-temperature and condensing boilers. For small residential buildings, owner-occupied in 2002, the deadline is (and remains) 2 years after change of ownership.

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

Requirements with regard to building systems cover the following issues:

> insulation of pipes (heating, DHW and cooling systems);

> controls (heating, DHW, AC and large ventilation systems);

> primary energy expenditure ratio of boilers (heating systems, combined heating and DHW systems) — see Tables 8 and 9;

> mandatory replacement of boilers reaching a lifetime of 30 years (heating systems, combined heating and DHW systems);

> specific fan power (AC and larger ventilation systems) — see Table 10;

> heat recovery (AC and larger ventilation systems).

II.ii. Regulation of system performance, distinct from product or whole building performance

Nearly all aforementioned obligations refer to the design or configuration of systems. They are distinct from product performance as well as from whole building performance.

The requirement for the installation of a maximum primary energy expenditure ratio[2] of a boiler is only partly influenced by the product performance of the boiler as a product – the building's heat demand and the individual features of installation (only for heating or in combination with DHW, installation outside or inside the thermal envelope) influence this ratio as well. The requirement for the maximum primary energy expenditure ratio is assumed to be met in case of low-temperature and condensing boilers.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

Tables 8 to 10 show the applicability of all specific system requirements to both new systems (installed in new or in existing buildings) and replacements or additions occurring in existing systems. The relevant elements relating to the mandatory update or replacement (required by German legislation) are addressed in the fourth column of Tables 8 to 10.

II.iv. Applicability to new buildings (optional)

In case of new buildings, the system performance is accounted in the calculation of overall energy performance. This allows a detailed assessment of the issues addressed by the system requirements and makes minimum requirements mostly unnecessary. Nevertheless, the minimum system requirements have to be met in new buildings as well. This is not only in compliance with Article 8 of the EPBD, but also prevents confusion of consumers, who are accustomed to, e.g., finding thermostatic valves in every room and temperature controls connected to every central heat generator.

[2] *Primary energy expenditure ratio of a heat generator (according to the German calculation standards) is the amount of non-renewable primary energy needed by this generator to produce 1 unit of heat.*

Subject	Requirements concerning water-based heating systems: new systems	extensions to existing systems	replacement	mandatory update of existing systems	Remarks
maximum primary energy expenditure ratio of boilers (1.3)	yes	yes (in case of additional boilers)	yes	boilers replacing old boilers in mandatory update scheme	primary energy expenditure ratio: amount of primary energy per unit of output energy
shut-down of boilers older than 30 years	not relevant			yes; from 1st January 2015	exemptions: • for small residential buildings, owner-occupied in 2002, update requirements adjourned until 2 years after change of ownership • in general, most pipes in heated space do not need insulation
insulation of pipes & valves according to inner diameter (tabled values; mostly: insulation layer = inner diameter with λ=0.035 W/m.K)	yes	yes	yes	initial deadline 2006; accessible, uninsulated pipes & valves in unheated space	
central controls (water temperature depending on time schedule and outside temperature)	yes	not relevant		yes, immediately	exemption for certain district heating systems with overall controls; equivalent solutions allowed
room temperature controls	yes	yes	yes	yes, immediately; but special provision for floor heating systems installed before February 2002: manual adjustment of heat delivery per room	exemption for rooms < 6 m² with floor heating
automatically adjusting pumps (continuous or ≥ 3 steps)	yes	yes	yes	no	exemption: systems < 25 kW

Table 8: Requirements for water-based central heating systems.

Subject	Requirements concerning DHW systems: new systems	extensions to existing systems	replacement	mandatory update of existing systems	Remarks
time-dependent controls to shut-off circulation pumps	yes	yes	yes	no	
insulation of pipes & valves according to inner diameter (tabled values; mostly: insulation layer = inner diameter with λ=0.035 W/m.K)	yes	yes	yes	initial deadline 2006; accessible, uninsulated pipes & valves in unheated space	exemptions: • no requirement for non-circulating pipes up to 3 litres volume • for small residential buildings, owner-occupied in 2002, update requirement adjourned until 2 years after change of ownership

Table 9: Requirements for DHW systems.

Subject	Requirements concerning AC-systems > 12 kW rated output for cooling and ventilation-systems with inlet air-flow ≥ 4000 m³/h: new systems	replacement of central units	replacement of ductwork	mandatory update of existing systems	Remarks
maximum SFP value: SFP 4 (EN 13779: 2007)	yes	yes	yes	no	
separate control set-points for humidifying and dehumidifying	yes	yes	no	yes; 6 months after detection in course of inspection	
insulation of cold-water pipes & valves (≥ 6 mm with λ=0.035 W/m.K)	yes	no	no	no	requirement also valid for replaced pipes & valves
automatic air-flow control dependent of actual needs or of time schedule	yes	yes	yes	no	• applying to systems with: specific inlet air-flow > 9 m³/h per square-meter supplied useful floor area • exemptions in cases of concurring regulations for workplace safety and health protection
heat recovery class H3 (EN 13053: 2007)	yes	yes	no	no	exemptions, when: • recovered heat is not needed in the building or • inlet and exhaust are situated in different parts of the building

Table 10: Requirements for large AC and ventilation systems.

II.v. Provisions for installation, dimensioning, adjustment and control

Despite the fact that requirements on building systems are formally addressed to the owner of the building, in practice most are to be fulfilled by the installer, since the requirements require a proper installation and system layout. Therefore, every professional installer working on systems in existing buildings is due to issue a contractor's declaration indicating that the requirements have been fulfilled. Not issuing such a declaration, or giving false declarations is an offence and can be prosecuted by penalties up to 5,000 € for the installer. Thus, detailed technical requirements are mainly the responsibility of the installer. The violation of the requirements as such (e.g., not replacing a boiler in due time) can be prosecuted with penalties up to 50,000 € for the owner, as far as the violation was done on purpose, or under serious neglect.

The main provisions are

> **for water-based heating systems:**

- installation of central controls to adjust the water temperature and to shut-off circulation pumps according to the time and the outside temperature (or an equivalent control parameter); this has been a mandatory retrofit requirement for many years; if nowadays a violation is detected (e.g., by the chimney sweeper), the owner is required to add the missing controls immediately facing penalties up to 50,000 €;
- installation of room temperature controls in every room of a building (except rooms with under-floor heating with an area less than 6 m²); this is also a mandatory retrofit requirement (with a special regulation for old under-floor heating systems);
- installation of circulation pumps automatically adapting to the actual demand of circulating water in at least 3 steps; this applies to both first-time installation, as well as replacement of these pumps, and can be achieved by choosing a controlled pump, or by combining a conventional pump with an external control unit;
- insulation of pipes and valves with certain exceptions; this is also a mandatory update requirement for accessible, un-insulated pipes in unheated spaces; the legal deadline for most cases (except some owner-occupied small residential buildings) expired in 2006.

> **for DHW systems:**

- insulation of pipes (provisions mostly similar to those for water-based heating systems;
- installation of automatic controls to shut-off hot water circulators (first installation or replacement).

> **for AC systems exceeding 12 kW rated thermal output for cooling and ventilation systems with 4,000 m³/h inlet air capacity:**

- in case of first installation or replacement of major elements, a maximum SFP value[3] (category SFP 4 according to EN 13779: 2007);
- in case of first installation or replacement of central units with indoor air moisture regulation, a control with separate set-points for humidification and de-humidification; this is also a mandatory update requirement if detected as missing in the course of a mandatory inspection;
- in case of first installation or replacement of central units or duct-systems in systems designed for specific inlet air volume of more than 9 m³/h per m² of useful floor space, systems have to be equipped with controls to automatically adjust the air-flow to the needs;
- in case of first installation or replacement of central units, the systems have to be equipped with heat-recovery units (minimum performance category H3 according to EN 13053: 2007).

Dimensioning of heating systems and their adjustment are no longer subject to legal requirements in Germany, since the calculation methods encourage proper dimensioning and hydraulic balancing. Dimensioning of AC systems is only dealt with in the course of mandatory inspections. A (non-mandatory) guideline for inspecting experts is DIN SPEC 15240: 2013-10. Based on DIN EN 15239, DIN EN 15240 and DIN EN 15243 and under consideration of DIN V 18599 (concerning the calculation of the energy demand for AC). This standard defines a method for the energetic inspection of AC systems.

[3] *SPF – Specific Fan Power*

II.vi. Encouragement of intelligent metering

A new provision to promote intelligent metering was first introduced by the 2008 amendment of the German Energy Industry Act (‘*Energiewirtschaftsgesetz*‘). Since 1 January 2010, every new building newly connected to the grids has to be equipped with intelligent meters. This applies also in cases of major renovations (as defined in Article 2 (10) of the EPBD). The law only excludes cases in which the installation of these meters is technically impossible, or economically not reasonable. Intelligent meters are defined as meters that show the real consumption, corresponding to the real time of usage, and that are connected to a communications grid.

Thus, the requirement to promote intelligent metering as stipulated in Article 8 (2) was already introduced before the EPBD in Germany. The legal requirement nowadays refers directly to the EPBD definition of major refurbishment. Currently, the revised calculation method DIN V 18599 allows taking intelligent metering into account for the energy performance of non-residential buildings (as part of the building’s energy management provisions, see also section II.vii).

II.vii. Encouragement of active energy-saving control (automation, control and monitoring)

With the recent amendment of the EnEV (2013), building automation became a subject of calculation of the energy performance of buildings. The new part 11 of DIN V 18599 became part of the method addressed in the EnEV. It follows the approach of EN 15232 and introduces classes of building automation and control. The requirements for new buildings are given by the reference building’s features, which include a state-of-the-art automation level. To encourage the use of improved building automation, if applicable, one of the two improved classes of automation can be taken into account in efficiency calculations for non-residential buildings using certain parameters assigned to these classes. This applies to new buildings, as well as in case of calculations for existing buildings (e.g., for the purpose of energy certification).

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The German building energy-certification system (first introduced in 2007) is based around independent experts, i.e., owners in need of a certificate may contract an assessor from the ‘open market’. The assessors act as independent experts and have to fulfil a set of qualification conditions. In order to implement the independent control-system according to the EPBD, certain administrative provisions had to be added following the recent amendment of the EnEV (2013). In particular, register of assessors, registration of newly issued certificates and a data model to carry out electronic controls were introduced. Also, the existing penalty system with regard to certification was revised.

In Germany, the 16 local governments (‘*Länder*’) are in charge of the control-system and the general enforcement of building energy performance certification. The overall administration is run by the DIBt (‘*Deutsches Institut für Bautechnik*’), a common authority for mainly nationwide issues of building control. Because of the strict data privacy law in Germany, the newly introduced central database is restricted to metadata (type of certificate and building, new or existing building, responsible local government, assessor). These data are accessible for the enforcing authorities and the individual expert, but not for the general public. Further information gathered during sample controls has to be made anonymous afterwards. The anonymous data can then be used for statistical purposes (e.g., to obtain information concerning the general state of refurbishment in Germany, as a whole or in a certain region).

The Energy Performance Certificates (EPC) in Germany can be grouped into two categories according to the type of assessment method: certificates based on calculated energy demand and certificates based on metered consumption. In doing so, all new buildings and cases of major renovation must have an EPC based on a calculation methodology. The simpler metered energy consumption method applies only for the following:

> existing residential buildings with at least 5 apartments, where the influence of individual user behaviour is statistically balanced by the large number of users;

> existing residential buildings with less than 5 apartments, which at least comply with the first German Thermal Insulation Ordinance for thermal insulation (1977);

> all existing non-residential buildings.

How flats are certified in apartment buildings

In Germany, the certificates are generally issued for the building as a whole, on the grounds that heat flows between apartments are considered significant and different EPCs for individual apartments could be misinterpreted in terms of accuracy. When a building is owned by a group of owners of individual apartments (shared property), the obligation is addressed to the specific group of shareholders, even if only one of them intends to rent out or sell the apartment. The others benefit from the EPC issued at this occasion, because the certificate will also be valid for their apartments for the following 10 years.

An exemption is foreseen for mixed-use buildings (residential mixed with non-residential), where in certain cases two certificates – one applying to residential use and the other to non-residential use of the building – are issued.

Format and content of the EPC

The EPC format was introduced in 2007 and amended twice (in 2009 and 2013).

Each certificate consists of five pages:

> Page 1 contains information about the building, the selected calculation methodology (asset rating or metered rating), the source of the input data and the assessor.

> Page 2 shows the results in case of asset rating (energy demand).

> Page 3 shows the results in case of metered rating (energy consumption).

> Page 4 includes recommendations and individual comments by the assessor.

> Page 5 provides explanations concerning the values and scales in the certificate.

There are different EPC formats for residential and non-residential buildings, however, both certificates shall, as far as possible, follow the same structure. Figure 3 shows as example of the current form for page 2 (showing the results in case of asset rating) and highlights the changes introduced in 2013.

Although detailed designs (including colours) are not mandatory, due to software implementation combined with a widely used official printing tool, the certificates mostly look as indicated in the annexes of the EnEV.

EPC activity levels

Before 1 May 2014, there was no registration of EPCs in Germany and therefore there was no database and no control system in place. Consequently, the certificates issued before this date do not have a registration number and cannot be subject to any control activities. The validity of these certificates (10 years) is however not affected by the recent changes of the EnEV. Within the first 8 months of running the scheme (May 2014 to December 2014), DIBt registered 173,192 certificates based on asset rating (energy demand), and 149,016 certificates based on metered rating (energy consumption). The average monthly number is now stabilised at approximately 40,000 certificates. Due to other changes in the system, it is probably not appropriate to assume that this was the monthly rate also in the period before May 2014. Moreover, indicators show that a very large portion of certificates was issued in 2008.

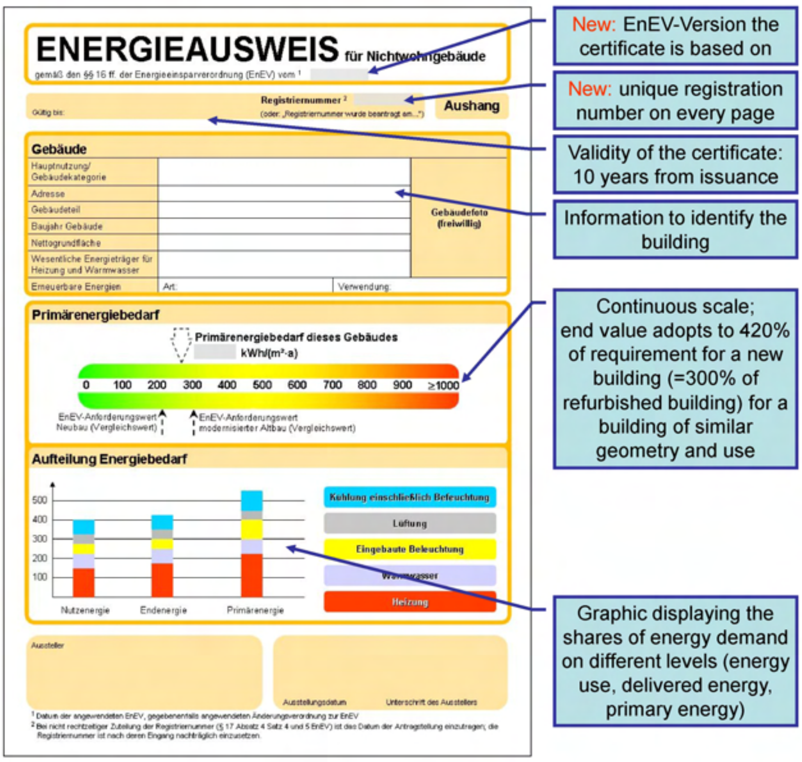


Figure 3: Page 2 of the EPC for residential and non-residential buildings, (asset rating, version 2013).

Typical EPC costs

The Energy Saving Ordinance (or any other legislative act) does not include any regulations with regard to the costs incurred in the energy certification process. Therefore, there is no set price for the cost of an EPC. The price may be determined by the assessor and property owner individually and typically ranges between 50 € and 800 € for residential buildings. It can be assumed that the new additional fees for registration (currently set at 4.50 €) have little or no effect on the price of an EPC. There is no recent analysis on the effects of the introduction of the database on the market price of EPCs.

Assessor corps

When the system authorising the issuance of EPCs was first introduced in Germany in 2007, there was a need for opening up the pool of qualified assessors due to the large number of certificates required in the first years of the scheme's application and in order to keep the prices low. The authorisation of a professional to issue certificates is based on the qualification of the expert in question.

For new buildings, the preconditions to act as an assessor are defined by regional law. These experts —mostly architects and engineers — are also entitled to issue certificates for existing buildings of similar use and size.

Other experts intending to issue energy certificates for existing buildings must identify their personal qualifications and check whether they meet the conditions set in the EnEV (§ 21). The individual requirements for the qualification of assessors for existing buildings include occupation (several different engineer qualifications and — for restricted fields of activity — building technicians and master craftsmen) and a corresponding level of occupational training and/or professional experience. The required qualifications are described in an annex of the EnEV and several organisations offer customised training. There is no official approval or certification procedure. A professional who issues an EPC while not entitled to do so, breaches the regulations and can be punished by law in the form of a fine. The risk of facing possible fines/penalties should prompt a potential assessor to cautiously examine whether he/she meets the conditions. Enforcement, also in this case, is a responsibility of the local authorities who are due to act if a violation is determined, e.g., via a complaint.

Since the introduction of the independent control system, experts intending to issue certificates must register through a personal account on the server of the DIBt. The creation of the account does not replace the 'self certification' procedure described above. The DIBt is not in charge of controlling the individual qualifications and additional preconditions of the expert for issuing certificates. Currently, there are more than 17,000 active expert accounts, including experts who perform inspections (AC systems); these are also entitled to issue certificates allowing synergetic effects.

Compliance levels by sector

There is no recent study of the compliance level including the impacts of

> the newly introduced control system;
> the requirements concerning advertisements;
> the recent alterations about the clearly defined onset of the requirement (advertisements, showing of houses).

The anticipated (but not yet scheduled) general evaluation of the EnEV (see section I.i.) should, among other issues, cover this aspect of impact, enforcement and compliance. Since the control system was introduced in May 2014, significant results are not yet available. Local authorities will only have to submit a detailed report about the results of the control system to the Federal Government by March 2017.

Enforcement with building owners and real estate actors

The requirement to display or hand out a certificate of an apartment or building becomes mandatory at latest at the time of showcasing the apartment or building for sale or rental to the prospective buyer or tenant. In case of non-compliance, normally brought to light by a complaint, a penalty can be imposed on the owner of the building by the relevant building authority (usually a local authority designated by the respective region). A special German market instrument, the 'warning notice' ('*Abmahnung*', see below in section III.iii.) issued by private stakeholder organisations or by competitors, has sufficiently helped to achieve a high level of compliance especially among estate agents and housing companies. In view of requirements concerning advertisements (see section III.iii), property owners are regularly being pressed by their estate agents — who as professionals fear a 'warning notice' — to have a certificate issued before any showing of the property to prospective owners or tenants.

Quality Assurance (QA) of EPCs

The recently introduced German approach of an independent control system works effectively and allows to keep both efforts and costs as low as possible. The liberal approach of a free market without official state approval was a barrier to the setup of the independent control system, as was the protection of data privacy for property owners, which is held in high regard in Germany.

For this reason, the control system has to work without a general data retention in a central database. A commissioned and authorised body ('*Deutsches Institut für Bautechnik - DIBt*') holds a central EPC register without collecting all the contents of the issued EPC. The register collects data from the assessor concerning the type of EPC issued and the location of the building. Each certificate is granted an individual registration number and can be part of the random quality checks. The contents of the certificate and additional input data will only be collected for certificates that are part of the random samples. For the purpose of a later long-term storage in a database, the datasets have to be made anonymous due to the above mentioned data privacy rules, after all checks have been completed.

Checks are organised in accordance with the three options of the Directive 2010/31/EU. The first step of plausibility checks (option A: validity check of input data of the building) is currently carried out automatically by DIBt on behalf of local authorities. For the year 2014, samples in the order of 5% (about 16,000 certificates overall) are selected with respect to type and location of the building for the automatic checks. The results are communicated to relevant local authorities (based on location of the building) and the assessor. Further and more detailed controls (option B: check of the input data and verification of results and option C: full check of the input data and results, possibly including site visit) are the responsibility of local authorities who are able to impose fines (up to 15,000 €) in case of violations of regulations on certification. For example, this could include incorrect issuing of certificates, refusal to issue or to submit a certificate, or deliberate inclusion of incorrect information in energy certificates.

For existing buildings, according to the EPBD, checks for appropriate samples of EPCs dated from 2014 will be carried out in 2015. Details and size of the sample are under consideration by a task force of competent regional authorities; the quotas will probably be set at the level of 0.5% for option B and 0.1% for option C.

With regard to new buildings, such checks are already subject to the building codes of several regions.

The first results of the analysis of the samples from 2014 (16,105 EPCs checked in option A, and a further ca. 1,900 foreseen for options B and C) are expected in 2015. For earlier years (2012 and 2013), a control of statistically representative samples was (and still is) not possible, due to the absence of a registration service or database.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

With the adoption of the Directive 2010/31/EU, the German transposition on Display of Energy Performance Certificates was updated.

There may as well be cases where the former Directive 2002/91/EC demanded a public display, but the new wording of the Directive 2010/31/EU would not demand one. On the other hand, a new, separate requirement to display the EPC addresses all cases of buildings frequently visited by the public, though only if a certificate has been issued. The German transposition ensures that buildings subject to the display requirement already before the 2013 amendment of the EnEV will also be subject to the display requirement in the future. This applies to, e.g., public theatres and schools. Non-public buildings in Germany frequently visited by the public — in accordance with the Directive 2010/31/EU — must meet a display requirement only when a certificate is already issued, or as soon as a certificate is issued on the account of future sale or rental.

A display may either consist of all 5 pages of the certificate, or include a reduced single-page display. Figure 4 shows the display format for asset rating.

Format and content of the EPC

The German legislation does not distinguish between public and large private buildings visited by the public and other non-residential buildings. The display form is an integrated part of every certificate for a non-residential building. The owner may display an EPC on a voluntary basis, even if not required to do so. If a certificate was issued under former legislation, a new display (e.g., needed because of new thresholds) based on this certificate must mention the applied version of the ordinance, but is otherwise not due for an update.

Frequency of updating

Certificates, as well as displays, are valid for a maximum of 10 years from the date of issuance and can be used in their original form during this period even if new forms are introduced by an amended ordinance for newly issued certificates. When a major building refurbishment is underway and a calculation of the energy demand is carried out in the course of these measures, a former energy certificate loses its validity and a new one has to be issued based on the recent calculation.

Activity levels

The display number of EPCs has not been analysed yet. This will probably be included in the upcoming general evaluation of the EnEV (see section I.i.). In order to set a positive example for other authorities, the federal government has implemented a programme from 2007 to 2010 to ensure that also buildings occupied by federal ministries and higher authorities – i.e., buildings frequently visited by the public – are equipped with certificates and displays. In the framework of this programme, about 35 federal state buildings in Berlin and about 45 buildings in Bonn displayed their certificates without obligation to do so, because of being 'frequently visited by the public'. Whenever a building owned and occupied by the federal government is subject of major refurbishment, a certificate is created and displayed even without any existing obligation.

Costs

There are no studies indicating the market prices of certificates for this group of buildings. During a study about energy certificates for non-residential buildings carried out in 2011, professional owners were asked about the price acceptability for a certificate for a simple, square, non-residential building with a single use. The replies ranged from an average of about 800 € for a certificate just meeting the minimum requirements to an average of 1,400 € if the certificate provides really useful information.

Assessor corps

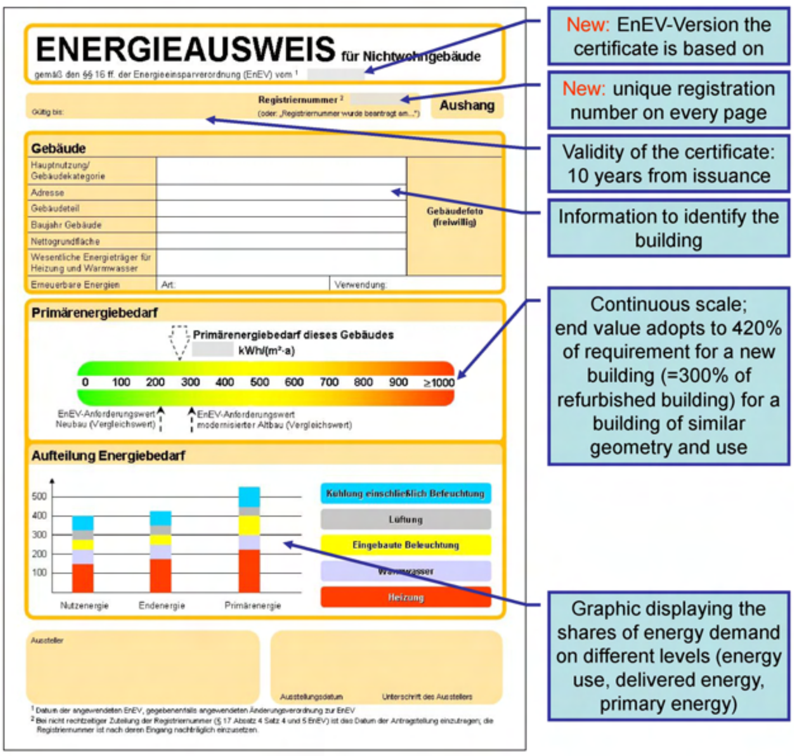
The assessor corps for non-residential buildings is more or less identical to the one for residential buildings, with the exception of master craftsmen and building technicians. Engineers and architects fulfilling the requirements of the EnEV (section III.i.) are entitled to issue certificates for all types of existing buildings, but apparently some qualified assessors refrain from doing so for non-residential buildings as the regulations and the technical aspects in this field are more complicated.

Quality Assurance (QA) of EPCs

In general, the German legal system postulates full compliance when an authority is the addressee of a regulation. Higher authorities are obliged to intervene if an authority under their responsibility does not fully comply with the law. A system of penalties and fines is therefore unnecessary for the prosecution of authorities that own or rent such buildings with display obligation for their purposes. For private owners, the issuance of the certificates is liable to penalties. However the recently introduced obligation to display certificates in case of non-public use with frequent visitation is not yet subject to penalties.

Certificates for public buildings are subject of the newly introduced control system as well. The first results are also expected from the 2014 samples under analysis.

Figure 4: Display EPC in case of asset rating (version 2013).



III.iii. Implementation of mandatory advertising requirement

The mandatory advertising requirement was introduced with the 2013 amendment of the EnEV and came into force on 1 May 2014. This obligation applies to advertisements in all commercial media (print and online, also estate agents displays, with the exception however of, e.g., whiteboards provided for free in other places and advertisements of a tenant looking for a follower). The advertising requirement is supported by a provision about penalties, addressing owners and — indirectly — estate agents acting on behalf of the owners.

Shortly after the introduction of this obligation it became evident that there is no real need for penalties. A specific German market instrument, the so-called 'warning notice' ('*Abmahnung*') issued by private stakeholder organisations or by competitors, has contributed to the high level of compliance especially among real estate brokers and housing companies. This instrument works as follows: specialised legal professionals observe the market on behalf of stakeholder organisations, or of competing estate agents. As far as the advertising requirement is concerned, whenever an advertisement lacking the due energy efficiency indicators is spotted, an official letter is send out to the party at fault demanding a declaration that this person or organisation will respect the regulation in the future. This warning letter entails also a significant fee for the lawyer and sometimes a compensation for the affected competitor. The addressee might file a lawsuit to avoid these payments, but normally will refrain from doing so because of legal costs and an unsure outcome. Legal professionals who issue such letters have a strong motivation because of easily earned fees. Even in cases when the certificate is not due (e.g., for monuments) or not yet due (e.g., for unfinished new buildings), real estate agents tend to advertise energy performance indicators just to avoid the legal implications of 'warning letters'.

In detail, the new regulation lists up to five indicators that must be published in different cases (e.g., for residential buildings: type of certificate, value of delivered energy, energy carrier, year of construction and energy class, if applicable). This quite extensive set of indicators is owing to the fact that German certificates (until recently) did not generally provide a single indicator for energy performance, but a set of different indicators without a fixed classification system.

Several supporting instruments are provided, e.g.:

> an official guideline for owners and estate agents on identifying the indicators in the current seven different types of energy certificates for residential buildings and six different types for non-residential buildings; this guideline is focused on the 'old but valid' generation of certificates, since the current version contains clear instructions;

> a smartphone app (Figure 5) usable also as online assistance to identify valid energy certificates and to find the correct indicators[4] and

> a list of abbreviations developed by the newspapers and published as header on relevant pages.

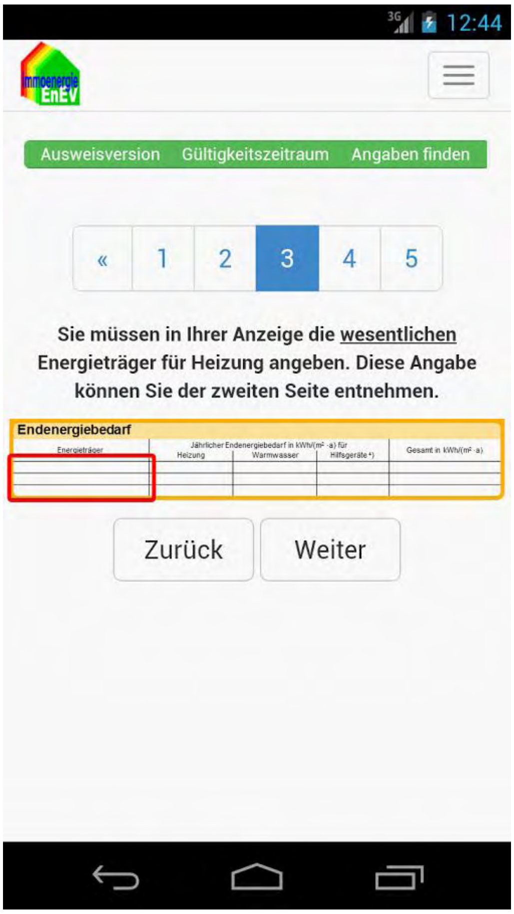


Figure 5: Smartphone app to determine the indicators for advertisements (Android, screenshot).

[4] www.immoenergie.de; *(German only; offline usable with Android).*

III.iv. Information campaigns

The Federal Government published two information brochures (Figure 6) about energy certificates according to the former version of the EnEV, one for the general public and one for experts and owners dealing with certificates for non-residential buildings. Both brochures were in high demand. The first one informed citizens on various issues of the energy regulations. An update of this brochure is underway, but the publication was postponed until 2015 due to the major changes of responsibilities within the Federal Government. The re-editing of the second brochure is under consideration. Meanwhile, additional information (including FAQs) is provided on official websites. In addition, stakeholders (e.g., consumer organisations, house owner federations) also publish information material for their own clientele.

III.v. Coverage of the national building stock

In absence of a registration system before 1 May 2014, there is no data available to indicate the coverage of the building stock with certificates. Taking into account earlier evaluations[5], and the fact that for every new lease of a single apartment in a building a certificate has to be issued for the whole building, being thus valid for all the apartments of the building in question, it can be assumed that housing companies with multi-family rental buildings reached a nearly full coverage already in 2008 for their 8.4 million apartments (in about 1.2 million buildings). On the other hand, private homes presented a low coverage at the time of the evaluation study. The same appears to apply to privately owned non-residential buildings, without though any statistical evidence. According to internal reporting by organisations of the federal and local governments, public buildings appear to have certificates in their ownership as far as they were constructed after 2007, or as far as display of energy certificates was required, however, there is no statistical evidence to support such a presumption. The same assumption applies to municipal buildings as well.

The total building stock in Germany by the end of 2012 amounted to roughly 18 million residential buildings and about 3 million thermally conditioned non-residential buildings. Based on the number of EPCs issued since registration began in 2014, and indications that 10 times that number of EPCs were issued prior to that date, it is estimated that 10% of the German building stock is already covered by certificates.

Indicators about the conditions leading to the issuance of certificates (e.g., sale and display obligation) could be later extracted from the control-samples.

Figure 6: Brochures for the information of citizens about energy certificates and requirements; new editions are expected in 2015.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

In the course of the implementation of Directive 2002/91/EC, Germany decided to adopt different approaches for heating and boiler inspections (alternative measures), and for the inspection of AC systems (inspections). This decision was made based on the requirements already in place in Germany. The already existing scheme for boiler inspection, does not cover all the provisions of the directive. In addition, there has been a long-term approach in place since 1978 providing for mandatory requirements for heating systems. These measures have resulted in a relative high standard for existing heating systems, thus reducing the probable impact of inspections of the accessible parts. For this reason, Germany decided to follow the 'alternative measures' approach for heating systems.

For AC systems, there were no similar measures in place until 2007. As a result, it was decided to follow the inspection option for AC systems.

[5] www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/BMVBS/Online/2010/DL_ON062010.pdf?__blob=publicationFile&v=2 (German only)

With the introduction of the Directive 2010/31/EU, Germany carried on with both these approaches:

> for heating systems, a combination of funding and information campaigns, requirements for replacement and compulsory updates, and inspection of boilers, including pumps and boiler controls;
> for AC appliances with an individual rated output exceeding 12 kW, a mandatory inspection scheme, which will be completed by an independent control system for inspection reports, carried out by the same organisations as the control system for energy certificates.

Inspections of AC systems as well as the package of equivalent measures for heating systems, are not systematically linked to activities according to Article 4 of the EED for building renovation. In future reports about equivalence, any possible overlap will be taken into account.

IV.i. Alternative measures, heating systems

Report on equivalence

Germany has reported to the Commission the selection of 'alternative measures' three times under the Directive 2010/31/EU. In 2013, a calculation showed that the above mentioned system of recurring measurement of boilers (especially with view to the severe enforcement leading to compulsory shutdown of faulty boilers) in combination with a funding scheme for replacement of conventional boilers with heat generators based on renewables, led to energy savings exceeding by far those of an inspection scheme for accessible parts of heating systems.

The report lists two kinds of alternative measures:

1. Measures with detailed impact assessment based on 'hard' market figures:

> recurring on-site measurements for all boilers according to the German environmental law, based on the statistics of the chimney sweeper association, with careful extrapolation to the future;
> funding[6] scheme for system refurbishment, only partially included in quantitative analysis because of overlaps;
> funding scheme 'MAP' concerning the replacement of conventional boilers with renewable-powered heat generators, based on the statistics of the funding organisation with careful extrapolation to the future.

2. Other measures supporting the above mentioned (without numerical evaluation in the report):

> detailed enforcement of the regulations on shutting down old boilers (plus their replacement by other, more efficient heat generators) and compulsory insulation of pipes;
> other compulsory measures without systematic enforcement (e.g., insulation of formerly uninsulated pipes);
> information campaigns by federal and regional governments, trade associations and privately driven initiatives.

Impact and equivalence assessment

The most recent report states that the impact of the alternative measures listed above under point 1 amounts, in terms of primary energy savings, to 3,860 GWh within the timeframe 2014-2016 (ex-ante analysis) compared to the savings that could be produced by an inspection scheme amounting to only 1,051 GWh in the same timeframe.

The calculation was facilitated by a reliable set of data and a calculation framework providing figures to estimate the improvements. The ex-post analysis could make use of the yearly statistical reports provided by the association of chimney sweepers and the documentations about funding.

Costs and benefits

The benefits stated above can be attributed to systems introduced and running for other purposes. Therefore, the above mentioned benefits are not linked to additional costs for inspections, which would have to be paid by the owners of the buildings. It can be assumed that the 'saved' costs for avoided inspections enhance the ability of the owner to invest in refurbishment, hopefully for improvement of the energy performance.

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

Regular inspections for AC systems are mandatory since 1 October 2007. Also mandatory is the regular maintenance of energy-related components of AC and ventilation systems by a professional

[6] *The scheme is about the introduction of renewables by replacing non-renewable heat generation.*

technician. The intervals for the latter should be fixed according to the manuals and must consider the needs (sizing) of the individual installation. The mandatory maintenance allows for a longer interval between inspections.

Every AC unit with a thermal output of more than 12 kW must undergo an inspection by an engineer specialist every 10 years. The scheme was first introduced in 2007 and established deadlines for the first inspections based on the age of the system by 1 October 2007: systems older than 20 years had to undergo the first inspection within 2 years, systems older than 12 years within 4 years and systems aged from 4 to 12 years within 6 years from the start date. Following the 1st inspection, further inspections are due every 10 years. This scheme was not changed with the recent amendment to the law, but provisions on registration and formal issues in order to identify the registered inspection report were introduced.

In particular, the engineer must inspect the appliance to check whether it meets the individual demands of the building and whether it requires modernisation. The inspector must provide recommendations for improving the system efficiency or replacing the system, according to the EPBD.

A compulsory inspection method was not legally introduced, but DIN recently issued a (non-compulsory) National Annex to EN 15240 as a guideline for inspectors.

Arrangements for assurance, registration and promotion of competent persons

The inspection report is subject to an independent control system run by the regional authorities in the same way and using similar means as the control system for energy certificates. For this purpose, the experts, as well as their reports, have to be registered with the *'Deutsches Institut für Bautechnik (DIBt)'*. This authority will also provide statistically representative samples of inspection reports issued in a certain year for the purpose of control by regional authorities.

Registration of experts started in early 2014, while registration of reports became mandatory as of 1 May 2014. Therefore, the experience with regard to the registration system is only recent. Assessors are now obliged to keep the reports issued, together with the data and evidence used to create the reports, and must provide these to the controlling authority when selected to be part of the sample for independent controls.

Promotional activities

As the inspection scheme is in place since 2007, owners should be aware of their obligation and of possible penalties in case of not having their AC systems inspected. Because the total number and location of the AC systems due for inspection is unknown, systematic enforcement is not possible. The system so far relies mainly on promotion. The introduction of the control scheme has been featured in many professional journal publications. The national organisation representing AC system installers is currently promoting the issue through the customer relations department of installation companies.

Enforcement and penalties

Owners who fail to have their AC systems inspected, or who do not order an inspection in due time risk exposure to penalties. Inspectors who carry out inspections without possessing the appropriate professional education (legally defined degrees of engineering), or those not having the required professional experience, can also be prosecuted and penalised. The registration scheme is expected to facilitate the enforcement of penalties in the future. Without information on the number of AC systems, nor their size, age and location, competent authorities may currently enforce only the obligation of the owner (to assign the inspection to an assessor in due time) mainly by addressing complaints.

Indicators show that there is room for improvement, especially concerning owners who fail to order an inspection in due time. There is currently an ongoing discussion on how to improve the enforcement, considering also the use of evidence from energy certificates for cross-checking.

Quality control of inspection reports

Competent regional authorities plan to enlist the help of highly experienced experts for control checks of issued inspection reports in order to enhance enforcement. A structured, semi-automatic control protocol and accompanying guidelines are currently in preparation for experts checking inspection reports on behalf of the enforcing local authorities, in order to ensure equal control criteria. Samples of inspection reports are currently being collected awaiting control in bundles as soon as the systematic scheme is approved in 2015.

Inspection activity figures

Current observations of registered inspection reports show an almost steady rate of about 150 inspection reports per month since registration became compulsory in May 2014. Consequently, the overall number of registered inspection reports issued in 2014 is about 1,200. Decisions about the precise size of the sample due to be checked are still pending, but there is no doubt that a significant number of reports issued in 2014 will be included.

Impact assessment

Stakeholders, and in particular the association of installers, attribute great benefits to the inspection of AC systems, not only relating to the improvement of energy performance in this sector, but also to promoting innovation and ensuring sufficient work demand for the installers. A recent study[7] highlights possible improvements and additional impacts from the installers point of view. The study also shows, in a very detailed manner and for different systems and their components, how costs of investments and benefits are connected to the improvements achieved by following recommendations. However, it does not address the issue of inspection costs, neither specifically for the different system dimensions and designs, nor as average costs. As per free market rules, there are no legal instructions about the inspection fees other than the fees for the registration process (a few € per issued report).

3. A success story in EPBD implementation

Interdisciplinary standardisation leads to better understanding

The German transposition of the EPBD is closely linked to a great effort in standardisation, using a new form of interdisciplinary collaboration and leading to a unique and exemplary result, the all-in-one calculation method DIN V 18599 for energy performance of buildings.

During the implementation phase and related activities for the Directive 2002/91/EC in the years before 2006, the German government instigated the development of a holistic calculation method covering all the aspects mentioned in Annex I of this directive. The method is presumed to be suitable for differentiating between the different uses and combination of uses identified in typical German non-residential buildings. The differentiation should, on the one hand, lead to a realistic calculated energy demand value that is comparable with the metered consumption under the same conditions of use. On the other hand, the calculation is expected to handle the different systems and respective solutions in a way that their specific energy needs are expressed realistically and that possible improvements on each system can be identified and compared to others.

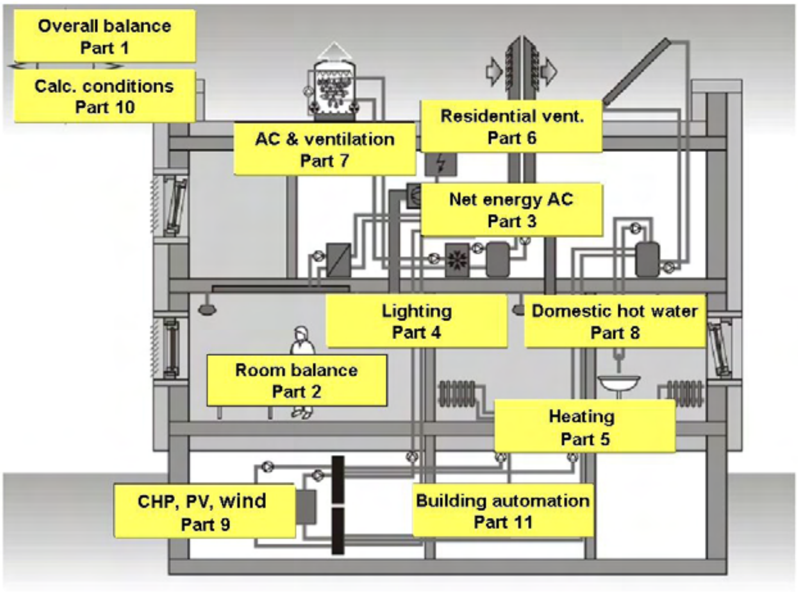
For the purpose of this standardisation process, the German standardisation institute (DIN) established an interdisciplinary committee that combines knowledge from the areas of building physics, heating and hot-water systems, AC and ventilation systems and lighting in the form of different sectoral committees. The aim was to develop a standard that calculates the energy performance in a unique calculation kernel with well aligned contributions from all systems, using defined internal interfaces.

The work resulted in a first version of the pre-standard DIN V 18599 which was issued in 2005 and used to set up the German regulations and to carry out field tests for energy certificates, especially for non-residential buildings. The experience gained in practice led to the first amendment (2007-02), which was used as a compulsory method assigned to the EnEV from 2007 until early 2014. The 10 parts of the 2007 version (Figure 7) were implemented in nearly 20 different commercial software packages. The second amendment in 2011 further improved this work and an eleventh part, dealing with building automation concepts, was added. The 2011 version of DIN V 18599 was legally introduced with the 2013 amendment.

The standardisation process led to a fruitful and exemplary cooperation of experts from very different backgrounds. This became the basis for better understanding among the different technical disciplines involved. DIN developed a new command structure in this field to overcome the differences in standardisation cultures and languages of the technical disciplines now working together with a common goal, i.e., to achieve energy performance calculation.

[7] *Schiller, H.; Mai, R.; Haendel, C. "Chancen der Energetischen Inspektion für Gesetzgeber, Anlagenbetreiber und die Branche", Fraunhofer IRB-Verlag, Stuttgart, 2013 (German language).*

Figure 7:
Structure of German calculation standard DIN V 18599.



The technical basis for DIN V 18599 comprises several approved international standards (e.g., EN ISO 13789, EN ISO 13790). The calculation procedure is in principle in line with other CEN standards from the mandate 343, being though much more consistent, unambiguous and clear to the users because of the 'all in one place' approach. Moreover, the 'common language' and consequent use of indicators and indices throughout this unique standard facilitates its use for legal purposes.

4. Conclusions, future plans

As odd as it may seem, since there are a lot of advanced buildings and a relatively ambitious level of energy performance requirements in the country, Germany has postponed thus far the publication of the detailed definition of Nearly Zero-Energy Buildings (NZEBs). Currently, one in two new residential buildings exceeds the requirements sufficiently so as to receive funding from the KfW funding bank.

The reason behind Germany's holding back is that the nearer to the point of introduction we stand, the more ambitious the energy levels for NZEBs can be set considering the economic circumstances: new technologies are being introduced, craftsmen and architects are getting acquainted with the specificities of energy efficient building, energy prices are rising (at least in the long term), whereas costs for energy saving measures are decreasing, and public awareness is growing. All these factors are conducive to an ambitious level of requirements.

The detailed determination of the NZEB level is to be completed before 2017. This task has been assigned to the government by the parliament within the Energy Saving Act 2013. In order to prepare for this step, the Federal Institute for Research on Building, Urban Affairs and Spatial Development has commissioned, on behalf of the government, several studies to determine the cost-optimal level for the next decade, identify the best way for establishing the requirements, update certain elements of the use patterns, align the different present legislative acts and, hopefully, to make it all as easy as possible.

In general, the German public is already aware of the need to improve the energy efficiency of new buildings. On the other hand, there is a strong need to deal with the shortage of affordable apartments in many urban regions. Politicians will have to ensure that NZEB levels are not in conflict with affordable costs for housing. As half of the German households live in rented accommodations, they are well aware of the increase of the 'second rent' consisting mainly of energy costs and adding to the rising, and, for people with lower income, sometimes nearly unbearable costs of the rent itself. Every effort to reduce energy costs nowadays helps to reduce the overall costs of housing, especially if the requirements are set out with care to avoid unreasonable construction costs.

It is also clear that a reduction of CO_2 emissions can only be reached by improving the energy efficiency of the current building stock. Specific requirements need to be applied in this area in case of refurbishment, but a reasonable level must be found first. Too strict requirements could result in investment reluctance. There is a huge task ahead for the building stock of the future to meet climate-neutral levels, and potential investment in energy efficiency should under no circumstances be discouraged!

Implementation of the EPBD in Greece

STATUS IN DECEMBER **2014**

1. Introduction

The implementation of the Energy Performance of Buildings Directive (EPBD) in Greece is the overall responsibility of the Ministry of Environment, Energy and Climate Change (MEECC[1]).

The law for the transposition of the Directive 91/2002/EC was approved by parliament in May 2008 (Law 3661). For the implementation of this directive, a ministerial decision for the new 'Regulation of Energy Performance of Buildings' (KENAK) was issued in April 2010 (Ministerial Decision D6/B/5825, National Gazette 407). The presidential decree necessary for defining the qualifications and training requirements of energy auditors was published in the National Gazette in October 2010 (Presidential Decree 100/NG177). Full implementation started in January 2011 for all types of buildings and building uses, and for both new buildings and existing buildings undergoing major renovations.

Directive 2010/31/EU was transposed into national legislation on 19 February 2013 (Law 4122/2013).

Implementation and quality control is performed by the Secretariat for the Environment and Energy Inspectorate, a public entity within the ministry, established for this purpose.

This report presents an overview of the progress and current status of implementation of the EPBD in Greece.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

The new 'Regulation on the Energy Performance of Buildings' (KENAK) replaced the existing 'Thermal Insulation Regulation' which had been in force since 1979. The thermal insulation requirements were tightened (Table 1), and the climatic zoning of the country was modified, increasing the number of climatic zones from three to four. Moreover, the regulation set minimum requirements for the efficiency of heating and cooling systems, as well as for hot water production for all types of buildings, plus lighting for buildings of the tertiary sector.

In the first phase of its implementation, energy performance requirements were imposed only for new buildings and for existing buildings over 1,000 m^2 undergoing major renovations. In view of the requirements of the Directive 2010/31/EU, the law was amended in June 2010, so as to remove the 1,000 m^2 limit, to introduce the definition of Nearly Zero-Energy Buildings (NZEB) and to require a minimum of 60% of Domestic Hot Water (DHW) demand to be covered by Renewable Energy Sources (RES) in new buildings. The obligation for issuing an

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[1] *YPEKA in the original Greek name*

Minimum requirements according to the new regulation		**U-value (W/m².K)**			
		Climatic zone			
		A	**B**	**C**	**D**
Heating degree days (18 °C)		800 - 900	1,100 - 1,400	1,700 - 2,100	> 2,200
Roofs	U_{V_D}	0.50	0.45	0.40	0.35
External walls *	$U_{V\text{-}W}$	0.60	0.50	0.45	0.40
External floors	U_{V_DL}	0.50	0.45	0.40	0.35
Floor over ground	U_{V_G}	1.20	0.90	0.75	0.70
External walls in contact with the ground	U_{V_WE}	1.50	1.00	0.80	0.70
Openings *	U_{V_F}	3.20	3.00	2.80	2.60
Glass façades	U_{V_GF}	2.20	2.00	1.80	1.80
Minimum requirements according to the previous regulation		**U-value (W/m².K)**			
		Climatic zone			
		A	**B**	**C**	
Roofs	U_{V_D}	0.50	0.50	0.50	
External walls	$U_{V\text{-}W}$	0.70	0.70	0.70	
Floor over ground	U_{V_G}	3.00	1.90	0.70	
External walls in contact with the ground	U_{V_WE}	3.00	1.90	0.70	

Table 1: Minimum energy performance requirements of building components.

* Not applied to passive systems such as Trombe walls. The requirements apply to windows (direct gain passive systems) only.

F/V (m^{-1})	**Max Um (W/m².K)**			
	Climatic zone			
	A	**B**	**C**	**D**
≤ 0.2	1.26	1.14	1.05	0.96
0.3	1.20	1.09	1.00	0.92
0.4	1.15	1.03	0.95	0.87
0.5	1.09	0.98	0.90	0.83
0.6	1.03	0.93	0.86	0.78
0.7	0.98	0.88	0.81	0.73
0.8	0.92	0.83	0.76	0.69
0.9	0.86	0.78	0.71	0.64
≥ 1.0	0.81	0.73	0.66	0.60

Table 2: Minimum energy performance requirements for the building envelope.

F: Surrounding Area
V: Volume of the building

Energy Performance Certificate (EPC) in case of building rental was put into force in January 2011, and was extended to individual apartments in January 2012.

Since 1 October 2010, an energy performance study must be submitted in order for a building permit to be issued. This requirement applies to all new buildings, as well as to existing ones when renovated. For new buildings, the study must demonstrate that after inspection, they would be labelled at least energy class B.

I.ii. Format of national transposition and implementation of existing regulations

The minimum energy performance requirements are expressed in relation to a reference building with predefined characteristics. The type and level of requirements are a function of the type of building (residential, or non-residential buildings including public buildings) and refer to:

- the design of the building, taking into account orientation, surrounding area, solar design, daylight, natural ventilation, etc.;
- maximum U-value for walls, windows, roofs etc., for each one of the four climatic zones, with the main parameter used for the definition of the climatic zones being the annual heating degree-days;
- maximum average U-value for the whole building;
- at least 50% heat recovery in the central air-conditioning (AC) units;
- minimum levels of insulation of the heating and cooling distribution networks;
- at least 60% DHW production from solar panels;
- minimum requirements for lighting installations for buildings in the tertiary sector (55 lm/W);
- minimum efficiency for heating generators (see section II).

The regulation sets minimum requirements (max U-values) for the building elements, as well as for the whole building envelope (Table 2). The U-values required vary by climatic zone. There are no specific seasonal requirements in the regulation, and the primary energy consumption used for the classification of buildings is calculated on an annual basis.

The energy performance calculation procedure is based on the monthly methodology of EN13790 and a set of national parameters defined where necessary. The assumptions and basic parameter calculations are described in a number of technical guides, published by the Technical Chamber of Greece in July 2010 and updated in March 2012. These guides also include the climate files used in the calculations, as well as the thermal properties of building materials. The classification of buildings in nine (9) energy classes is done according to the scale shown in Table 3. Class B corresponds to the minimum acceptable class for new buildings and for those undergoing major renovations. 'E.A.' is the total primary energy consumption of the existing building and 'K.A.' refers to the total primary energy consumption of the reference building. The reference building is defined as a building with the same geometrical characteristics as the building under consideration, which has the U-values presented in Table 1 for all the structural elements. The calculation takes into account:

> thermal comfort, by assuming temperature set points for the heating and cooling demand;
> indoor air quality, by assuming minimum ventilation rates according to the use of the building;
> infiltration using the area of the openings and average infiltration coefficients;
> thermal bridges;
> shading devices through the evaluation of shading coefficients.

A software tool for the calculation of the energy performance was developed by the Technical Chamber of Greece and is provided to engineers at a very low cost (100 € per license). This tool can be used on its own, but it is also available to software companies for integration into their own tools. Any new software that comes into the market is verified by the Secretariat for the Environment and Energy Inspectorate of the MEECC. The main criterion for verification is that the software uses the computational engine developed by the Technical Chamber of Greece and produces the same results for a test case.

Quality Assurance (QA) and compliance checking for new buildings is performed upon completion of the construction. An energy audit is conducted when the building is completed, in order to check the compliance of the constructed building with the energy performance characteristics prescribed in the energy study that was submitted for the building permit. The building class should be at least B. If this is not the case, the owner has one year to improve the energy performance of the building following the recommendations of the auditor. A second audit is performed after the required improvements have been implemented

Class	Limits
A+	E.A. ≤ 0.33 K.A.
A	0.33 K.A. < E.A. ≤ 0.50 K.A.
B+	0.50 K.A. < E.A. ≤ 0.75 K.A.
B	0.75 K.A. < E.A. ≤ 1.00 K.A.
Γ	1.00 K.A. < E.A. ≤ 1.41 K.A.
Δ	1.41 K.A. < E.A. ≤ 1.82 K.A.
E	1.82 K.A. < E.A. ≤ 2.27 K.A.
Z	2.27 K.A. < E.A. ≤ 2.73 K.A.
H	2.73 K.A. < E.A.

E.A.: Primary Energy Consumption of the building under consideration (kWh/m².year)

K.A.: Primary Energy Consumption of the reference building (kWh/m².year)

Table 3: Definition of energy classes.

and, in case of non-compliance, sanctions are imposed on the building owner. The owner is obliged to take all actions necessary (and cover the corresponding costs) for the building to meet the minimum requirements; otherwise, it cannot be connected to the utility networks (for electricity, gas, water, etc.). The same compliance checking procedure applies to major renovations of existing buildings. In case of non-compliance, the building is considered to have been built without a permit and all the foreseen fines are applied (monetary fines or even demolition of the building).

I.iii. Cost-optimal procedure for setting energy performance requirements

Law 4122/2013 introduces the cost-optimal procedure and the calculation methodology, according to the EU Regulation 244/2012 supplementing Directive 2010/31/EU. However, the national cost-optimal study for setting energy performance requirements is still in the implementation phase, without any concrete results by the end of 2014.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The NZEB definition was introduced to national legislation by amendment of the Law 3661 in June 2010 and is identical to the EPBD definition. This definition is also included in Law 4122/2013, which specifies that, after 1 January 2019, every new building of the public sector should be a NZEB. This obligation applies also to all new buildings constructed after 1 January 2021. However, the national NZEB definition has not yet been applied.

Figures and statistics on existing NZEBs

Due to the lack of the national application of the NZEB definition, it is not possible to identify NZEB buildings. Some new buildings with very low energy consumption have been constructed, but it is not possible to label them as NZEBs.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The measures foreseen for the implementation of Article 4 of the EED regarding the strategy for the renovation of residential and commercial buildings include the following:

a. the '*Eksikonomisi Kat' Oikon*' (Energy Savings at Home) project, which offers financial incentives for the refurbishment of heating and cooling systems, as well as building envelopes and DHW systems in the residential sector;
b. the pilot 'Green Neighbourhood' project for the energy upgrade of social housing;
c. financial incentives to SMEs in the tourism, commerce and services sectors to upgrade their energy consumption profile.

In all these measures, in order to receive the financing it is required to issue an EPC first during the application for funding, then again after the implementation of the measures, in order to verify the results.

The list of public buildings falling under Article 5 of the EED was published on 31 December 2013 and includes central government buildings that have an area greater than 500 m^2. The list includes 82 buildings with a total area of 309,712 m^2. The refurbishment of these buildings is included in the national structural funds programmes.

Furthermore, the following measures that focus on the exemplary role of the public sector also apply to local government buildings:

a. the financing of energy refurbishment in central government buildings that appear in the published list;
b. the promotion of the Covenant of Mayors for integral energy planning of municipalities;
c. the financing of refurbishments in existing school buildings and higher efficiency designs in new school buildings;
d. the programme 'Green roofs on public buildings' for financing investments in green roofs;
e. compulsory installation of DHW using solar energy in all public sector buildings that have hot water demand;
f. compulsory replacement of all lighting systems with energy-efficient lighting systems in public buildings;
g. 'Energy Smart Museums', a programme for financing the energy upgrade of public museum buildings.

For all the measures mentioned above, applying for funding goes hand in hand with the issuance of an EPC. The evaluation of the funding applications is based on the energy savings calculated in the EPC. A second EPC must be issued after the completion of the interventions in order to verify these results.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

In new buildings and major renovations (in which case the building should have an energy performance rating B after the refurbishment), heating, cooling and lighting installations must fulfil the following requirements:

a. Boilers must be certified with at least a 3-star (***) energy efficiency rating.
b. Heat pumps in heating mode must have a COP ≥ 3.2 if air-cooled, and ≥ 4.3 if water-cooled.
c. Heat pumps in cooling mode must have an EER ≥ 2.8 if air-cooled, and ≥ 3.8 if water-cooled.
d. Central (AC) units with a fresh air supply higher than 60% must have a heat recovery ratio of at least 50%.
e. Heating/cooling systems must incorporate a weather compensation system.
f. Separate thermostatic controls must be installed in each individual heating zone.
g. Solar thermal systems must provide 60% of the DHW demand.
h. Hot water distribution networks must have an insulation of at least 13 mm thickness and a $\lambda \geq 0.04$ W/m.K.
i. Air ducts of AC systems must have a minimum of 40 mm insulation with $\lambda \geq 0.04$ W/m.K.
j. General lighting systems must have a luminous efficacy of at least 55 lm/W.

The requirements above are compulsory for replacing and upgrading systems in existing buildings. There are additional requirements for the proper sizing of systems (following the technical guidelines of the Technical Chamber of Greece), as well as for adjustment and control.

II.ii. Encouragement of intelligent metering

Law 3855/2010 foresees that all energy suppliers should provide intelligent metering systems (at competitive prices) to their customers. These metering systems should provide information regarding the time of use, and the suppliers should provide information to the users in respect to the rational use of energy. In case of central heating and cooling systems, including district heating systems, individual intelligent metering devices should be installed for each consumer.

The installation of intelligent meters, weather compensation systems and individual control of heating systems per consumer are compulsory for new buildings and for existing buildings undergoing major renovations.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The authority responsible for maintaining the electronic registry of EPCs (buildingcert) and energy auditors is the MEECC through its energy inspectorate.

How flats are certified in apartment buildings

For apartments in residential buildings, there are two options for the owner to choose from. In the first option, each apartment can be certified independently and an EPC is issued for each individual apartment. The alternative is to issue an EPC for the whole residential building, covering all the individual flats, i.e., one single EPC applicable to all the apartments in the building.

Format and content of the EPC

The EPC format (Figure 1) is of similar appearance with the energy labels for electrical domestic appliances with which the public is familiar. It contains a nine-level classification scale, from A+ to H, with three classes above the B level (A+, A, and B+) to stimulate competition towards very efficient building designs in the future. This EPC applies to all types of buildings, residential or non-residential.

The first page of the EPC contains the following information:

- basic building data, i.e., location, owner, building use, climatic zone, year of construction, total surface area, heated area, etc.;
- classification, based on the primary energy consumption of the building compared to the primary energy consumption of a reference building;
- calculated primary energy consumption of the building and of the reference building;
- calculated CO_2 emissions.

For existing buildings it contains in addition:

- the metered total energy consumption data and the consumption by energy carrier based on the bills available over the last three years, as well as the calculated CO_2 emissions;

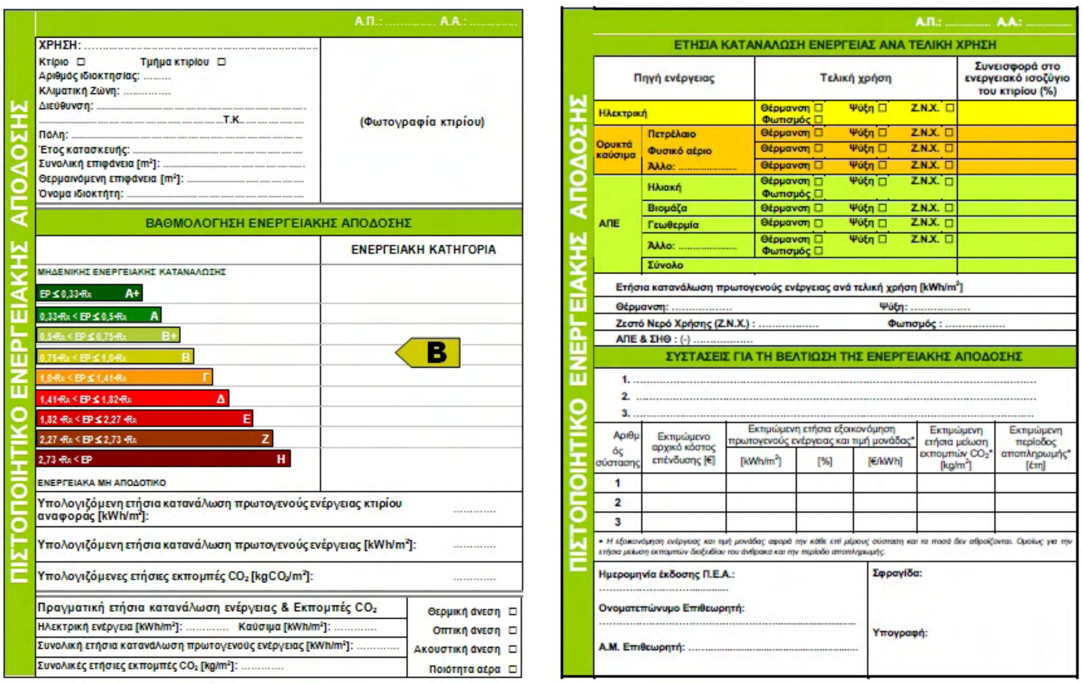

Figure 1: Building Energy Performance Certificate format, 1st page and 2nd page.

Table 4: Breakdown of EPCs per type of building.

Buildings	Number of EPCs	Total area (m^2)
New and renovated buildings	1,199	335,869
Existing buildings	412,062	48,507,879
Existing residential buildings: first audit for the 'Energy Savings at Home' programme	67,701	7,493,596
Refurbished residential buildings: second audit for the 'Energy Savings at Home' programme	34,926	3,909,690
Public schools: first energy audit	86	125,724
Local government buildings programme: first audit	298	274,068
Total	**516,272**	**60,646,827**

Table 5: Number of energy auditors per category.

Category	
Building auditors	15,859
Heating system auditors	7,011
AC system auditors	6,532

> an indication of the quality of thermal, visual and acoustic comfort and air quality, as a subjective opinion of the auditor.

On the second page of the certificate, there is space for presenting at least three recommendations specific to the building, for which the software calculates the primary energy savings (per m^2 and as a percentage), the CO_2 emissions reduction and the investment cost and payback period for each kWh saved. On this page, an analysis of the calculated primary energy consumption per use and energy carrier is also presented.

All EPCs are valid for a period of ten years, unless the building in the meantime undergoes a major renovation, in which case the EPC should be re-evaluated.

EPC activity levels

According to the information provided by the Energy Inspectorate, a total of 516,272 EPCs were issued up to 14 September 2014, of which 226,077 in 2013. The breakdown per type of building is shown in Table 4.

Typical EPC costs

Based on data collected from the market, the cost of an EPC for an apartment or house ranges between 0.5 - 1.5 €/m^2, which corresponds to an average cost of around 100 € per apartment. For commercial and public buildings, the corresponding range is between 0.25 - 1 €/m^2.

Assessor corps

Qualified energy auditors are listed in the National Registry of Energy Auditors, developed and maintained by the Centre for Renewable Energy Sources and Saving (CRES) and the Hellenic Energy Inspectorate of the MEECC.

The qualifications and training requirements of the energy auditors are outlined in the new regulation. The whole procedure foresees a total of 120 hours of training and exams split over several sub-courses.

Qualified Experts (QE) should be engineers and architects with at least three years of experience. QEs are classified into three categories: building inspectors (60 hours of training), heating system inspectors and/or AC system inspectors (each 30 hours of training). Depending on their academic background, they are also classified into two classes; class A QEs will be allowed to perform inspections and issue EPCs for buildings with heating and/or AC installations up to 100 kW, while class B QEs can perform inspections for all sizes of buildings and systems.

The Technical Chamber of Greece developed the training material and is responsible for the examination process. Training courses are offered by academic institutions and certified vocational training centres following the curriculum elaborated by the Technical Chamber. The first training courses started at the end of 2011.

Following a successful exam, the experts are registered in the National Registry for Energy Auditors. Table 5 shows the total number of energy auditors by category.

Compliance levels by sector

In Greece, there is a legal requirement that each new rental or sale transaction (either for a flat or a building) must be accompanied by an EPC. The sale or rental contract needs to be submitted to the tax office together with a copy of the EPC.

For new buildings, the EPC is a prerequisite for getting connected to the electricity network. This way it is ensured that an EPC is issued and a 100% compliance rate is achieved for new buildings in all sectors.

Therefore, no transaction is considered legal if it is not accompanied by an EPC.

Quality Assurance (QA) of EPCs

The Hellenic Energy Inspectorate carries out random EPC control checks and controls specific EPCs based on complaints. The checks include:

a. control of the data in the electronic database used for the energy performance calculations for each certificate (also checking the suggestions for improving the energy performance);
b. on-site inspection of the building in order to verify the data used for the EPC.

In the period from 1 January 2011 until 15 July 2014, the energy inspectorate controlled 4,897 EPCs using the database, and performed 51 on-site checks. Furthermore, 12,560 EPCs have been checked based on the process of revocation and replacement of issued EPCs. Thus, an average of 5,800 EPCs were checked on a yearly basis.

The penalties foreseen in case of non-compliance include fines and temporary suspension or permanent exclusion of the auditor, depending on the severity of the violation, the consequences, the building floor area and the possibility for re-occurrence. Until the end of 2014, 15 energy auditors have been penalised through this process.

III.ii. Progress and current status on public and large buildings visited by the public

According to the provisions of Law 4122/2013, all the buildings that are used by the public sector and visited by the public, with a total area above 500 m^2, should issue an EPC and display it publicly. The law foresees that from July 2015, the area limit be reduced to 250 m^2. Until 2014, the total number of EPCs issued for public sector buildings is 4,450. However, there are no controls regarding the public display of these EPCs.

III.iii. Implementation of mandatory advertising requirement

According to the provisions of Law 4122/13, it is mandatory since 2013 to include the EPC in advertisements for sales or rentals of buildings or building units that already have an EPC. But, as the EPC is only required at the moment of sale or rental and not before, in most cases there is still no EPC when the building or flat is advertised. Therefore, many advertisements do not include information on the energy rating. However, most of the advertisements include the information in case an EPC is already available (Figure 2). There are no fines foreseen for non-compliance with this requirement.

III.iv. Information campaigns

At the starting phase of implementation, in 2010, the MEECC has produced information material on the new 'Regulation of Energy Performance of Buildings' (KENAK), the EPC and the energy efficiency of buildings. This information is uploaded onto the MEECC's website (Figure 3) and is also included in a brochure produced for and distributed at various events. Furthermore, the implementation of the financing scheme '*Eksikonomisi kat'Oikon*' described in

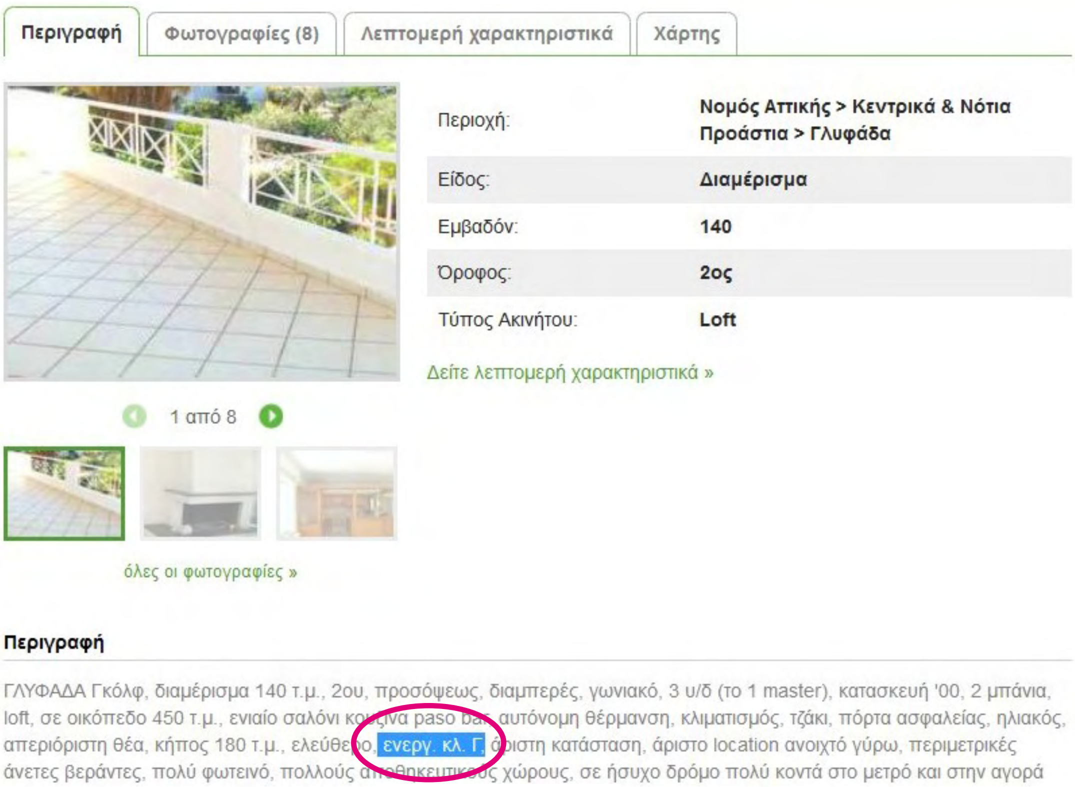

Figure 2: Example of advertisement with a reference to the energy category of the apartment.

Figure 3: Information material on the website of the MEECC.

section 3, is accompanied by information material issued by the MEECC, but also by the banks that operate the scheme.

III.v. Coverage of the national building stock

As shown in Table 4, a total of 516,272 certificates were issued until 15 July 2014. This number includes the second EPC, issued after the energy refurbishment, of buildings and flats that were included in the various incentive schemes. It is difficult to calculate the percentage of the existing building stock having an EPC -because, as was mentioned previously, certificates are issued for either individual apartments or buildings- but a first estimation is between 5% and 10% of the total building stock, which corresponds to 3,821,175 buildings (according to 2001 statistics). In general, the majority of EPCs are issued for apartments, since each owner decides to have the EPC issued whenever it is required. In 2013 alone, 226,077 EPCs were issued.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

In Greece, inspections of heating and AC systems are performed based on the new energy building regulation and the technical guides issued by the Hellenic Technical Chamber of Greece which describe in detail the procedures for auditing of boilers, heating systems and AC units. The inspection is followed by advice from the auditor on possible energy efficiency measures. There is a total of 7,011 provisional energy auditors for heating systems in the national registry for energy auditors. A provisional body of auditors has also been established for AC inspectors, with a total of 6,532 members. Both lists are available online through 'buildingcert'.

Although it was foreseen that inspections of heating and AC systems should start on 1 January 2014, in practice only voluntary audits have been performed so far. As the inspections of technical systems have not yet started, no promotional activities have been implemented either.

IV.i. Progress and current status on heating and AC systems

Overview, technical method and administration system

The same administration and QA system used for EPCs applies also to inspections. Experts are required to attend a 30 hour training and go through an examination. Training courses started at the end of 2011.

For the inspection of heating systems, a provisional body of auditors[2] was established until the end of 2013. Since then, the national registry for energy auditors includes the list of recognised inspectors.

[2] *www.buildingcert.gr/inspectors/startValues.view*

Audits of heating systems should be carried out:

> at least every five years for boilers with an effective nominal rated power between 20 kW and 100 kW;
> at least every two years for boilers rated over 100 kW for every fuel source, except natural gas (once at least every four years).

AC systems with a capacity above 12 kW should be audited every five years.

Auditors prepare a report assessing the efficiency and sizing of the system and give instructions and recommendations regarding the maintenance or replacement of the heating and AC systems, and other alternatives. The inspection reports are submitted to the online platform 'buildingcert', which is also used for the EPCs and subject to the same quality procedures as EPCs. No official inspection reports have been submitted so far.

The energy inspectorate is responsible for the operation of the scheme of inspections. However, since the inspection system is still operating on a voluntary basis, no quality control checks have yet been performed.

Impact assessment

There are no studies at the moment regarding the impact assessment of the heating and AC system inspection scheme, since the full operation of the scheme is not yet in place.

There are also no studies regarding the possible cost of the operation of the scheme and the related benefits.

3. A success story in EPBD implementation

One of the most successful programmes indirectly related to the EPBD implementation is the *'Eksikonomisi kat' Oikon'* (Energy Savings at Home).

The programme utilises the body of energy auditors and the 'Regulation of Energy Performance of Buildings' (KENAK). Its main goals are to determine the energy demand of buildings and the interventions leading to energy savings.

The programme has officially started on 1 February 2011 and provides subsidies of up to 70%, while the remaining amount is in the form of no interest loans, and the total budget for each case should not exceed 15,000 €.

The initial budget of the programme outlined by the state was 396 M€ coming from structural and national funds, where 241 M€ are revolving funds. At a second stage, another 152 M€ have been added as direct subsidies. The programme is based on the collaboration between the major banks and the MEECC. Banks are providing another 800 M€, leading to a total budget of almost 1.2 b€.

The main steps of the process are:

1. initial loan application;
2. first energy audit and issuance of EPC (as a prerequisite for entering to the programme, the household must have a rating of D or worse);
3. application to the banks describing the interventions for the upgrade of the energy performance of the household building. Interventions should either lead to an upgrade of the EPC by at least one category, or achieve an energy saving of at least 30% in relation to the energy demand of the reference building (rated B by default);
4. approval of the application and signing of a loan contract;
5. implementation of the interventions;
6. second energy audit and issuance of a new EPC.

The programme foresees interventions for the upgrade of the building envelope (e.g., new windows, insulation and shading devices), upgrade of the heating system (including controls) and installation of RES systems for the production of heating and DHW.

Until November 2013, 169,133 applications have been submitted and about 50% of them have received an initial approval for a loan. Out of them, 41,925 applications proceeded to the implementation phase (the owners of the remaining applications decided not to proceed for various reasons). A total of 14,881 interventions have been completed.

Most of the interventions concern the replacement of windows (83.9%), the insulation of the building envelope (53.7%), and the upgrade of the heating system and DHW production (71%).

The achieved energy savings (based on the completed 14,881 projects) are 221.4 GWh per year of primary energy according to the calculation performed before and after the intervention at the time the EPC was being issued. This represents an energy saving of around 0.40 €/kWh.

Overall, the programme is considered very successful, leading to significant energy savings and CO_2 emission reductions. In addition, it has also triggered energy investments of around 1.2 b€, very positively affecting the national economy and employment, during a period in which the construction sector has greatly suffered due to the economic crisis. More funds from new structural programmes and the national budget will allow the programme to continue.

4. Conclusions, future plans

A centrally operated national system of issuing EPCs is in place in Greece and is run by the MEECC. All information required for the calculation of each EPC and used at the first level of quality control is stored in an electronic database. On-site visits are the second level of control and supplement the overall QA system.

All auditors are qualified engineers who also attend a training course (60 hours for EPCs, 30 hours for heating system inspections and 30 hours for AC system inspections). As a result, the quality level of the audits performed so far is quite high.

The overall reaction from the market is quite positive, and EPCs are used in the financial incentive schemes for the refurbishment of buildings as a mechanism for checking the results of the interventions. Information campaigns proved to be a very effective motivational mechanism for building energy refurbishment.

The full implementation of the energy audit of heating and AC systems did not start in January 2014 as was planned, but was postponed to January 2015. This has caused significant delays in the implementation of energy efficiency measures for heating and AC systems.

Directive 2010/31/EU was transposed into national law in the beginning of 2013 and the EED transposition is currently going through a public consultation process. A revision of the buildings energy regulation is planned to start in 2015 and will most probably modify the current energy performance requirements by applying the cost-optimal methodology.

Implementation of the EPBD in Hungary

STATUS IN DECEMBER **2014**

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1. Introduction

In Hungary, most of the articles of the Energy Performance of Buildings Directive (Directive 2010/31/EC, EPBD) were implemented between 2012 and spring 2014. For buildings that receive any public funding, the energy performance requirements were upgraded to the cost-optimal level at the beginning of 2015. The cost-optimal requirements will only be introduced as mandatory requirements in 2018, whereas Nearly Zero-Energy Building (NZEB) requirements will come into force in 2019 and 2021 for public buildings and all new and majorly renovated buildings respectively. At the end of 2014, the National Building Energy Strategy is in the phase of open discussion, envisaging very ambitious renovation goals until 2020 and in particular, an exemplary role for public buildings. Since 2013, the registration and the quality control of the Energy Performance Certificates (EPCs) have been conducted on an electronic basis, resulting in a remarkable increase in the number of certificates issued annually. Hungary has adopted alternative measures for inspection of heating and air-conditioning (AC) systems and thus several support programmes have been in operation over the recent years. Information campaigns have been carried out with special attention to cost-optimal renovation solutions.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

The first Ministerial Order to transpose the Directive 2002/91/EC (7/2006. (V. 24) Decree about Determination of Energy Efficiency of Buildings) was issued in May 2006 and was in force between 1 September 2006 through 31 December 2014. This order included the requirements, the design input data and the calculation method. The requirements have changed from the beginning of 2015 onwards. Although the requirements generally did not change between 2006 and 31 December 2014, there were a few exceptions:

> new requirements for the building service systems and minimum requirements for building elements and system elements in case of non-major renovations were put into force on 9 January 2013;

> in 2012 and in April 2014, slight modifications were introduced in the calculation procedure;

> from 30 January 2015, the scope of the above mentioned decree became wider: monuments, and some agricultural buildings are also subject to the requirements.

The minimum energy requirement for new buildings is equivalent to an EPC class C rating.

The Decree of the Minister of Interior 40/2012 (VIII.13) has introduced new requirements for building service systems and minimum requirements for building elements and system elements in case of non-major renovations. The decree has been in force since 9 January 2013. The following Decree of the Minister of Interior 20/2014 (III.7) introduced new cost-optimal requirements from the beginning of 2015 for buildings that receive public funding and for any construction projects financed by the state budget. The same requirements will be generally introduced for all buildings (with exceptions allowed by the EPBD) at the beginning of 2018. The same decree lays down the definition and requirements of NZEB to be introduced in 2019 for public buildings and in 2021 for all new buildings and those undergoing major renovations.

I.ii. Format of national transposition and implementation of existing regulations

The requirement system has three facets, as far as new buildings and major renovations are concerned. Maximum permitted U values are set for elements and specific heat loss coefficient (W/m^3.K), as function of the surface to volume ratio. The losses from thermal bridges (with the simplified or detailed procedure) and the effects of shading devices are also considered. Finally, the specific yearly primary energy need must not exceed a limit, which depends on the surface to volume ratio and the type of use of the building. Maximum permitted values are given for a few typical uses (residential, school, office), whilst in the case of mixed use, a reference building is to be considered.

The primary energy needs include heating, Domestic Hot Water (DHW), cooling and, for non-residential buildings lighting needs. Airtightness measurements are not required, but the quality of windows is examined visually by experts on the site and the estimated infiltration is taken into account in the calculation. For new buildings and major renovations, thermal comfort and minimum requirements on fresh air supply are set, but these values are not considered in the calculation procedure for certification. The calculation procedure refers to several European standards (see Figures 1 and 2).

The most detailed and comprehensive technical guidance document for energy experts is the book ‘Building Energetics’ (Zöld, A. and others. Building Energetics, 2009. ISBN: 978-963-7298-31-8; see Figure 3). This book is a step-by-step guide for professionals including the legislative background, the calculation process of the asset method, the certification process and analysis of existing buildings. As this book is already partly outdated, the Ministry of Interior has issued a technical guidance document. The most up-to-date version is available online[1].

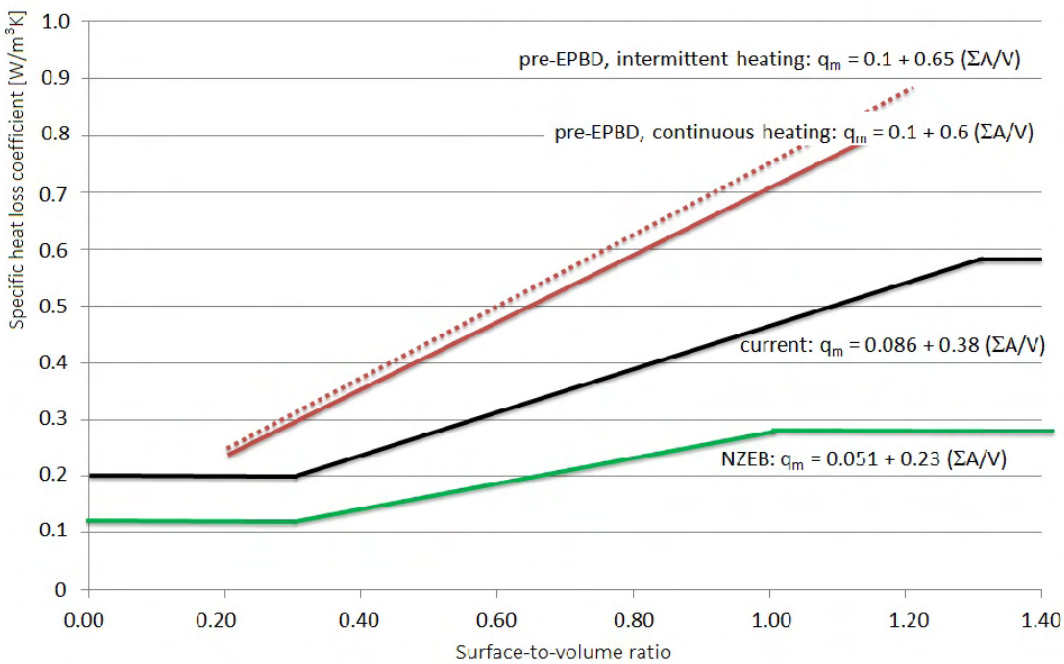


Figure 1: The specific heat loss coefficient (W/m^3.K) before (pre-EPBD) and after 2006 (in force until the end of 2014) and the cost-optimal requirements that were introduced in 2015 for buildings receiving public funding. It will apply to all buildings in 2018.The foreseen NZEB requirements for the specific heat loss coefficient is identical to the cost-optimal requirement.

[1] www.e-epites.hu/energetikai-tanusitas/modszertani-utmutatok

Other relevant documents can be found online[2] including a manual for cost-optimal renovation. The www.e-epites.hu website is one of the official portals for the EPBD implementation in Hungary. The other official portal www.lakcimke.hu is operated by the '*Energiaklub*' Climate Policy Institute and Applied Communications, and contains guidance information for citizens and end users (see Figure 4).

I.iii. Cost-optimal procedure for setting energy performance requirements

The cost-optimal calculations have been carried out according to the common EU methodology framework issued by the 244/2012 Order on the basis of Directive 2010/31/EC. The detailed calculation is available at the 'e-epites' website[3]. The procedure has proved that the current requirements are sub-optimal, therefore new requirements were introduced in 2015 for buildings receiving public funding, and in 2018 for all buildings. The application of most of Renewable Energy Sources (RES) has not proved to be cost-optimal. The cost-optimal requirements are laid down in the Decree of the Minister of Interior 20/2014 (III.7). It is worth mentioning that the energy prices in the Hungarian residential sector have decreased since the cost-optimal procedure has been prepared (see Table 1 and Figures 5 and 6).

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The general national targets for NZEBs are set in the '2nd National Energy Efficiency Action Plan until 2016 with an outlook to 2020' (NEEAP) ratified by the Governmental Decree 1374/2011 (XI.8). According to this decree, the National Building Energy Strategy has to be developed by the Ministry of National Development. The development of this strategy was at the phase of open consultation at the end of 2014.

The government decided on 3 February 2012 that the NZEB requirements shall only come into force in 2019 and 2021 respectively. As an intermediate step, the cost-optimal requirements that are already defined by the legislation will be introduced in 2015 and 2018.

Figure 2:
The 2006-2014 and 2015 cost-optimal requirements for the specific yearly primary energy need. The foreseen NZEB requirements will be 25% lower than the cost-optimal (not indicated on the diagram).

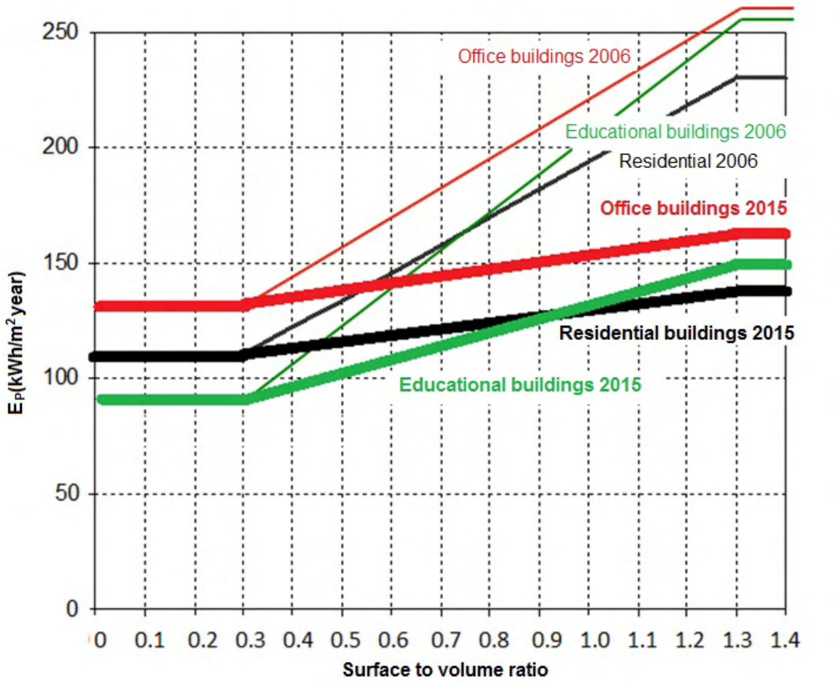


Figure 3:
Cover of the book 'Building Energetics'
(Zöld, A. and others, 2009, ISBN: 978-963-7298-31-8).

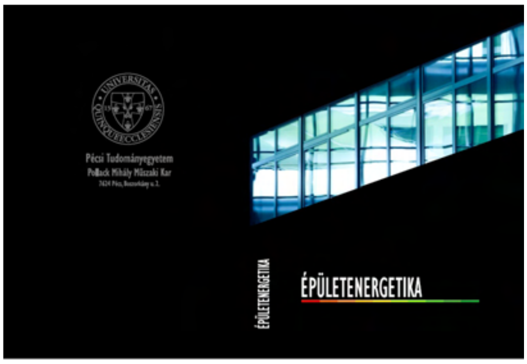


Figure 4:
Practical information about energy performance certification.
www.lakcimke.hu/sites/default/files/lakcimke_2010.pdf,
www.e-epites.hu/energetikaitanusitas/modszertaniutmutatok,
www.kormany.hu/hu/miniszterelnokseg

[2] www.e-epites.hu/energetikai-tanusitas/tajekoztatok-es-utmutatok

[3] www.e-epites.hu/hirek/az-epuletek-energiahatekonysaganak-koltseg-optimalizalt-szintjerol-keszult-tanulmany-velemenye

Table 1:
Maximum U values (W/m².K) of building elements in 2014 and foreseen requirements of the cost-optimal and NZEB levels.

Building element	2014 requirement	foreseen requirements in 2015, 2018, 2019, 2021
Exposed wall	0.45	0.24
Flat roof	0.25	0.17
Attic floor slab	0.30	0.17
Floor slab over basement	0.50	0.26
Window, non-metal frame	1.60	1.15
Window, metal frame	2.00	1.40
Entrance door	3.00	1.45
Glazing	-	1.00

According to the Decree of the Minister of Interior 20/2014 (III.7) a NZEB is a building that meets the cost-optimal requirements and has 25% of its primary energy demand covered from RES, onsite or nearby. It is a brief definition that has to be further elaborated in the future in order to be applied in practice. Furthermore, the calculations of the cost-optimal levels for NZEBs will be further elaborated at a later stage, when the price levels of investment and operational costs become more predictable and therefore, more accurate. The level defined in the brief definition above might be modified in the future.

Figures and statistics on existing NZEBs

There are no reliable statistics on the number of existing NZEB buildings. The Ministry of National Development has recently published a tender for a project to monitor the national building stock. The results are expected in May 2015.

According to the Hungarian Passive House Association, there are approximately 100-200 existing NZEBs. Most of them are single family houses or public buildings which have been renovated with the support of the Environmental and Energy Efficiency Operation Programme. Taking into account the usual construction trends, it is expected that by 31 December 2020, the number of constructed NZEBs will be between 10,000 and 30,000, of which 80% will be apartment buildings. It is predicted that the demand for low energy buildings will significantly increase between 2015 and 2020.

Within the existing NZEBs in Hungary, the prize-winning *Solanova* pilot NZEB project consists of an apartment building containing 42 units that has been retrofitted. The original building was built with

Figure 5: Results of the cost-optimal calculations for different building types.

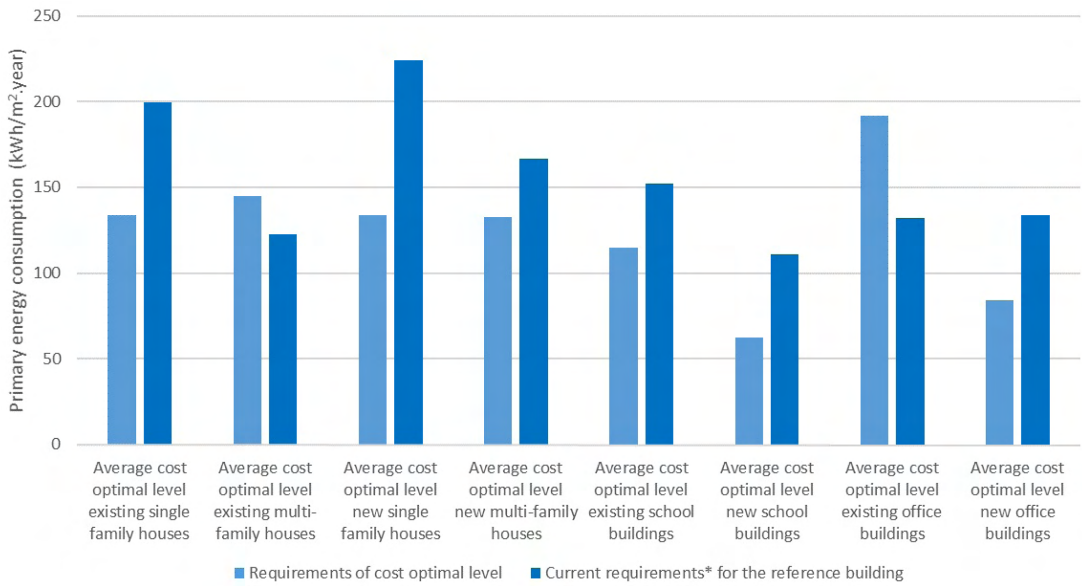
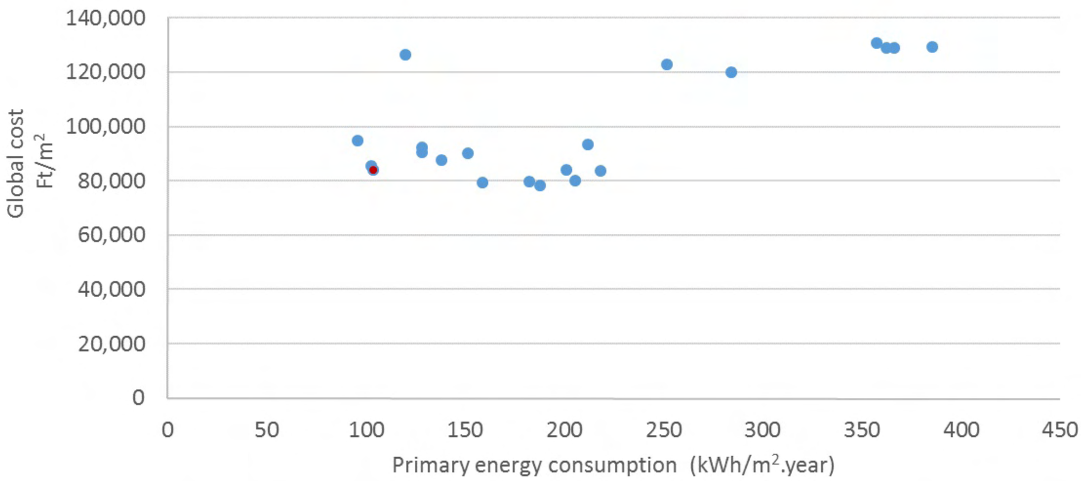


Figure 6: Renovation packages of a defined single-family house (1 € = 300 Ft).



prefabricated reinforced concrete sandwich elements typical in Eastern-Europe between 1960 and 1990. After retrofit, the heating energy consumption achieved is under 40 kWh/m^2.year (see Figure 7).

Figure 7: The Solanova building in Dunaújváros.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The first steps for the implementation of the EED Articles 4 and 5 are laid down in the previously referenced NEEAP. Three percent (3%) of the total floor area of heated and/or cooled buildings owned and occupied by the central government are to be renovated each year. In order to finance this, European funds and the income from the CO_2 trade quotas will be used. The selection for the first 100 buildings to be renovated must be completed by the beginning of 2015.

The buildings owned and occupied by the central Government institutions, are defined in the Act No. CVI. of 1997 (Property of the State), and the Government Decree 152/2014. (VI.6 - tasks and awareness of the Government). The scope of the renovation of the public building stock will be much wider than that of the central government buildings. Many schools, nurseries, hospitals, police stations will be targeted for renovation projects in over the next couple of years. The estimated total floor area of public buildings is 1.9 million m^2. The renovation cost is about 76 billion Forints (253 M€) over 5 years.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The requirements on heating, DHW, AC and large ventilation systems have been in force since the 9 January 2013. These requirements are partly recommended and partly obligatory (described in section II.v of this report). The requirements apply to new buildings, buildings undergoing major renovations and also for minor energy renovations. The requirements are set down by the Decree of the Minister of Interior 40/2012 (VIII.13). No further revision of the requirements for technical building systems is envisaged until 2020.

II.ii. Regulation of system performance, distinct from product or whole building performance

There are no specific requirements on the performance of building systems beyond those that apply from specific product quality standards. However, the building still has to achieve the minimum overall requirements which depend on the surface to volume ratio and the type of use of the building as stated in the previous chapter. This automatically sets some limits on the performance of the system, although in an indirect manner.

For minor renovations there are no requirements on the whole building performance, only on the system elements to be renovated or changed.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

If any building element or building service system element is to undergo an energy retrofit, the system element must fulfil the current requirements of the relevant elements. This rule does not apply in case of maintenance measures.

II.v. Provisions for installation, dimensioning, adjustment and control

The requirements on heating, DHW, AC and large ventilation systems have been in force since 9 January 2013. These requirements cover the rules of installation, adjustment and control and must be applied to new buildings and for every new or replaced TBS only.

A part of the requirements is only a recommendation. In the application of condensing boilers and room-wise heating control systems, as well as in the case of a balanced ventilation system, it is suggested (or recommended) that the heat recovery efficiency be higher than 70%.

The other part of the requirements is obligatory. Thermal comfort (indoor air temperatures) and the indoor air quality (quantity of fresh air, maximum concentration of CO_2) should be based on the standard EN 15251. It is also obligatory to apply a central control system in buildings which have a heated floor area of over 100 m^2. The balancing of the heating, cooling, ventilation and DHW systems is required and must be proved by the verification of 10% of the valves.

The documentation of the hydraulic balancing and its verification is a part of the pre-conditions in the closure of the construction process. The circulation pumps must be operated according to a time schedule. The pressure drop losses are limited for ventilation system elements. The operation mode of the ventilation system and the airtightness of the ductwork are to be set according to the standard EN 13779 in order to optimise the fan power.

II.vi. Encouragement of intelligent metering

The introduction of an intelligent metering system is realistic only in the long term, regardless of the energy source (gas, district heat or electricity) and the building type. There are only experimental projects on the issue. A feasibility study about the applicability of intelligent metering in multi-family buildings was elaborated in 2011. The study has proved that there are significant technical difficulties to install intelligent (gas) metering units in many multi-family buildings, because the existing systems (particularly gas and heating systems supplied by district heating) are often centralised and the installation of the metering units would require the reconstruction of the distribution system. There are also conflicts about personal rights: users do not want that the service providers have a look on their consumption habits.

II.vii. Encouragement of active energy-saving control (automation, control and monitoring)

According to the new Hungarian legislation for new buildings and major renovations, it is obligatory to apply a central control system (weather compensation) in buildings which have a heated floor area of over 100 m^2 and circulation pumps must be operated according to a time schedule.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

Starting from January 2012, all existing residential and non-residential buildings need to be certified when sold. The owner must present a valid EPC to the buyer, when the sale contract is agreed upon. For rentals, the EPC is on a voluntary basis until 31 December 2015. From then on, the owner must present a valid EPC to the renter when a rental contract is agreed upon.

As of 2006, new buildings must reach at least an EPC class C rating. The same rule applies in the case of a major renovation of a building. If a new unit or wing is added to an existing building, there are two options: either the extension only, or the building as a whole, should meet the requirement. Such a retrofit or extension is subject to a building permit, which will be issued only if the required energy performance level can be demonstrated using the calculations.

EPCs are valid for 10 years unless the building undergoes a major renovation, in which case a new EPC is required.

The EPCs are issued by independent experts who have passed the exam at the Hungarian Chamber of Engineers or at the Hungarian Chamber of Architects.

The Governmental Decree 105/2012 (V. 24.), amendment of several governmental decrees on building affairs and territorial design, amended the Governmental Decree 176/2008 (VI. 30.) on the energy certification of buildings. In accordance with the Directive 2010/31/EC, the new legislation introduces the detailed rules of certification and the new rules for display of certificates in public buildings. The new legislation introduces a binding electronic registration, as well as the review and quality control system of EPCs.

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

Since mid-2014, the implementation of the EPBD is controlled by the Prime Minister's Office, while the subsidy programmes and the strategic and operational programmes are managed by the Ministry for National Development.

Since January 2013, EPCs are registered in a central database operated by the *Lechner Non-Profit Organisation*. The database is partly public. Demonstrating this, a building´s energy performance class can be searched by its address. Statistical information from the database is also publicly available. The licences for the certified experts are issued by the Hungarian Chamber of Engineers and the Chamber of Architects. The Chamber of Engineers runs the control system of the EPCs.

How flats are certified in apartment buildings

Apartment units can be certified individually or, if the EPC is available for the whole building, this EPC can then be used for an individual unit as well. In most cases, the EPCs are issued for individual apartments.

Format and content of the EPC

The EPC assigns an energy performance label to residential and non-residential buildings or building units and it lists cost-effective measures for improving their energy performance. The energy label classifies the buildings on an efficiency scale ranging from A+ (high energy efficiency) to I (poor efficiency). The classification is based on the requirement of the specific yearly primary energy need. An example of an EPC is provided in Figure 8.

Figure 8: Cover page of an Energy Performance Certificate (EPC).

The practical benefit of the energy performance certification is found in the recommendations that are provided to the building owner. These are summarised on page 2 of the certificate. The suggestions include a short description of improvements specific to the proposed building and the impact on the energy rating, if all measures were to be implemented. The level of detail in the calculations depends on whether the owners of existing buildings are applying for a subsidy.

In this case, evidence of the expected outcome of the retrofit in energy terms must be provided and, therefore, a more accurate survey and calculation is necessary to guarantee that the subsidy conditions will be satisfied. The EPCs must have an annex as well which describes the calculation details.

EPC activity levels

Up until the end of 2014, the number of EPCs registered in the electronic system is 201,134. The electronic system has been in use since January 2013. The estimated number of EPCs before the introduction of the electronic system was below 100,000 (this figure is not included in the number of EPCs registered in the electronic system). Most of the EPCs were issued in Budapest (71,017), 51,479 belonged to other large cities, 47,558 to small cities and 31,136 to villages.

Typical EPC costs

The cost of a certificate for an apartment unit is prescribed by the law (40 € + VAT per unit). The same price applies for single-family houses. This cost has often been criticised by experts as unrealistically low and it thus has a strong negative impact on the quality of the certificate. However, travel costs, measurement costs and data collection costs can be added to the above value (up to a maximum of circa 60 € + VAT per unit). For non-residential buildings, there is no legally prescribed amount on the cost of an EPC, but in practice, the certificate costs between 100 € and 1,500 € depending on the size and complexity of the building.

Assessor corps

The EPC electronic registration system is operated by *Lechner Nonprofit Organization* under the umbrella of the Prime Minister's Office. Licences for independent EPC experts are issued by the Hungarian Chamber of Engineers and the Hungarian Chamber of Architects. These organisations are also responsible for the exams. The Qualified Experts (QEs) are mostly civil engineers, architects or mechanical engineers, but other engineers are also allowed to become QEs.

Long and detailed courses are regularly organised by universities and training institutions, but the exam can be taken without such a course via self-study. In addition to the obligatory exam, any member of the Hungarian Chamber of Engineers and the Hungarian Chamber of Architects has to attend regular short training programmes in order to keep their knowledge up-to-date. In these programmes the topic ‘building energy regulations’ is an obligatory element for all members of the chambers (not only for the QEs). The system is an efficient means to maintain constant interest towards life-long learning.

At the moment there are approximately 2,500 registered experts. Half of them have already submitted at least one certificate to the online system and a quarter of them have submitted more than 5.

Compliance levels by sector

In the case of a new building, the EPC must be presented within 90 days of issuing the occupancy permit. If this is not done, the owner will be required to pay a penalty fee. The Building Authority has the right to compel the preparation of the missing EPC in these cases. The penalty can be repeated any time until the EPC is uploaded into the electronic database.

Enforcement with building owners and real estate actors

For building sales after 9 January 2013, lawyers are required by law to insert the registration code of the EPC generated by the electronic registration system into the written contract.

For rental of buildings or building units, the EPC is voluntary until the end of 2015, when it will then become compulsory.

Quality Assurance (QA) of EPCs

An EPC electronic registration system has been in operation since 9 January 2013. An EPC can be considered official only after uploading it to the online system. The EPC can be uploaded in two ways:

> manually inserting the set of input calculation data of the building, as well as the precalculated results (a set of output data) into the EPC registration system. The system is not a calculation tool, only a database with some automatic cross-checking modules;

> exporting the calculation results into a pre-defined xml format with any software available on the market (an exporting module can be included in the software or the data should be inserted manually).

The online system also serves as a first level of quality control. First, it automatically checks the permit of the energy expert. Following this step, the system checks for unrealistic figures.

The second and third control levels are performed by the Hungarian Chamber of Engineers. Two and a half percent (2.5%) of the EPCs are controlled by an office check and 0.5% (20% of the 2.5%) are verified on-site. Both actions are carried out by independent experts and all control results are registered on an electronic database.

If the quality control detects a miscalculation of a difference by more than two energy classes, the expert loses his licence for 3 years. This is the only possible penalty at the end of 2014, but the introduction of ‘softer’ penalties is under consideration.

Until the end of 2014 (test period), 3,757 EPCs altogether were checked and no penalties were applied. The share of incorrect EPCs is below 10%. The first sanctions are expected in the summer of 2015.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The display campaign for public buildings started in 2009. The format and content is identical to other EPCs and is issued by the same QEs as any other EPC, but using operational rating is only allowed for the purposes of the display campaign. The energy classification is based on the yearly specific primary energy demand requirement.

In Hungary, the definition of a public building includes every state-owned non-residential building. Initially, only the larger buildings (exceeding 1,000 m^2 floor area) were required to display their EPC, making it visible to the public. Since 9 January 2013, the EPC is obligatory for public buildings and large buildings open to the public exceeding 500 m^2 floor area (after 2015, this limit will be decreased to buildings exceeding a 250 m^2 floor area) and the EPC must be displayed in a visible place. For the display itself, there is no control and sanction system in operation at the end of 2014.

The EPC is valid for a maximum of 10 years. It can be updated on a voluntary basis.

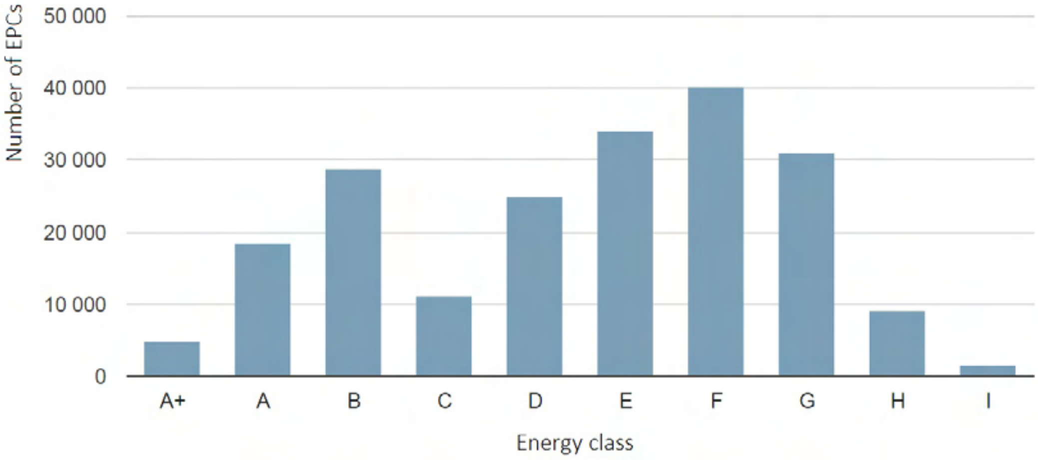


Figure 9: Number of EPCs in function of energy class registered in the electronic system until 18 January 2015.

Activity levels

The number of EPCs currently on display is unknown, as only the number of electronically uploaded EPCs are registered on the system (see Figure 9).

Costs

The cost of an EPC for public buildings must be determined on the basis of real cost reports and generally is between 100 € to 1,500 €.

Quality Assurance (QA) of EPCs

The quality assurance of displayed EPCs is identical to other EPCs. However the public display itself is not checked.

III.iii. Implementation of mandatory advertising requirement

According to the Governmental Decree 176/2008 (VI.30), as of 9 January 2013, the energy categories must be displayed in all commercial advertisements for all buildings or building units, (including individual apartments in blocks of flats, single-family houses and non-residential buildings) when sold or rented, if the EPC is available. Individual apartments were exempted from this requirement until 1 June 2013. In most cases, the EPC is not available in the period of advertising, but only at the moment of sale or rental. As of January 2015, it is not controlled nor sanctioned if the mandatory advertising requirement is obeyed or not.

III.iv. Information campaigns

In the early stages of implementation in 2006, a very intensive information campaign was launched. Several TV and radio interviews addressed the general public, while workshops and open forums were available to the professional community. A webpage and an electronic guide gave updates on the correct interpretation of the directive and national regulations. Printed guides for architects and engineers, in addition to popular pocket guide books for housing associations were published (see Figures 10 and 11).

Figure 10: A poster from the energy awareness campaign of Hungarian energy suppliers.

Figure 11: Owners can estimate the rating of their buildings using the online calculator at www.lakcimke.hu /kalkulator

Later on, the emphasis of the campaign stopped addressing the professional community and focussed solely on providing information to the general public. The *Energiaklub* (NGO) created a home page (www.lakcimke.hu) where the basic concepts such as renewable energy, sustainability and certification, as well as everyday tips for saving energy, were presented in laymen´s terms with many simple illustrations.

Similarly, the Display campaign under the Intelligent Energy Europe Programme was partly supported by the ministry. In addition to printed material and workshops, free software was made available to local authorities that are responsible for public buildings in order to estimate energy consumption (see Figure 12).

In 2013, a manual for cost-optimal renovation was developed by the Ministry of Interior and the Budapest University of Technology and Economics. It was addressed to both residential and public building owners and managers. A longer electronic version is available on the www.e-epites.hu/3430 portal and a shorter printed version has been distributed at the public desks of the government (see Figure 13).

III.v. Coverage of the national building stock

There are 2,640,000 residential buildings and 38,000 non-residential buildings in Hungary. In 2014, the number of apartments is around 4,155,000 (data provided by the Central Statistics Office). The number of new apartments is approximately 10,000. The EPC registration system does not register whether the EPC belongs to a new or existing building. As a result, the number of buildings with EPCs is also unknown (only the number of EPCs is known).

Since the electronic registration of the EPCs started in January 2013, reliable statistics are available only after that date. By the end of 2014, a total of 201,134 EPCs were registered in the electronic system. The number of EPCs registered in the electronic system in the residential sector alone is 189,177. It represents mostly apartments or single-family houses and is approximately 4% of the total number of dwellings (individual flats plus single-family houses).

The total number of EPCs in the non-residential sector is 12,052.

The number of buildings with a certificate is unknown and, thus, the degree of coverage of the EPCs cannot be estimated.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Hungary has adopted alternative measures for inspection of heating systems and AC systems. This means that the inspection system will be replaced by other alternative actions, such as information campaigns on the exchange of obsolete or low-efficiency boilers, AC and heating systems. Such a campaign is already integrated in the NEEAP.

IV.i. Report on equivalence of alternative measures

Three percent (3%) of the 1.2 million boilers operating in Hungary have capacities below 20 kW, 80% have capacities between 20 and 30 kW, and 17% have capacities above 30 kW. Overall, 1,116 million boilers are affected by the EPBD requirement for onsite inspections. The share of household boilers is 90%, while the share of boilers in commercial and public institutions is 10%.

In 2013 the Ministry for National Development sent the report on equivalence of equivalent measures to the European Commission. The response of the Commission included a list of issues for clarification. The clarification process is still ongoing and no results are available yet.

IV.ii. Progress and current status on heating systems

The government has initiated several programmes to subsidise the installation of new condensing boilers to replace obsolete low-efficiency boilers and water heaters. The Environmental and Energy Efficiency Operation Program supported heating system modernisation actions and the integration of RES for public buildings in the recent years. The applicants could select from several renovation packages, including complex renovation and different combinations of 2 or 3 retrofit measures.

Figure 12: A sample certificate from the Display campaign, display.lechnertudaskozpont.hu

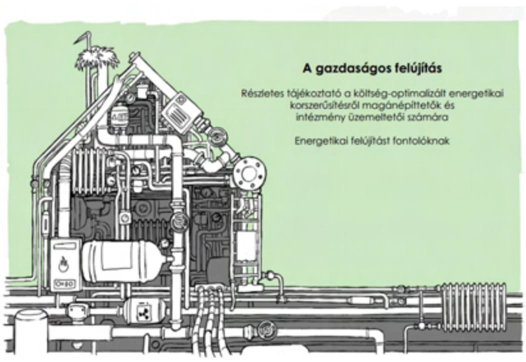


Figure 13: Economical retrofit. Online manual for cost-optimal renovation; published by the Ministry of Interior, 2013.

In the autumn of 2014, a new programme for single-family houses and small apartment buildings was implemented. The programme provided non-refundable funds especially for retrofitting the heating system of residential buildings having less than 4 residential units. The budget of the subsidy programme was 100,000,000 HUF (330,000 €).

No further results are available yet.

IV.iii. Progress and current status on AC systems

A total of 8,877 EPCs reported that the respective buildings or building units had an AC system, which represents only 4.4% of the total number of all EPCs that were issued. AC systems are rarely applied in Hungary, particularly not in the residential sector.

The support of AC systems is not a preferred element of the Hungarian energy policy actions. Instead of subsidising AC systems, the installation of shading devices is preferred. In the current 'window exchange programme for single-family houses and small residential apartment buildings' the installation of shading devices is a priority.

No further results are available yet.

3. A success story in EPBD implementation

The independent control system for EPCs was set up in the autumn of 2013 under the umbrella of the Budapest and Pest County Chamber of Engineers. The work is carried out on a 6 month basis where a package of 2.5% of the EPCs are randomly selected and submitted by the *Lechner Non-Profit Organisation* to the Hungarian Chamber of Engineers. The electronic EPC registration system provides the annex containing the calculation details of the EPC in pdf format (only the data of the first EPC page is registered in detail), which makes the work challenging. After the receipt of the EPCs, they are classified per location and are delegated to regional level with the involvement of circa 20 working groups, including about 70 independent controllers nominated by the County Chambers for further processing. The work is carried out on the basis of a common protocol.

A main element of the process is a pre-defined excel checklist that has to be filled in for all controlled EPCs. The checklist consists of nearly 100 fields that must be filled in. Sixty (60) of them refer to technical issues to be checked and the other forty (40) are administrative issues (identification number, address details, information about the expert, the controller, etc.). The QEs can select from dropdown menus, but there are also some fields for narrative descriptions. During the process, typical mistakes have to be checked together with the accuracy of the EPC calculation and results. As a first step, all EPCs (of the 2.5%) undergo an office check and the questionable EPCs are selected during this process for on-site visits. Twenty percent (20%) of the controlled EPCs are checked on-site by the same experts. A summary report is carried out afterwards. There are four possible evaluation results: 'perfect', 'acceptable', 'EPC with a miscalculation of a difference by more than two energy classes' and 'probability of fraud'.

The reports are sent back to the Budapest and Pest County Chamber of Engineers for further processing where they are uploaded into an electronic database. Then, the controlled EPCs undergo a statistic analysis. A significant amount of useful information is obtained from this analysis about the experts, the controlled buildings, the typical mistakes and the general quality of the EPCs. The share of incorrect EPCs is below 10%.

It is also rather efficient to collect opinions of the controllers. All experts are asked to write a one page long expert opinion in each control period. Several recommendations have already been formulated and forwarded to the responsible Ministry of Interior including advice on improving the legislation. This is also a quality control check of the verification process. The system is regularly upgraded based upon the controllers' opinion.

The experts are also evaluated, particularly those who were checked more than twice. Afterwards, an evaluation list is carried out about 'good' and 'bad' experts which is the basis for sanctions.

Sanctions will be applied for incorrect EPCs uploaded after January 2014. If an EPC fails with an error of more than two energy classes, the expert loses his licence for 3 years; this is currently the only possible sanction. Such sanctions will be issued only after the beginning of 2015. As the sanction is very strict, the suspicious EPCs have to be verified by at least two independent controllers. Hopefully in the medium term, these strict sanctions will have a positive impact on the quality of the EPCs, and thus on the general acceptance by the public.

4. Conclusions, future plans

The 2015 EPBD requirements for new buildings and major renovations will certainly bring important energy savings in the near future, although new and renovated buildings only represent a small share of the entire building stock in Hungary (around 4.3 million dwellings). Between 2008 and 2012 the number of new apartments has decreased from 35,000/year to around 10,000/year and the number of major renovations is still quite low. To mention a positive trend, a moderate increase has been experienced in the construction sector in the last two years, particularly for construction of public buildings. In addition, the annual GDP-growth of the country is better than the European average. However, the impact of applying energy performance requirements to new and renovated buildings is limited and will lead, within a short time-frame, to a moderate reduction in energy consumption in the building sector.

In spite of the difficulties, the introduction of energy performance requirements on partial renovations since 2013 and the introduction of cost-optimal requirements in 2015 for buildings that obtain public funding can have a remarkable effect. The National Building Energy Strategy envisages a significant reallocation of funds and support for the building sector for the coming period until 2020, but the strategy is still at the phase of open discussion by the end of 2014.

The introduction of the electronic registration of EPCs has brought around a very substantial increase in the number of certificates. As a result, most people know what an EPC means, although not all of them are convinced about its usefulness. However, the introduction of the independent control system in autumn 2013 and the strict sanctions from autumn 2014 onwards will probably have a positive effect on the quality of the EPCs, therefore improving the general opinion of the public. In the following years, the number of EPCs will stabilise to around 100,000 annual registrations. In the medium term, as the number of available EPCs increases, the mandatory advertising requirements will also have a significant impact on the market.

The recommendations made by experts in the certificate are important guidelines in the context of a renovation, or as an individual cost-effective measure and can be put to good use by the building owner. Financial concerns about the investment costs of using energy efficient technologies and the decreasing energy prices in Hungary are, however, a major obstacle in the present situation.

In the medium term (after 2018), the introduction of the cost-optimal requirements for all kinds of buildings and the NZEB concept after 2019 and 2021 will be determining factors in the construction market.

Implementation of the EPBD in Ireland

STATUS IN DECEMBER **2014**

1. Introduction

Implementation of the Energy Performance of Buildings Directive (EPBD) in Ireland is the formal responsibility of the Department of the Environment, Community and Local Government (DECLG). Operationally, responsibility is assigned between DECLG and the national energy agency, the Sustainable Energy Authority of Ireland (SEAI). Oversight and coordination is performed through a so-called EPBD Implementation Group, comprising senior officials from DECLG, the Department of Communications, Energy and Natural Resources (DCENR), and the SEAI. The enforcement authorities for both energy performance requirements and energy certification are the Building Control Offices within the local authorities/municipalities.

Ireland has continued to make strong progress in transposing and implementing the requirements of the EPBD and the impact of the implementation of Directive 2010/31/EU is subject to ongoing evaluation. Building Energy Rating (BER) is the term used in Ireland for Energy Performance Certificates (EPCs). Recent and ongoing activities include updated energy performance standards to reflect gap analyses within the cost-optimal study, plans for Nearly Zero-Energy Buildings (NZEBs), active energy renovation initiatives, a strengthened independent control/ enforcement system, business and IT systems development, and EPC database use for energy policy research, prioritisation, design and evaluation.

The mandatory requirement to include EPC information in advertisements, introduced in January 2013, combined with a recovering property market, contributed to a significant increase in the number of published EPCs. At the end of 2015, there were over 609,000 EPCs covering approximately 30% of the national building stock, over 250,000 buildings had received energy efficiency upgrading under national stimulus programmes, and quality guidelines and standards continue to be strengthened.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

The Building Regulations Part L - Conservation of Fuel and Energy for **new residential buildings** were strengthened on three occasions in the period 2005 - 2011. The primary energy consumption and related CO_2 emissions for a whole new residential unit (houses and apartments) performance is calculated using the Dwelling Energy Assessment Procedure (DEAP). The use of Renewable Energy Sources (RES), fabric insulation including the limitation of thermal bridging, airtightness, minimum boiler efficiency, building services controls, insulation of pipes, ducts and vessels, and mechanical ventilation systems are specified as required minimum performance levels for these individual components or aspects. The current minimum energy performance level is a 60% improvement relative to 2005

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standards. This equates approximately to an Energy Performance Coefficient[1] of 0.4, a Building Energy Rating (BER) of A3 with 63 kWh/m^2.year primary energy needs and a mandatory 10 kWh/m^2.year (thermal equivalent) energy contribution from RES (Figure 1).

The requirements for **existing residential units** apply to extensions, material alterations, material changes of use, and window and door replacement. The key areas to be addressed are reasonable levels of fabric insulation in all new construction, limitation of thermal bridging, minimum boiler efficiency and building services controls. In general, a whole building performance calculation is not required for existing residential units undergoing renovation.

DECLG is leading a comprehensive review of the Building Regulations Part L for **new and existing buildings other than dwellings** (non-residential and public buildings)[2], to strengthen the performance requirements following the cost-optimal calculations and gap analysis report completed in March 2013. This regulation and guidance was last revised in 2008 to include a maximum permitted whole building Energy Performance Coefficient and Carbon Dioxide Performance Coefficient when compared to a reference building. The reference building is used to assess compliance with the Building Regulations and it has the same size, shape, zoning arrangements, activities and servicing strategy (heating, ventilation and cooling) as the actual building, but with a typical energy specification as would have applied in 2008.

The reference building uses a "mixed mode" servicing strategy (heating and mechanical ventilation) and its performance would correspond to a BER of C3.

I.ii. Format of national transposition and implementation of existing regulations

Regulations

The Building Regulations transpose the energy performance provisions of Directive 2010/31/EU into Irish law. A Technical Guidance Document Part L (TGD L) is issued by DECLG when the revised Building Regulations Part L is published. The Technical Guidance Document Part L provides detailed compliance guidance to the building industry and is available at www.environ.ie/en/tgd. There are two sets of Part L regulations and TGDs, one for residential units, and one for non-residential buildings.

These are supplemented by an array of other support documents, also available at the same site, to assist the industry in adopting acceptable good practice methods of achieving compliance with particular provisions in the regulations and Technical Guidance Documents.

A new Code of Practice for energy efficiency retrofitting/renovation of residential units was published in March 2014 providing extensive best practice guidance to building industry practitioners[3].

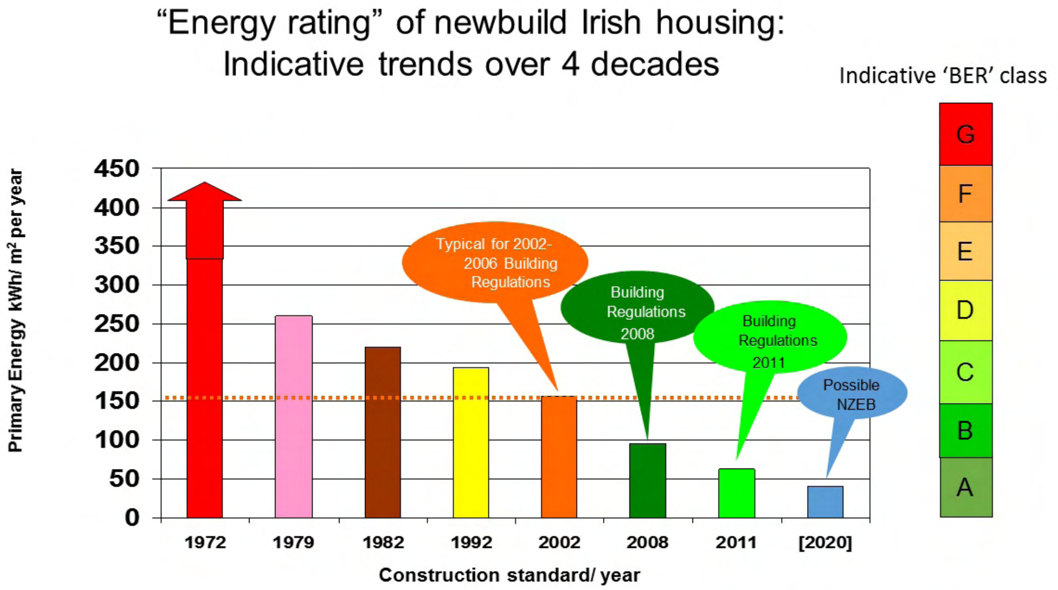

Figure 1: Changes in energy efficiency in residential units (1972-2011).

[1] *The Energy Performance Coefficient is the ratio of the primary energy consumption of the actual residential building to that of a corresponding reference building but with a typical energy specification as would have applied in 2005. There is also a similar requirement for a maximum permissible Carbon Dioxide Performance Coefficient.*

[2] *DECLG is signalling that the draft regulations will be issued for consultation in the first half of 2016.*

[3] *www.nsai.ie/S-R-54-2014-Code-of-Practice.aspx*

Energy performance methodologies

The Dwelling Energy Assessment Procedure (DEAP) and Non-dwelling Energy Assessment Procedure (NEAP) frameworks, which comply with EN 13790, are the mandatory methods for calculating primary energy use and associated CO_2 emissions for space heating and (where applicable) cooling, ventilation, associated motive power and lighting under standardised conditions of use. Both procedures are used for energy performance certification/ Building Energy Rating (BER) purposes. They also include checks for summer time overheating.

Dwellings (residential units): As outlined above, the review of primary energy/CO_2 targets in 2011 resulted in a 60% improvement relative to 2005 requirements, in the form of Maximum Permitted (MP) levels for the Energy Performance Coefficient and Carbon Dioxide Performance Coefficient, expressed as 'MPEPC' and 'MPCPC' (currently 0.40 and 0.46). These broadly correspond to the A3 band on the EPC (BER) scale.

Where there is mechanical ventilation, an air infiltration rate not exceeding 5 $m^3/h.m^2$ at 50 Pa is prescribed using the approved blower door method.

Non-Residential Buildings: The Non-Domestic Energy Assessment Procedure (NEAP) compares the primary energy consumption and CO_2 emissions of the proposed building with those of a reference building to check compliance with building regulations (new buildings), with the maximum permitted Energy Performance Coefficient and CO_2 Performance Coefficient both currently set at 1.0. This approach, which is based on comparisons rather than absolute values, minimises arguments about how well the absolute primary energy consumption and CO_2 emissions are predicted because the proposed and reference buildings are subject to the same calculation approach. Instead, it concentrates on improved energy efficiency and the use of RES where appropriate.

In NEAP[4], buildings are defined in terms of zones in which identifiable, standardised activities take place, geometry of each zone, the thermal performance characteristics of the building fabric elements surrounding each zone, the building services systems which serve each zone (or groups of zones) and the building location. NEAP also uses standard databases or information sources for environmental conditions and operating/occupation patterns in each part of the building. NEAP checks that specific construction elements in the proposed building comply with minimum performance standards specified in Technical Guidance Document L (2008).

I.iii. Cost-optimal procedure for setting energy performance requirements

From the cost-optimal study, published in 2013[5], the requirements for new residential units are already in the cost-optimal range and are better than the cost-optimal level in many cases. There is thus no plan to review the current requirements for new residential buildings (houses and apartments) to achieve cost-optimal levels. The cost-optimal calculations will be used to inform the NZEB plan and review requirements for the NZEB target for 2018 and 2020.

Energy performance levels for existing residential buildings are set on a component basis. DECLG is committed to reviewing performance standards for components in light of cost-optimal levels. In comparing cost-optimal levels with individual elemental values given in current regulations, there appears to be a significant gap. However, there are physical constraints that may make achieving the cost-optimal levels impractical. In light of this information and in the context of the next review of the regulations, DECLG intends to study the effect on grouping technical measures and assessing the cost-optimal points of certain packages. Other influencing parameters, such as buildability, available spread of technologies to achieve cost-optimal performance, and robustness of technologies across all sectors of the residential building stock, will also be taken into account.

Energy performance levels for new non-residential buildings are calculated using NEAP as described in the Building Regulations Technical Guidance Document, Part L. This regulation and guidance was last revised in 2008 to include maximum permitted whole building Energy Performance Coefficient and Carbon Dioxide Performance Coefficient when compared to a reference

[4] *Further details on the NEAP methodology are published on www.seai.ie/Your_Building/BER/Non_Domestic_buildings/Download_SBEM_Software/SBEM Technical Manual V3-4a Oct 2009.pdf*

[5] *Further details on the cost-optimal studies are published on ec.europa.eu/energy/en/topics/energy-efficiency/buildings*

building. The current requirements are more than 15% inferior to cost-optimal. The regulation and guidance is currently undergoing a review process. DECLG is committed to the new regulation and guidance achieving cost-optimal levels. Buildability, spread of technologies to achieve cost-optimal performance, and robustness of technologies across all sectors of the non-residential building stock will also be taken into account. The difference between naturally ventilated buildings and air-conditioned buildings will also be considered. The significance of the effect of services on the energy performance of new buildings and the retrofit of existing buildings will also be a consideration.

Energy performance levels for existing non-residential buildings are set on a component basis, as also set out in Part L of the Building Regulations. The component level performance standards in this regulation were last reviewed in 2002. The gap is greater than 15% between requirements and cost-optimal. The Regulation and Technical Guidance Document are currently undergoing a review process. It is intended that the new regulations and guidance for components will be reviewed in light of cost-optimal levels for components.

Figure 2: Best NZEB of post-primary education sector: Colaiste Choilm.

Table 1: Anticipated energy and CO_2 savings achieved and anticipated in 2020.

	Energy savings (GWh, PEE)			CO_2 savings (kt CO_2)		
	2012 (achieved)	2016 (expected)	2020 (expected)	2012 (achieved)	2016 (expected)	2020 (expected)
Public	1,050	2,358	3,716	238	583	918
Business (Commercial /Industry)	3,257	5,114	7,594	802	1,238	1,813
Buildings	3,778	6,896	10,379	922	1,641	2,459
Transport	1,342	2,746	4,548	342	700	1,134
Energy supply	1,710	1,996	4,418	488	362	597
Cross sectoral (carbon tax)	1,200	1,300	1,300	306	330	330
Total	**12,337**	**20,410**	**31,955**	**3,098**	**4,854**	**7,251**

PEE – Primary Energy Equivalent

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

The DECLG action plan *"Towards Nearly Zero Energy Buildings in Ireland Planning for 2020 and Beyond*[6]*"* sets out the nearly zero-energy performance levels for new and existing buildings to 2020:

> For residential buildings, the NZEB standard, informed by the cost-optimal calculations to lead to the NZEB target for 2018 and 2020, is still being developed in 2015. The advanced energy performance level established in 2011 is a significant step on the road towards 2020.

> For non-residential buildings, an intermediate target is proposed to be an aggregate of +40% improvement relative to the 2005 baseline, with an indicative +60% improvement in 2020. This will be a significant milestone on the path towards NZEB for this sector.

Since 1997, the Department of Education and Skills energy programme has won international recognition for design excellence. All new primary schools are now built to standard BER A3 or better. Figure 2 shows the award-winning research and demonstration project *Colaiste Choilm*, which incorporates passive, active and renewable energy techniques.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Through successive action plans, Ireland has maintained its commitment to a 20% energy savings target in 2020 and to achieving a 33% reduction in public sector energy use. These remain the central pillars of the Irish national energy efficiency policy. While there have been substantial savings in the last three years, it is clear that a significant acceleration of effort is required if Ireland is to realise the 2020 targets and the economic benefits that will accrue.

Table 1 lists the progress achieved since the second Irish Nation Energy Efficiency Action Plan[7] (NEEAP), detailing the key actions underway in buildings, the public sector, industry, transport and energy distribution.

[6] ec.europa.eu/energy/en/content/eu-countries-nearly-zero-energy-buildings-national-plans

[7] *Further details on the NEEAP are published on* ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_en_ireland_0.pdf

Planning the renovation for Ireland's existing building stock means finding solutions that can be applied to as much as 1.6 million homes, 109,000 commercial buildings, 10,000 buildings in the public sector and up to 4,300 industrial sites.

The first iteration of Ireland's National Energy Renovation Strategy[8], published in April 2014, identifies the benefits that could be delivered by increasing the rate of renovation in the Irish economy, along with the barriers that are preventing individuals and businesses from taking action. It also sets out the policies and measures that are already in place to allow households and businesses alike to improve the energy efficiency of their properties and discusses a number of new measures that will be implemented over the next three years.

To inform and complement this strategy, research has been commissioned and published to provide a comprehensive overview of the commercial and public building stock in Ireland.

Regarding Energy Efficiency Directive (EED) Article 5 (exemplary role of public bodies' buildings), the primary approach being followed in Ireland is the alternative approach to renovation, namely the adoption of other cost-effective measures. This has included the establishment of systematic energy management systems, regular automated energy use monitoring and reporting from the inventory of public buildings, significant behavioural and training initiatives with key personnel, establishment of a national framework to encourage Energy Services Companies (ESCOs) investments, and establishment of an Energy Efficiency Fund. The NEEAP has set an energy efficiency improvement target of 33% for the public sector by 2020, which equates to an annual saving of around 2,000 GWh.

I.vi. Other relevant plans

The Building Control Amendment Regulations[9] established an enhanced system of independent control and enforcement of compliance with the provisions of the Building Regulations, including energy performance, and includes accompanying responsibilities for implementation between the building control authorities and the building industry.

The National Energy Services Framework[10], established by SEAI in 2013-2014, is aimed at facilitating an acceleration to energy efficiency projects, particularly in the buildings sector. It explains the process and provides guidance on project development, sourcing of finance and other supports for developing ESCO and energy performance contracting projects in the public and commercial sectors.

In 2013, the Government set up the National Energy Efficiency Fund[11] with 35 M€ of seed capital for investment in energy efficiency projects.

Further transitional funding models, such as pay-as-you-save (PAYS) are being hampered by the current economic climate. SEAI's Better Energy programme has shown the important role that the energy retrofitting of buildings can play, with its Better Energy Communities programme growing particularly strong across Ireland. The Better Energy programme has delivered energy efficiency upgrades to over 250,000 homes over the period 2009-2015 and has supported 260 community energy efficiency projects since 2012.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The Technical Building Systems (TBS) requirements are set out in the Technical Guidance Documents that accompany the Building Regulations[12].

> New or replacement oil or gas-fired boilers must achieve a minimum seasonal efficiency of 90%. This is an improvement from the 2008 requirement for new or replacement boilers (86% efficiency).The Home-heating Appliance Register of Performance (HARP)[13] database is the official product efficiency database for home-heating appliances used in Ireland.

[8] *www.dcenr.gov.ie/energy/en-ie/Energy-Efficiency/Pages/Ireland's-Renovation-Strategy.aspx*
[9] *www.irishstatutebook.ie/pdf/2014/en.si.2014.0009.pdf*
[10] *www.seai.ie/Your_Business/National_Energy_Services_Framework*
[11] *www.seai.ie/Your_Business/National_Energy_Services_Framework/Energy_Efficiency_Fund.html*
[12] *www.environ.ie/en/TGD/*
[13] *www.seai.ie/harp*

> The seasonal efficiency for biomass boilers should be not less than 77%. Heating controls should provide automatic space heating temperature control, automatic control of stored hot water temperature, separate and independent time control for space and hot water heating, and shutdown of the heat source when there is no requirement for space and hot water.
> For new Air-Conditioning (AC) and mechanical ventilation systems in refurbished buildings, or where an existing system in an existing building is being substantially altered, the specific fan power should be no greater than 3.0 W/(l/s).
> Where a mechanical ventilation system designed for continuous operation (with or without heat recovery) is installed in a residential unit, the system is required to meet the performance levels specified in "Energy efficient ventilation in dwellings – a guide for specifiers" (GPG 26), available from SEAI, and must also have a specific fan power not worse than 0.8 W/(l/s) for continuous operation.
> The Triple E (Excellence in Energy Efficiency) Products Register[14] is a benchmark register of best in class energy efficient products, covering over 7,000 specific products in 52 technology groups, including heating, hot water, AC and large ventilation systems. All products on this register meet a set of stringent efficiency criteria. Ireland's Energy Efficient Public Procurement Regulations, S.I. No. 151 of 2011, state that, when procuring products in these categories, a public body shall only procure products listed on this register.
> Also utilising the Triple E register, the Accelerated Capital Allowance (ACA)[15] is a tax incentive for companies paying corporation tax that aims to encourage investment in qualifying energy efficient equipment. The ACA offers an attractive incentive whereby it allows companies to write off 100% of the purchase value of such equipment against their profit in the year of purchase.

II.ii. Regulation of system performance, distinct from product or whole building performance

The Building Regulations require new buildings to be designed and constructed to ensure that their performance is such as to limit the amount of energy required for operation and the amount of associated CO_2 emissions, as far as is reasonably practicable. For new residential units, the requirement shall be met by, inter alia, providing and commissioning energy efficient space and water heating systems with efficient heat sources and effective controls. For non-residential buildings, the requirement shall be met by providing energy efficient space and water heating services, including adequate control of these services and providing energy efficient artificial lighting systems (other than emergency lighting, display lighting or specialist process lighting), and adequate control of these systems.

II.iii. Provisions for installation, dimensioning, adjustment and control

Under the Building Regulations, the heating and hot water system should be commissioned so that, at completion, the system and controls are left in the intended working order and can operate efficiently. The building owner should be provided with sufficient information about the building, fixed building services and their maintenance requirements, so that the building can be operated in such a manner to use no more fuel and energy than is reasonable.

A way of complying would be to provide a suitable set of operating and maintenance instructions that building users can understand. Without prejudice to the requirement to comply with health and safety requirements, the instructions should explain how to operate the systems efficiently including adjusting time and temperature settings and routine maintenance needed to maintain operating efficiency at a reasonable level throughout the service life of the system.

II.iv. Encouragement of intelligent metering

The Commission for Energy Regulation (CER), working closely with the DCENR, established the National Smart Metering Programme (NSMP) in late 2007. During phase 1 of the programme, a trial was carried out in order to assess the costs and benefits of smart meters and to inform decisions relating to the full rollout. In July 2012, a decision was announced to roll out electricity and gas smart meters for all residential units and small and medium-sized businesses.

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[14] www.seai.ie/Your_Business/Triple_E_Product_Register/
[15] www.seai.ie/Your_Business/Accelerated_Capital_Allowance/

Phase 2 commenced in January 2013 and is broadly composed of a high level design and procurement process.

S.I. No. 426 of 2014, which gives effect to Directive 2012/27/EU, provides the Commission for Energy Regulation, as the competent authority, with the necessary legal provisions to support the rollout of the NMSP.

II.v. Encouragement of active energy-saving control (automation, control and monitoring)

Linked to the rollout of smart meters is the provision of information to the user on the amount of energy consumed, based on usage and costs. This can be undertaken in a number of ways, including via realtime displays and correlation to bills. It is intended to progressively provide electronic displays linked to meters to provide real-time information on electricity usage and costs.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

Since the EPC (BER) scheme commenced operation in 2007, SEAI has deployed integrated IT systems including software tools, national registers and the assessor registration management system. These systems also connect with the SEAI finance system, EPC quality assurance management system, Better Energy Homes grant management system, ESB (electricity supply) Meter Point Reference Number database and the national assessor examination management system.

S.I. No. 243 of 2012 of the European Union (Energy Performance of Buildings) Regulations[16], makes provisions for the inclusion of EPC information in property sale and rental advertisements. Following initial publication in December 2012, revised guidelines were published in May 2013[17].

How flats are certified in apartment buildings

For apartments, certification applies to the individual building unit and does not include common areas such as access corridors. For an apartment building, each apartment requires a unique EPC, calculated using the DEAP[18] methodology and the common areas require a non-residential EPC, calculated using the NEAP.

Format and content of the EPC

As shown in Figure 3, the EPC (BER) consists of a label on a linear scale ranging from A to G. In the case of a residential building (house or apartment), the position on the scale is proportionate to the calculated absolute primary energy intensity of the building, with each full band having a width of 75 kWh/m^2.year (and with each sub-band in the A to C ranges being 25 kWh/m^2.year). For other building types, the EPC is proportionate to the ratio of calculated primary energy of the building compared with a reference building. The ratios of 0.5, 1.0, 2.0 and 3.0 correspond to the shared boundaries of the A/B, B/C, D/E and F/G bands, respectively. A secondary scale shows a CO_2 rating in relation to these same energy uses.

Each EPC is accompanied by an 'advisory report' outlining a series of options and recommendations for improving the energy performance of the building. Proposed recommendations are generated by the EPC software, based on the information recorded by the assessor, who can then edit the list.

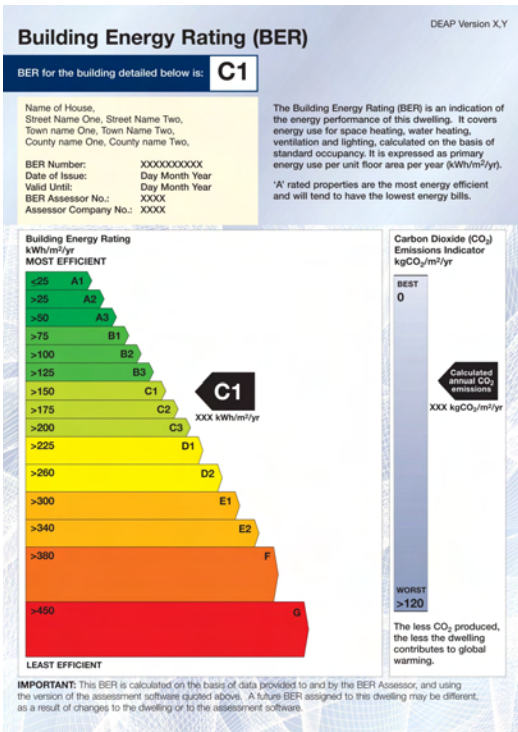

Figure 3: Cover page of the EPC.

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[16] *S.I. 243 of 2012 of the European Union (Energy Performance of Buildings) Regulations.*

[17] *available at www.seai.ie/Your_Building/BER/Advertising_of_BER*

[18] *www.seai.ie/Your_Building/BER/BER_Assessors/Technical/DEAP/Introduction_to_DEAP_for_Professionals.pdf*

Figure 4:
Residential EPCs, monthly year on year history.

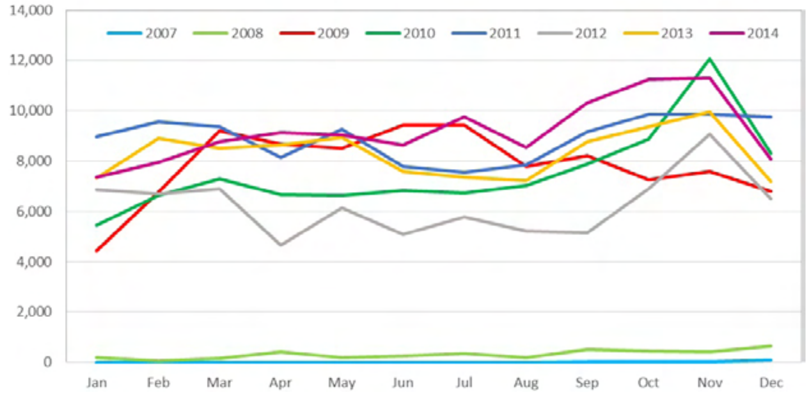


Figure 5:
Non-residential EPCs, monthly year on year history.

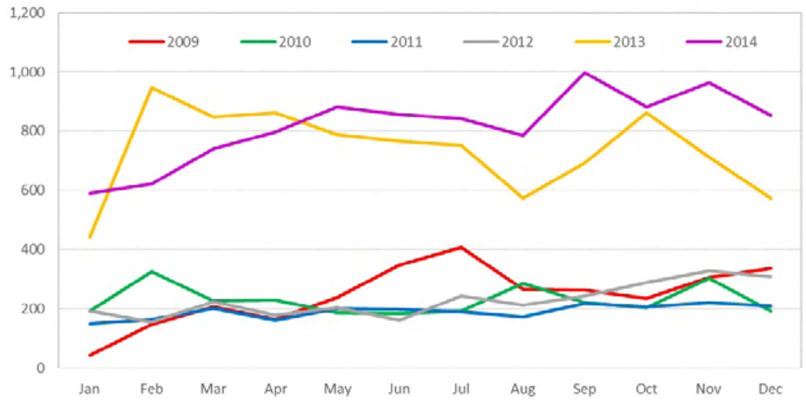


Figure 6:
Profile of residential EPCs.

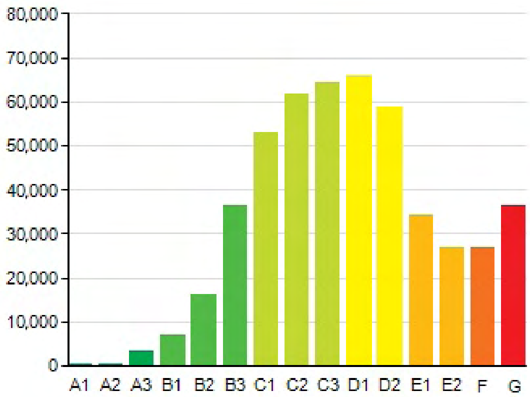
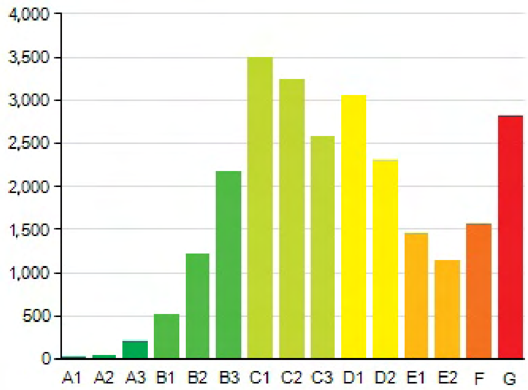


Figure 7:
Profile of non-residential EPCs.



EPC activity levels

EPC activity levels up to the end of December 2014 are summarised in Figures 4 and 5.

The profiles of EPCs published from the initiation of the scheme up to the end of September 2014 are shown in Figures 6 and 7. This shows EPCs predominantly in the range A to C for new residential units. For existing residential and for non-residential buildings, there is a wide range generally from B to G, averaging D1 to D2.

Typical EPC costs

There is no set fee for issuing an EPC. A 2013 survey found the average cost for a three bedroom semi-detached house and a two bedroom apartment[19] to be 165 €.

The cost of an EPC for non-residential buildings depends on a range of factors, including building size, activity, number of HVAC systems, etc. Therefore, it is not possible to give a typical cost for such buildings.

Assessor corps

The prequalification requirement for EPC (BER) assessors of residential buildings is a Quality and Qualifications Ireland (the qualifications authority - NQAI) Level 6 Award (equating to technician diploma) in construction studies or equivalent[20]. Training providers must be registered with a national accreditation body. The training programme must meet SEAI's EPC training specifications in full. The training course specification and award were updated by Quality and Qualifications Ireland. To register, trained candidates must pass a national residential BER Examination. The national examination also acts as Continuing Professional Development (CPD). The exam must be repeated every two years following initial registration.

The prequalification requirement for EPC assessors of non-residential buildings is a NQAI Level 7 or 8 Award (equating to ordinary, or honours degree) in a building related discipline or equivalent, plus membership of the professional qualifying organisation at an appropriate grade listed for the assessor level. Further training is optional, but the candidate must pass the national non-residential EPC examination. In addition, applicants wishing to register as non-residential EPC assessors using an approved software tool are required to pass the approved qualifying examination from the relevant software provider.

[19] *www.consumerhelp.ie/index.jsp?a=1005&n=475&p=121*

[20] *To learn more about the Irish qualifications system, please visit www.nfq-qqi.com/qualifications-frameworks.html*

Compliance levels by sector

Building Control Regulations introduced in March 2014 require designers, engineers and builders to verify compliance at design and construction stages and submit declarations to local authorities for all parts of the Building Regulations (e.g., fire, structure, sound, energy). This new control system will ensure greater compliance with energy performance regulations, as well as other Building Codes. A survey has not been completed, but it is anticipated that there is significant compliance for new buildings since the introduction of the new Building Control Regulations.

For buildings sold, it is expected there is a high rate of compliance as the lawyers will not perform a conveyance without an EPC. For rented properties, EPCs are required for advertising and on request, but compliance levels are unknown. The percentage of buildings with a total useful floor area over 500 m^2, occupied by a public authority and frequently visited by the public, and for which a valid EPC exists, is unknown.

Enforcement with building owners and real estate actors

Legislation assigns responsibility for enforcement of compliance – both with the Building Regulations and with the provision of EPCs on buildings newly built or offered for sale or rental - to building control offices within the local authorities. Building control officers are empowered to carry out inspections and, where necessary, undertake enforcement action in order to ensure compliance. Penalties include a fine of up to 5,000 €, or up to three months in prison, or both. SEAI is not aware of any fines applied to date.

A continuing key factor in ensuring compliance at the time of transaction has been the Law Society of Ireland's Conveyancing (property transactions) Committee direction of 2008 to members (solicitors or notaries) acting for an owner or prospective buyer/tenant, giving a clear instruction on the owner's legal obligation to provide the EPC. DECLG has also reminded building control authorities of their duties to ensure compliance.

Enforcement is complemented by a 'rights based' approach, focussed on creating a compliance culture, including major industry and public awareness campaigns. An example is shown in Figure 8.

Quality Assurance (QA) of EPCs

From the first 104,785 residential and non-residential EPCs that were issued, SEAI ramdomly selected 288 for verification purposes. SEAI also selected an additional 430 EPCs for verification purposes based on complaints and other risk indicators.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The Display Energy Certificate (DEC) requirement was introduced for public service buildings over 1,000 m^2 from January 2009.

From 9 January 2013, any building in excess of 500 m^2 and frequently visited by the public is required to display either an EPC, or a DEC, in a prominent place clearly visible to members of the public. The 500 m^2 limit is lowered to 250 m^2 from 9 July 2015. Legislation assigns responsibility for enforcement of compliance by building owners/occupiers to building control offices within the local authorities. SEAI is not aware of any penalties applied for non-compliance.

Format and content of the EPC

The DEC has a similar format to that of the EPC (A-G scale) for primary energy and a secondary CO_2 indicator, but is based on the measured energy use in the building compared to a benchmark for similar buildings. Benchmark energy performance indicators for 29 functional building types were derived from the CIBSE TM46: Energy Benchmarks dataset analysis[21].

Figure 8: Example of EPC compliance advertising campaign.

[21] *www.cibse.org/knowledge/cibse-tm/tm46-energy-benchmarks*

A Display Energy Certificate is valid for a maximum of 1 year from the date of issue depending on the energy measurement periods used.

An EPC issued for a new building satisfies the Display Energy Certificate requirement until it is possible to produce a DEC based on measured data.

Activity levels

The online web based DEC tool was introduced in February 2014, replacing an earlier Excel spreadsheet and Microsoft Access database. As of December 2014, the number of valid DECs was 260 and there were 82 active registered DEC assessors. This represents a low compliance level. However, by way of contrast, in pursuit of the public sector energy management and targeting provisions within the EED, there is a very high level of cooperation by public bodies in enabling automatic monitoring and reporting of their energy consumption (over 30,000 meters registered, representing over 90% coverage).

Costs

There is no prescribed fee for Display Energy Certificates. The publication levy charged by SEAI is 50 €.

Assessor corps

Registration as a non-residential EPC assessor is a precondition for Display Energy Certificate assessors. Candidates must also attend and successfully complete a half day workshop on top of the required EPC training.

Quality Assurance (QA) of EPCs

The Quality Assurance (QA) scheme for Display Energy Certificate will be aligned to the system currently in place for residential and non-residential EPCs, but it is not yet in place at the end of 2014.

III.iii. Implementation of mandatory advertising requirement

Under the transposing legislation S.I. No. 243 of 2012, it is mandatory that all advertising, in print or on-line media, of buildings offered for sale or rental from 9 January 2013, must include the EPC. SEAI has developed and published guidance on the format of the EPC positioning and held information events for the property industry. Market analysis of compliance rates has not yet been concluded but it is clear that there is high visibility of EPC ratings on property websites, press advertisements and property literature. SEAI published EPC advertising guidelines[22] to ensure the consistent representation of EPC information in advertisements. Building Control Authorities who are also responsible for enforcing the Building Regulations check compliance and may take action.

The annual EPC publication rates are presented in Table 2. The increase in publication rates for 2013 compared to 2012 reflects the considerable impact of the mandatory advertising requirement and the early stages of the recovering property market.

Table 2: Annual EPC publication rates 2012 - 2014.

	2012	2013	2014
Residential	74,951	99,715	110,173
Non-residential	2,745	8,822	9,809

III.iv. Information campaigns

A national information campaign on EPC using national press, radio, television and online media has been run since 2008. A campaign was run in 2012 to reinforce awareness of the EPC, increase compliance, especially within the rental market, and particularly highlight the benefits of having an EPC. Impact indicators include compliance levels, i.e., EPC uptake and web traffic (increased unique visits).

An 'omnibus' market assessment survey in early 2013 indicates that 64% of participants (76% of homeowners, 50% of renters) understood the term BER (EPC) in relation to homes/buildings. This has grown from 55% in 2011 and 30% in 2009. Ninety-two percent (92%) of respondents indicated that the EPC would have some influence on their property choice. Moreover, in the 12 month period to April 2013, there were over 76,000 unique visitors to the BER website and almost 590,000 page viewings.

The live register of EPC data (in anonymised form) is publically accessible on-line through the BER website, for research purposes and has been actively employed by many researchers in the context of various policy studies. Building owners may access their own EPCs[23]. In addition, since early 2014, the Central Statistics Office has published on-line

[22] *www.seai.ie/Your_Building/BER/Advertising_of_BER/BER-Advertising-Guidelines-Issue-2-.pdf*

[23] *EPC data is available to the general public with the first 3 lines of the address, and other data that could identify the address or owner, removed. If the owner/occupier provides a utility bill with address, then the electronic file for a specific address is provided.*

quarterly updated datasets extracted from the EPC register in order to facilitate socio-economic and technical analyses by the research community.

III.v. Coverage of the national building stock

By the end of 2014, there were 517,365 residential and approximately 28,205 non-residential EPCs published, representing cumulative coverage of more than 30% and 23% of the housing and non-residential buildings sectors, respectively. In total 260 public buildings are currently displaying energy certificates.

III.vi. Other relevant plans

The Better Energy Programme, administered by SEAI, was established in 2009 to support energy efficiency upgrades to buildings and facilities in all end use sectors. Across the programme, over 315 M€ has been provided in support funding, leveraging investments of 500 M€ in 230,000 buildings by the end of 2014, with estimated annual energy cost savings of over 135 M€. Since 2011, under the Better Energy Homes element of this programme, it is mandatory to issue an EPC following completion of the energy efficiency works.

This programme is in a process of migrating from a grant based model towards a full market model in conjunction with financial institutions (using 'pay-as-you-save' and ESCO-type models) and with energy suppliers and service companies.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

In September 2012, Ireland notified the EU Commission of its decision to avail of the alternative approach provided under Article 14(4) of the EPBD. The approach in Ireland centres on the implementation of an effective information campaign aimed at encouraging regular heating system inspections/maintenance and the replacement of inefficient heating systems with high efficiency alternatives. The use in AC in residential buildings in Ireland is insignificant, and an alternative approach complying with Article 15(4) has also been adopted.

IV.i. Report on equivalence

A comparison of the annual energy saving potential arising from a hypothetical regular inspection scheme complying with Article 14(1)-(3) and the alternative approach adopted in Ireland, complying with Article 14(4), is shown in Table 3.

The following key assumptions were used when assessing the impact of a hypothetical regular inspection scheme for residential heating systems:

- A biennial inspection regime for boilers with capacities > 20 kW is introduced and applies to the December 2013 boiler population (710,501 boilers).
- Approximately 76.3%[24] (~542,350 boilers) of residential heating systems > 20 kW currently receive a maintenance servicing at least every 2 years. Efficiency gains that would arise due to a mandatory inspection scheme were only credited to the 23.7% (~168,150 boilers) of heating systems that currently service boilers less frequently than biennially.
- Not all householders would be willing to spend money on extra servicing, despite the introduction of a mandatory inspection scheme. It has been assumed that the conversion rate from service intervals greater than 2 years to biennial servicing is 50%. Only 1% of households would respond to recommendations arising from inspections.
- Consumer research indicates that the main driver for residential boiler upgrade is breakdown, with unavailability of spare parts and, to a lesser extent, the availability of grants. This is particularly true during a period of economic austerity. This analysis assumes that inspection measures alone would not be sufficient to encourage boiler upgrades/replacement without the incentive of a grant.
- All households, on average, would reduce energy use following a biennial heating system inspection, leading to a 1% reduction in energy use across the inspected boiler population. This would be achieved by lowering room temperatures, better tuning of existing control systems, or minor investments in insulation of heating system components.

Table 3: Comparison of energy savings: inspection schemes versus alternative measures (heating).

Hypothetical regular inspection scheme – Article 14(1)-(3)			Alternative measures Article 14(4)		
Annual energy saving	GWh	98.9	Annual energy saving	GWh	314.1
Annual CO_2 savings	tonnes	23,917	Annual CO_2 savings	tonnes	67,658

[24] *Based on the results of market research studies carried out by Millward Brown and Ignite on behalf of the Sustainable Energy Authority of Ireland (SEAI).*

The shift to biennial servicing of oil and solid fuel boilers would lead to a 3.5% energy saving, and the shift to biennial gas boiler servicing would lead to a 1% energy saving. These savings represent the difference between the efficiency loss after 2 years and the higher losses that would occur if a longer service interval was chosen. The savings are based on data published by the SEAI[25].

The cost for a boiler inspection and a review of the heating system would be of the same order as the cost for a Building Energy Rating (BER) inspection, i.e., 165 €. The cost of additional boiler servicing, if triggered by an inspection regime, is 100 € per service.

The assessment of the impact of alternative measures for heating systems in the residential sector is presented in Table 4.

The analysis, conducted in the second half of 2013, indicates that the alternative approach in Ireland, consisting of an awareness scheme and capital grants for heating system upgrades, would yield over three times the energy and CO_2 savings that would be achieved by a hypothetical inspection scheme over the reporting period from June 2011 to June 2014.

IV.ii. Progress and current status on heating systems

Detailing of activities to improve energy performance of heating systems

National promotional/advertising campaigns are run yearly to promote regular servicing of boilers.

Under the Better Energy Homes scheme of grants for efficient heating installations, high efficiency boilers and heating controls, upgrades were installed in 51,500 homes by November 2015.

In the context of the equivalence rationale, the 2011 and 2012 Better Energy Workplaces programme has supported exemplary sustainable energy projects and evaluated new approaches for implementing energy upgrades in the commercial sectors.

Impact and equivalence assessment

Table 4 summarises which elements have the most significant contribution to energy savings according to an impact and equivalence assessment.

Table 4: Impact and equivalence assessment (heating).

Action	Annual energy saving (GWh)	Annual CO_2 savings (tonnes)	Operational timeframe
National Awareness Campaign	46.2	11,589	2008 ongoing
Better Energy Homes Scheme	159.5	33,668	2008 (pilot) and ongoing to 2014
Better Energy Workplace Scheme	108.4	22,400	2011 – 2012
Total annual saving	**314.1**	**67,658**	

IV.iii. Progress and current status on AC systems

Detailing of activities to improve energy performance of air-conditioning systems

With the introduction of the F Gas regulation (and company certification) that requires inspection of some of the systems also covered by the EPBD, the quality and frequency of inspections have improved. There has also been an increase in the number of system inspections, with a 30% increase in inspection of larger systems, and 15% for smaller systems.

Ireland intends to run a national communications campaign in relation to regular servicing of AC systems and consideration of replacement of systems.

SEAI's Better Energy Workplaces programme supported exemplary actions for efficient AC as part of sustainable energy upgrading projects in the public, commercial, industrial and community sectors.

SEAI's Public Sector Programme supports energy management and energy efficiency in the public sector. Its Business Sector Information and Advice activities highlight high efficiency technologies and operational and maintenance practices to maximise AC system efficiencies. The BER advisory reports for non-residential buildings include AC system advisory information.

The on-line Triple E product register of energy efficiency products at www.seai.ie/triplee includes motors and drives, refrigeration and cooling systems, and HVAC control systems.

Impact and equivalence assessment

The annual energy savings in relation to AC systems attributable to the above direct measures are estimated at 6.6 GWh, resulting in 3,215 tonnes of CO_2 savings, as summarised in Table 5.

Table 5: Impact and equivalence assessment (air-conditioning).

Hypothetical regular inspection scheme – Article 15(1)-(3)			Alternative measures Article 15(4)		
Annual energy saving	GWh	5	Annual energy saving	GWh	6.6
Annual CO_2 savings	tonnes	2,430	Annual CO_2 savings	tonnes	3,215

[25] www.seai.ie/Power_of_One/Heat_Your_Home_For_Less/Servicing_Your_Boiler/

The analysis indicates that the alternative approach in Ireland would yield over 30% more energy and CO_2 savings than would be achieved by a hypothetical inspection scheme over the reporting period from June 2011 to June 2014.

3. A success story in EPBD implementation

Since the EPC (BER) scheme commenced operation in 2007, SEAI, as issuing authority, has developed a number of distinct but integrated IT systems to facilitate its regulatory role. This includes three different software tools for assessors to enable energy performance certification, corresponding to national registers of EPC assessments and the assessor registration management system.

These systems have web service connections with internal systems including the SEAI internal finance system, the BER quality assurance management system, and the Better Energy Homes grant management system. The SEAI registers are also connected to the external ESB (electricity supply) Meter Point Reference Number database, the national assessor examination management system, and are used for derived publications by the Central Statistics Office.

The main registers are hosted on a resilient infrastructure hosted in the Government shared services data centre, with a failover site in the SEAI head office. Database replication technology is used to reduce recovery to less than 15 minutes.

To give researchers access to statistical data from the scheme, SEAI has provided a BER Research Tool. This tool provides access to information on all aspects of construction that affect the energy performance of residential units. Results can be viewed on screen, or downloaded in the form of a Microsoft Excel spreadsheet. Data is updated nightly, so search results represent an up-to-date summary of published residential EPCs.

This research tool has already been widely used by local authorities, Non-Governmental Organisations and researchers. The Episcope research project[26] is working across 16 European countries to establish a methodology to track the rate of energy refurbishment of housing stocks with respect to national and EU energy saving targets. This is enabled through integration of the BER Research Tool with the Central Statistics Office spatial geocoding.

Equipped with business intelligence tools, the central register of EPCs provides powerful insight into the optimal strategies for building energy retrofit investment. The non-residential EPC database has also been combined with extensive survey results and spatial geocoding database to yield a comprehensive overview of the national commercial buildings stock. This provides key input data to the building energy model for the calculation of technical energy savings potential, informing the content of Ireland's national strategy for mobilising energy renovation of the building stock pursuant to Article 4 of the EED.

The annual volumes of EPCs published are shown in Table 6.

Table 6: EPCs published 2007-2014.

Year	EPCs published
2007	127
2008	3,794
2009	97,054
2010	93,134
2011	109,441
2012	77,696
2013	108,537
2014	119,982
Total	**609,765**

4. Conclusions, future plans

Overall, significant progress continues to be made with implementing the Energy Performance of Buildings Directive (EPBD), in particular the energy performance and certification requirements. Priorities over the next two to three years include upgraded performance standards for non-residential buildings, the Nearly Zero-Energy Building (NZEB) roadmap, driving continuing Energy Performance Certificate (EPC) - known in Ireland as BER - awareness, activity and compliance, and leveraged support to the national building energy renovation strategy. An additional key element in the strategy of implementation continues to be the use of advanced IT and communication systems to maximise the efficiency, quality and market impact of the implementation.

The range of IT systems developed by the Sustainable Energy Authority of Ireland (SEAI) since 2007 to administer the EPC system had evolved without an overarching application architecture and strategy. SEAI has been running a very complex system with lean human resources and has gained a good reputation. However key challenges include maintenance and support of the software tools, maximising the levels of integration and avoiding data duplication. It has therefore been decided to undertake a comprehensive review of current systems design and infrastructure and develop an IT Roadmap for the next three years.

Building on the success of the Building Energy Rating (BER) Research Tool, the IT system must meet the growing need for access to critical information by

[26] *http://episcope.eu/welcome/*

stakeholders and emerging Government policies:

- Building Regulations Part L updates for non-residential buildings;
- introduction of the Eircode, the national postcodes, in EPCs in 2015 (facilitating data integration);
- the Public Service Reform Plan 2014 – 2016;
- eGovernment Strategy 2012 – 2015 (Digital Mapping and Geographic Information Systems; ensure that public service data is available for reuse);
- increased focus by Government on driving up EPC certification levels;
- Energy Efficiency Directive (Directive 2012/27/EU) – the requirement to empower consumer to take informed decisions/choices will drive changes to Advisory Reports which accompany EPCs;
- EPC data is a key resource to inform and deliver the National Energy Efficiency Action Plan (NEEAP III).

During 2015-2017, the framework of the IT Roadmap will extend the scope and influence of data available and measures taken by building owners to ultimately result in better living and working environments across Ireland.

Implementation of the EPBD in Italy

STATUS IN DECEMBER **2014**

1. Introduction

After the first decree setting the basis for the national legislative EPBD framework enacted in 2005, a number of legal acts (legislative, ministerial and presidential decrees) have been issued to progressively define and specify all aspects of the national EPBD transposition.

In 2013, three new decrees were issued:

- *Presidential Decrees 74/2013 and 75/2013 have completed the implementation of the EPBD in the sections related to inspections of the heating, ventilation and air-conditioning (HVAC) and domestic hot water (DHW) systems and qualification of energy assessors.*
- *Law 63/2013 (enacted by Law 90/2013) has implemented Directive 2010/31/EU, introducing significant modifications in Legislative Decree 192/2005 (the Directive 2002/91/EC transposition act).*

In 2014, Law 9/2014 partially modified the qualifications of the energy assessors included in Presidential Decree 75/2013.

Energy-related topics are a shared task between the state and the 21 regions and autonomous provinces. Consequently, regional authorities may implement autonomous transpositions of the EPBD, as long as they do not contradict the general principles and requirements provided by national and EU regulations. The national regulation stays in force for the regions that have not issued their own legislation.

At the end of 2014, 6 regions (Liguria, Emilia Romagna, Toscana, Val d'Aosta, Piemonte and Lombardia) and the 2 autonomous provinces (Trento and Bolzano) have fully transposed the EPBD. All other regions follow the national legislation, which, by itself, is a full transposition of the EPBD.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

While transposing the EPBD (Directive 2010/31/EU), Law 63/2013 announced future acts, expected in the first part of 2015, that will provide:

- an updated energy performance calculation methodology according to Directive 2010/31/EU, Annex I;
- minimum energy performance requirements for new buildings and existing buildings subject to major renovations, on the basis of a cost-benefit analysis while taking into account the entire estimated lifespan of the building.

In case of new buildings and major renovations, calculations shall be based on a comparative methodology framework with reference buildings representative of their construction typology and outdoor climate conditions.

New minimum performance requirements will also include thermal performance and transmittance indexes, as well as overall energy performance indexes, expressed both in terms of total primary energy and non-renewable primary energy use.

Until new minimum requirements and calculation methodologies are introduced, existing requirements set by Legislative Decree 192/2005 will stay into force. Current calculation methodologies are based on national standards derived from CEN. The new methodologies shall be based on an updated set of technical standards (see Box 1).

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UNI/TS 11300 2014 (parts 1 to 4) - energy performance calculation methodologies:

- *Parte 1: Determinazione del fabbisogno di energia termica dell'edificio per la climatizzazione estiva ed invernale.*
- *Parte 2: Determinazione del fabbisogno di energia primaria e dei rendimenti per la climatizzazione invernale e per la produzione di acqua calda sanitaria.*
- *Parte 3: Determinazione del fabbisogno di energia primaria e dei rendimenti per la climatizzazione estiva.*
- *Parte 4: Utilizzo di energie rinnovabili e di altri metodi di generazione per la climatizzazione invernale e per la produzione di acqua calda sanitaria.*

UNI EN 15193 2008 - Calculations for artificial lighting - Prestazione energetica degli edifici - Requisiti energetici per illuminazione.

Recommendation CTI 14, 2013 - Primary energy factors - Prestazioni energetiche degli edifici - Determinazione della prestazione energetica per la classificazione dell'edificio.

Box 1: Updated set of technical standards.

I.i. Progress and current status

Legislative Decree 192/2005 draws the general framework for the transposition of the EPBD, setting the minimum requirements for energy performance and the U-values for windows, walls, floors and roofs, in case of new buildings and major renovations. In 2009, Presidential Decree 59 extended the calculation methodologies and minimum requirements to the summer energy performance of cooling and lighting systems; it also updated the minimum requirements for the energy performance of buildings and of heating systems. A new ministerial decree setting the new requirements for new buildings (including NZEBs) and major renovations is near completion at the end of 2014 and will substitute DPR 59/2009.

With the Legislative Decree 28/2011 transposing the Renewable Energy Services (RES) Directive, the requirements regarding the share of renewable energy for new buildings and major renovations were increased, establishing a calendar with a progressively larger share of renewable quota for DHW and heating and cooling energy demand for all building permits:

a. 20% renewable quota for permits requested between 31 May 2012 and 31 December 2013;

b. 35% renewable quota for permits requested between 1 January 2014 and 31 December 2016;

c. 50% renewable quota for permits requested from 1 January 2017 onwards.

A draft regulation is under development in order to introduce newly defined cost-optimal building performance requirements and the Nearly Zero-Energy Building (NZEB) concept, as well as the new standard values for cooling, ventilation and lighting, the last one only for non-residential buildings. The new rules are expected to come into force by the end of June 2015.

I.ii. Format of national transposition and implementation of existing regulations

Requirements for new buildings

Since January 2010, all new residential and non-residential buildings must comply with the minimum requirements for winter performance, set by Legislative Decree 192/2005. Energy performance values vary according to building type (energy performance for residential buildings is expressed in terms of kWh/m^2.year of primary energy, while energy performance for non-residential buildings is expressed in terms of kWh/m^3.year of primary energy), climatic zone, local degree days, and surface-area-to-volume ratio of the building, as depicted in Tables 1 and 2. Figure 1 shows a map of the distribution of climatic zones over the territory. The energy performance requirements for summer cooling as set by Presidential Decree 59/2009 are shown in Tables 3 and 4. Furthermore, in case of new buildings and major renovations, the designer is expected to:

> adopt compulsorily window shading and calculate their contribution to the winter and summer performance;

> either check that (i) the mass of the external walls is larger than 230 kg/m^2 (except northeast to northwest), or that (ii) their value for periodic thermal transmittance (a dynamic parameter introduced with the Standard UNI EN ISO 13786:2008) is lower than 0.12 W/m^2.K;

> check that the periodic thermal transmittance of roofs, floors and northeast to northwest external walls only is lower than 0.20 W/m^2.K.

Requirements for existing buildings

Minimum requirements are differentiated according to the degree of the planned renovation. The minimum energy performance requirements for new buildings apply fully in case of:

> demolition/reconstruction or renovation of all building elements (for buildings with heated floor area >1,000 m^2);
> building enlargements over 20% of the original volume, only for the newly built section.

In case of any degree of refurbishment, a set of basic requirements applies to single building elements. Table 5 shows the minimum U-values for different building elements such as walls, roofs, floors, windows and window glass.

Minimum requirements in specific regions

When designing their local EPBD implementation, regional governments and autonomous provinces are allowed to set stricter minimum requirements. Table 6 shows the state of EPBD implementation among regions and autonomous provinces.

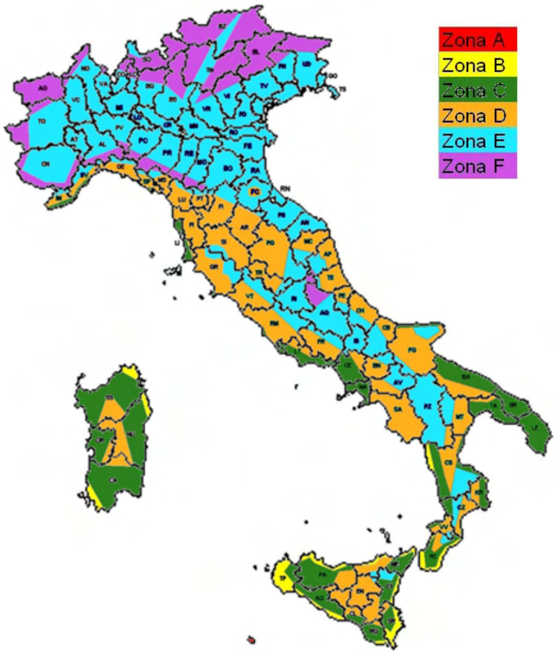


Figure 1: Italian climatic zones

Table 1: Minimum energy performance requirements (primary energy) for heating in residential buildings (kWh/m^2). See map for zones' distribution.

surface area to volume ratio	Climatic zones (by degree days - °C)									
	A	B		C		D		E		F
	≤ 600 dd	> 601 dd	≤ 900 dd	> 901 dd	≤ 1,400 dd	> 1,401 dd	≤ 2,100 dd	> 2,101 dd	≤ 3,000 dd	> 3,000 dd
≤ 0.2	8.5	8.5	2.8	12.8	21.3	21.3	34	34	46.8	46.8
≥ 0.9	36	36	48	48	68	68	88	88	116	116

Table 2: Minimum energy performance requirements for heating (primary energy) in non-residential buildings (kWh/m^2).

surface area to volume ratio	Climatic zones (by degree days - °C)									
	A	B		C		D		E		F
	≤ 600 dd	> 601 dd	≤ 900 dd	> 901 dd	≤ 1,400 dd	> 1,401 dd	≤ 2,100 dd	> 2,101 dd	≤ 3,000 dd	> 3,000 dd
≤ 0.2	2	2	3.6	3.6	6	6	9.6	9.6	12.7	12.7
≥ 0.9	8.2	8.2	12.8	12.8	17.3	17.3	22.5	22.5	31	31

Requirements for public buildings

Buildings used and owned by public authorities are expected to set an example and play a leading role. Therefore, energy performance and U-values are set 10% lower than those required for private buildings (Decree 59/2009).

Calculation methodologies of the energy performance of buildings

The national standards UNI TS 11300 2014 (energy performance calculation methodologies), UNI EN 15193 2008 (calculations on artificial lighting) and CTI Recommendation 14 2013 (primary energy factors) are all applications of European standards. Calculation procedures include thermal comfort requirements, indoor air quality requirements, infiltrations, thermal bridges and shading devices. Regional calculation methodologies refer almost entirely to the national standards, while only the Lombardia region and the autonomous province of Bolzano adopted standards derived directly from

Table 3: Minimum energy performance requirements for cooling (primary energy) in residential buildings (kWh/m^2).

Climatic zones (by degree days - °C)					
A	B	C	D	E	F
< 600	from 601 to 900	from 901 to 1,400	from 1,401 to 2,100	from 2,101 to 3,000	over 3,000
40	40	30	30	30	30

Table 4: Minimum energy performance requirements for cooling (primary energy) in non-residential buildings (kWh/m^3).

Climatic zones (by degree days - °C)					
A	B	C	D	E	F
< 600	from 601 to 900 dd	from 901 to 1,400	from 1,401 to 2,100	from 2,101 to 3,000	over 3,000
14	14	10	10	10	10

EN ISO 13790 2008 (*Prestazione termica degli edifici - Calcolo del fabbisogno di energia per il riscaldamento*).

CTI Recommendation n.14 released in February 2013 set conversion factors for the building energy performance calculation (for renewable and non-renewable primary energy) as listed in Table 7.

Table 5:
Minimum required U-values for building elements (W/m².K).

	U-values (W/m².K)				
Climatic zones	**walls**	**roof**	**floors**	**windows**	**window glass only**
A	0.62	0.38	0.65	4.6	3.7
B	0.48	0.38	0.49	3.0	2.7
C	0.40	0.38	0.42	2.6	2.1
D	0.36	0.32	0.36	2.4	1,9
E	0.34	0.30	0.33	2.2	1.7
F	0.33	0.29	0.32	2.0	1.3

Table 6:
State of EPBD implementation among regions and autonomous provinces.

Regions and autonomous provinces	Regional EPBD regulation	Issued EPCs*	EPC database*
Abruzzo		28,517	○
Basilicata		3,096	○
Bolzano	●	16,009	○
Calabria		2,991	
Campania			
Emilia-Romagna	●	595,389	●
Friuli Venezia-Giulia	●	17,851	●
Lazio		72,743	○
Liguria	●	213,098	○
Lombardia	●	1,476,674	●
Marche		69,698	
Molise			
Piemonte	●	604,350	●
Puglia	○		○
Sardegna		25,400	
Sicilia	○	141,930	○
Toscana	●	39,000	○
Province of Trento	○	35,643	○
Umbria		5,155	○
Valle d'Aosta	●	11,541	●
Veneto		275,581	○
		3,637,166	

● active
○ in course of development

*CTI report 2013

Table 7:
Primary energy factors for different energy carriers.

Energy carrier	$f_{P,nren}$	$f_{P,ren}$	f_P
Methane gas	1	0	1
LPG	1	0	1
Fuel oil	1	0	1
Biomass solid, liquid and gaseous*	0.3	0.7	1
Electric energy	2.174	0	2.174
District heating (DH)	**	-	-

** as defined in Legislative Decree 152/2006, Annex X*
*** value defined by the DH provider*

$f_{P,nren}$ = conversion factor in non-renewable primary energy
$f_{P,ren}$ = conversion factor in renewable primary energy
f_P = conversion factor in primary energy

Table 8:
New residential buildings. Comparison of present law requirements and optimal solutions performance indexes.

Climatic Zone	Building	A_{env}/V_l [m⁻¹]	$EP_{i,ott}$ [kWh/m²]	$EP_{i,lim}$ [kWh/m²]	Δ%
B	Large apartment building	0.43	10.2	21.0	- 52%
	Small apartment building	0.6	19.2	28.6	-33%
	Single family unit	0.99	40.3	42.0	-4%
E	Large apartment building	0.43	32.0	57.7	-45%
	Small apartment building	0.6	39.6	72.1	-45%
	Single family unit	0.99	72.6	97.5	-26%

A_{env}/V_l = Surface area to gross volume ratio [m⁻¹]
$EP_{i,ott}$ = Cost-Optimal Energy Performance index [kWh/m²]
$EP_{i,lim}$ = Minimum requirement for Energy Performance index [kWh/m²]
Δ% = Difference (%)

Compliance and Quality Assurance (QA)

Compliance checks of minimum requirements are performed systematically by municipal authorities. Local authorities may carry out on-site visits during or after the construction phase. A final report signed by an engineer confirming compliance with the town planning rules, the construction regulations and the energy performance requirements is compulsory.

Monitoring activities

The Ministries of Economic Development and of the Environment, as well as the regional governments, monitor the state of implementation of the EPBD and periodically provide a report to the Parliament.

I.iii. Cost-optimal procedure for setting energy performance requirements

On 2 August 2013, Italy issued its national study on cost-optimal procedures for setting energy performance requirements according to the guidelines provided by the European Commission. The report also outlined some reservations about the guidelines and hence on the results of the study.

The planned interventions were defined with a mix of 17 intervention combinations, taking into account outdoor climatic conditions, building typology (24 reference buildings overall, divided into single homes, small and large apartment buildings and office buildings) and the intended use of the building. A comparison of the requirements of the law with those arising from the application of the methodology is shown in Table 8.

Notwithstanding the reservations and the need for an in-depth review still ongoing at the end of 2014, the results confirm the prediction of the need for the adjustment of minimum performance levels. Those requirements, as defined by national standards in 2006, albeit with a progression towards greater efficiency in 2008 and 2010, could not take into account technological developments and new components and systems now currently available on the market.

For some results which have contradicting elements (e.g., a single-family building in zone B), a specific review will be enacted.

Law 63/2013 announced future acts to release updated minimum requirements for U-values of building components (current values are reported in Table 5).

I.iv. Action plan for progression to Nearly Zero-Energy Buildings

National application of the NZEB definition

The decree of transposition of the EPBD accepted the definition of NZEB as a building with very high energy performance. The performance requirements are to be developed in the subsequent implementation decrees in this regard.

A national action plan to provide a proper definition for NZEBs and to promote their construction is foreseen to be completed by the first half of 2015. The document foresees that, starting 1 January 2019, all new buildings that are property of or utilised by public administrations will have to be classified as NZEBs. All the other new buildings shall be NZEBs from January 2021.

Figures and statistics on existing NZEBs

No statistical data or estimates are presently available on the number of NZEBs that already exist in Italy. This is in part due to the lack of an official definition. However, many ongoing pilot projects are in place and numerous solutions are available on the market. Figure 2 shows an example of such types of buildings.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Buildings renovation (Art. 4)

Legislative Decree 102/2014 transposing the Energy Efficiency Directive indicates that the National Agency for Energy and Environment (ENEA) will be responsible for the elaboration of the long-term strategy for the renovation of the building stock provided for in Article 4 of the EED. An assessment of the consistency of the building stock has been carried out in

Figure 2: Residential buildings certified CasaClima A+, Trino Vercellese, Piemonte.

order to estimate the actions necessary for the upgrading of the energy efficiency. Based on the results obtained from the application of the comparative methodology, the potential national energy savings resulting from energy efficiency measures attributable to residential and non-residential sectors have been evaluated, taking into account both the regulatory tools and incentives currently in place as well as those planned, in view of achieving the national energy savings targets (see Table 9).

Exemplary role of public buildings (Art. 5)

The decree transposing the EED provides that from 2014 to 2020, interventions will be made on the building stock of the central public administration, including peripheral real estate, capable of achieving energy requalification of at least 3% per year of the heated useful floor area or, alternatively, resulting in a cumulative final energy savings between 2014 and 2020 of at least 0.04 Mtoe[1] (465,200 MWh). As to the cumulative yearly savings in public administration buildings overall, the 2014 National Plan for Energy Efficiency foresees a savings of 0.57 Mtoe (6,629,100 MWh) of final energy consumption, equivalent to 0.8 Mtoe (9,304,000 MWh) of primary energy.

Table 9: Consumption reduction potential in 2020 through residential buildings renovations enacted, starting in 2014.

Type of building	Hypothesis of intervention on the building stock		Type of renovation and estimated yearly energy savings					Energy saved until 2020	
	Type of renovation	Refurbished surface/year	Roofs	Walls	Windows/ glazing	Systems	Global renovation		
		m²	GWh/year					GWh/year	Mtoe /year
Single-family unit	Partial interventions	39,407,808	221	132	83	265		4,907	0.42
	Global interventions	26,551,030					2,230	15,610	1.34
Multi-unit	Partial interventions	79,141,300	253	475	253	658		11,473	0.50
	Global interventions	25,142,222					2,414	16,898	1.45

Note: The terms 'partial interventions' and 'global interventions' are similar to those used in the tax deductions for the energy upgrading of existing buildings. 'Partial interventions' refers to actions on individual elements of the building structure or heating system, while 'global interventions' refers to restorations of multiple elements of the building and heating system.

[1] *Mtoe – one million of tons of oil equivalent*

Of the 0.57 Mtoe of final energy consumption savings, 0.1 Mtoe is based on EPBD standards, and 0.47 Mtoe on incentives schemes.

The Ministry of Economic Development, in collaboration with the relevant public administrations, shall prepare a program of interventions to be carried out annually. The criteria for the identification of the latter will be based on:

> optimisation of investment recovery time;
> buildings with the worst energy performance index;
> shorter time for the initiation and completion of the intervention;
> extent of any forms of co-financing, including third-party financing.

In order to monitor the performance, the companies supplying energy to consumers registered to a central public administration must communicate to the ENEA by 31 January of each year the annual consumption data per energy carrier for the previous year.

I.vi. Other relevant plans

The National Action Plan for Energy Efficiency (*Piano d'Azione per l'Efficienza Energetica - PAEE*) describes the energy efficiency targets set by Italy for 2020, the policy measures to enable their attainment and the savings already achieved by 2012. The latest version of the plan was adopted in July 2014.

In particular, the plan, in accordance with the guidelines of the European Commission and in agreement with the views expressed in the National Energy Strategy (*Strategia Energetica Nazionale, SEN*), contains national targets for the reduction of primary and final energy consumption, and specifies the savings in final energy use expected by 2020 for each economic sector and for the main instruments for promoting energy efficiency (Tables 10a and 10b).

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The Italian legislation envisages since 1993 minimum requirements for air and water heating systems, for the centralised production of DHW and for large controlled mechanical ventilation systems. More recently, minimum requirements specifically for heat pumps were also introduced.

It is important to remember that the requirements described in this section are related to the national legislation; regional regulations may provide slightly different requirements, which must always be more restrictive or compensate on other aspects of the building technical systems regarding a greater tolerance for a single requirement. In any case, the index of the global energy performance of the building, new or renovated, must either remain unchanged or be lower than the one set by national legislation.

II.ii. Regulation of system performance, distinct from product or whole building performance

Heating and central production of DHW: seasonal efficiency should be higher than (75 + 3 log P_n) (%), where P_n is the nominal power output of the boiler. In addition, the heat generators of DHW must have a useful thermal efficiency (the ratio between the thermal power of the fuel and the power transmitted to the boiler) no less than the values prescribed by the law, and the hot air ones must

Table 10a: Energy savings attained in 2005 – 2012 and expected in 2016, according to PAEE 2011 (final energy, Mtoe/year).

Sector	Measure				Attained savings 2005 – 2012	Expected savings by 2016	Attained objective (%)
	Minimum requirements (according to Legislative Decree 192/05)	White Certificates	55% tax rebates	Mobility incentives and Regulation 443/2009/EU			
Residential	2.10	1.31	0.71	-	3.79	5.16	73.5%
Tertiary	0.06	0.11	0.02	-	0.19	2.11	9.0%
Industry	0.15	1.57	0.04	-	1.76	1.73	101.8%
Transport	-	-	-	0.63	0.63	1.87	33.6%
TOTAL	*2.32*	*2.99*	*0.77*	*0.63*	*6.38*	*10.88*	*58.6%*

Table 10b: Yearly energy savings attained in 2011 – 2012 and expected in 2020 according to SEN (final energy, Mtoe/year).

Sector	Measure				Attained savings 2011 – 2012	Expected savings by 2020	Attained objective (%)
	Minimum requirements (according to Legislative Decree 192/05)	White Certificates	55% tax rebates	Mobility incentives and Regulation 443/2009/EU			
Residential	0.62	0.14	0.21	-	0.96	3.67	26.2%
Tertiary	0.02	0.03	0.01	-	0.05	1.23	4.1%
Industry	0.05	1.04	0.01	-	1.09	5.10	21.4%
Transport	-	-	-	0.22	0.22	5.50	4.0%
TOTAL	*0.68*	*1.20*	*0.23*	*0.22*	*2.33*	*15.50*	*15.0%*

comply with minimum combustion efficiency values prescribed by the law as shown in Table 11.

Heat pumps: seasonal efficiency (combined heating and cooling) should be higher than (75 + 3 log P_n) (%), where P_n is the nominal power output of the heat pump.

Large ventilation systems: the use of heat recovery systems is required whenever the total flow of replacement air (G) and the number of annual hours of operation (M) of the ventilation systems are superior to the limit values prescribed by the law.

For public buildings:

> seasonal efficiency for heating systems should be higher than (75 + 4 log P_n) (%);

> only centralised heating systems are allowed.

These requirements apply to new installations, as well as in case of heating or cooling system renovations or boiler replacement.

In case of boiler replacement alone, as an alternative to compliance with the requirement of seasonal efficiency, it can comply with all the following conditions simultaneously:

> installation of a boiler with a combustion efficiency ≥ (90 + 2 log P_n) (%) or a heat pump that has a yield ≥ (90 + 3 log P_n) (%) (where the heat pump efficiency is the ratio between the energy delivered and the electric energy converted to primary energy, according to the national conversion rate; the efficiency will be higher than 1 whenever the Coefficient of Performance (COP) of the heat pump exceeds the conversion rate);

> installation of thermostatic valves or modulating devices in any room or area which can be favoured by solar free gains;

> installation of a programmable thermostat which allows the adjustment of the indoor temperature on two settings over 24 hours.

Any safety reasons (such as collective flue gas chimneys) preventing the installation of generators with the above foreseen yields, as well as any increases in power generators, will have to be justified by a technical report. For centralised systems, a check of the balancing of the system is required.

The following additional requirements also apply to all new technical systems and renovations:

Installation:

> If the total power exceeds 350 kW, at least two generators should be installed.

> In case of centralised systems serving several building units, the production of heat and DHW should be carried out with different generators.

> Pipework and vessels must be insulated, according to the foreseen minimum insulation requirements.

Dimensioning: the centralised systems producing DHW must be dimensioned according to UNI 9182.

In all existing buildings with more than 4 residential units or otherwise equipped with a centralised system of more than 100 kW, any intervention aimed at the transformation of the centralised heat generation in individual systems for single-dwelling units must be justified by a technical report.

Regulation and control: heating systems in the service of new buildings must be equipped with temperature control systems and metering of energy consumption for each apartment.

The recent transposition of the EED also foresees that, by the end of 2016, in multiple-apartment buildings and multi-purpose buildings supplied by centralised heating and district heating/cooling, it will be required to install individual meters for each housing unit. The installation must be carried out by the companies providing the service and is subject to a preliminary technical assessment.

Table 11: Minimum efficiency values.

	Power range	**Seasonal efficiency**	**Efficiency ratio**			
			at Nominal load		**at Partial load**	
Boiler type	(kW)	Rate (%)	Avg. Water Temp (°C)	Rate (%)	Avg. Water Temp (°C)	Rate (%)
Standard boiler	4 ÷ 400	≥ 75 + 3 log P_n	70°	≥ 84 + 2 log P_n	≥ 50°	≥ 80 + 3 log P_n
Low temp boiler			70°	≥ 87.5 + 1.5 log P_n	40°	≥ 87.5 + 1.5 log P_n
Condensing boiler			70°	≥ 91 + log P_n	30°	≥ 97 + log P_n
Heat pumps		≥ 75 + 3 log P_n				

P_n = 'nominal power' or 'rated power'

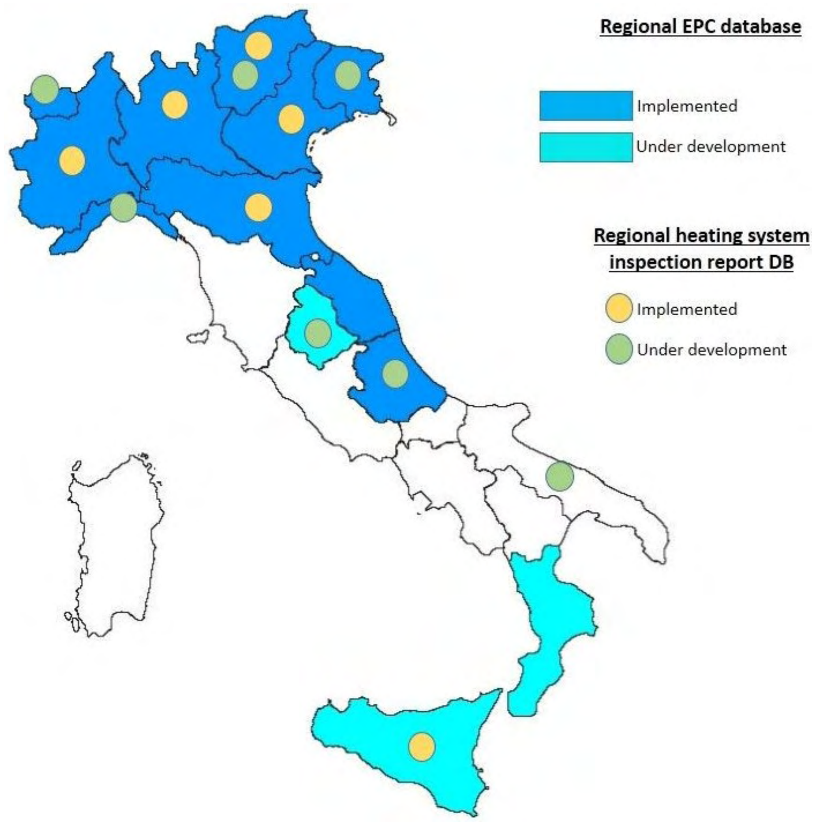
II.iii. Encouragement of intelligent metering

The replacement of existing electricity meters with smart meters has been under implementation in Italy since 2006. The roll-out of smart meters has been almost completed: at the end of 2011, more than 95% (over 30 million) of the customers had smart meters installed on their premises.

In the natural gas sector, the regulatory authority AEEG in 2008 promoted the roll-out of gas smart meters, which by 2016 will be provided to 17.5 million users (Ruling ARG/gas 155/08). At present, the target of 60% replacement of smaller-sized meters (G6 category and smallest) is foreseen to be reached by the end of 2018.

Subject to the measures already adopted, the AEEG should prepare within 24 months the technical specifications for smart metering systems with which the distribution companies will be required to comply. The smart metering devices should provide to end users information on the real-time use of energy and of energy efficiency targets. It is also foreseen that, once the criteria for technical and economic feasibility have been established, the replacement of existing meters will be extended to the fields of district heating, district cooling and DHW supply. At present, smart metering has no link to the EPBD, as it does not affect the energy indicator or inspections.

Figure 3: Regional EPC and heating system databases.



II.iv. Encouragement of active energy-saving control (automation, control and monitoring)

The transposition decree for Directive 2010/31/EU provides that the design, installation and maintenance specifications of active control systems, such as automation, control and monitoring, aimed at energy savings, will be identified by the new decrees expected within the first half of 2015.

Some regions, as part of their legislative autonomy in the transposition of the EPBD, have already issued regulations to this regard. The region of Emilia-Romagna, for example, has enacted minimum levels of active energy savings (the so-called Building Automation Control System – BACS) for new buildings since 2008. All the buildings are actually divided into four classes on the basis of performance of control and automation systems (home automation for energy efficiency).

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The Italian Energy Performance Certificate (EPC) administration system is presently based on regional systems with distinct registries and databases. Ten regional EPC databases were operating by the end of 2013, while three more will be implemented in the near future, as shown in Figure 3. The other regions will adopt a foreseen national database as soon as it is released before the end of 2015.

How flats are certified in apartment buildings

The EPC may refer to one or more housing units that are part of the same building. The certification of the energy performance related to multiple units can be issued only if they have the same intended use typology and the same characteristics influencing performance (orientation, geometry, etc.) and are served by the same thermal systems for winter and summer climatisation.

Format and content of the EPC

The format and content of the national EPC will be updated through the new National Guidelines for Energy Certification of Buildings, expected within the first half of 2015. Pending the update of the format, the current multipage format of the national EPC is shown in Figure 4.

The building energy performance is expressed in terms of primary energy in kWh/m².year for residential buildings and in kWh/m³.year for non-residential buildings. EPC classes range from A⁺ to G. The building performance is expressed for the whole energy used in the building and for the single-end uses: heating, DHW, and cooling. The global energy performance (EPgl) is the sum of partial energy performance indicators.

Figure 5 shows the standard graphic layout of a dashboard. The energy performance for heating is calculated in terms of primary energy. In case of summer cooling, the energy performance refers to the load only because the system performance is not considered. The summer energy performance is calculated as prescribed by Standard UNI/TS 11300 and expressed in terms of primary energy in kWh/m².year for dwellings and in kWh/m³.year for all other uses. In the foreseen update, lighting will be included for non-residential buildings only.

The regions of Emilia-Romagna, Liguria, Lombardia, Piemonte, Toscana, Valle d'Aosta and the autonomous provinces of Trento and Bolzano have developed different regional EPC formats, as shown in Figure 6.

The cost of an EPC is not subject to predefined tariffs. The average EPC cost for a flat ranges from less than 100 up to 300 € according to the location and the taxes/costs imposed by the respective regional scheme.

Figure 4: National EPC format.

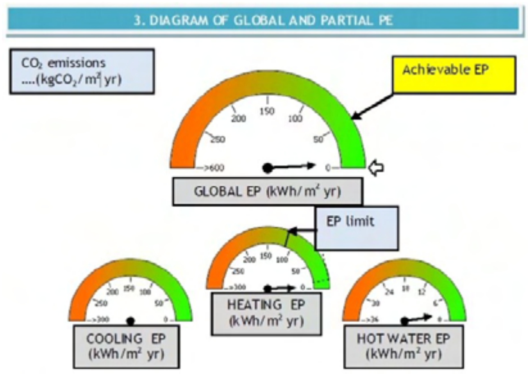


Figure 5: Enlarged view of the Dashboard display portion of the national EPC.

Assessor corps

The national legislation currently in force (Presidential Decree 75/2013) enables some professionals (mainly engineers and architects registered with their respective professional bodies) to issue EPCs, and it requires the completion of training courses for other professionals, which last a minimum of 80 hours and vary according to the degree possessed.

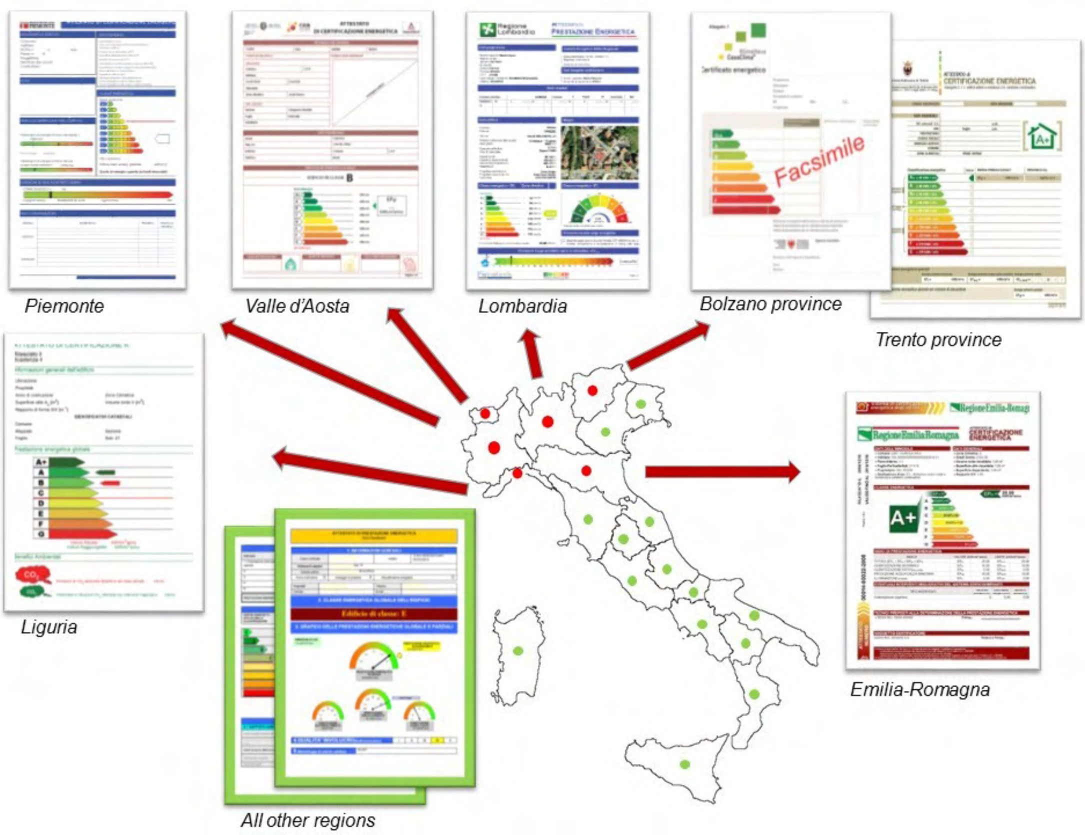


Figure 6: EPC formats in use in the different regions and autonomous provinces.

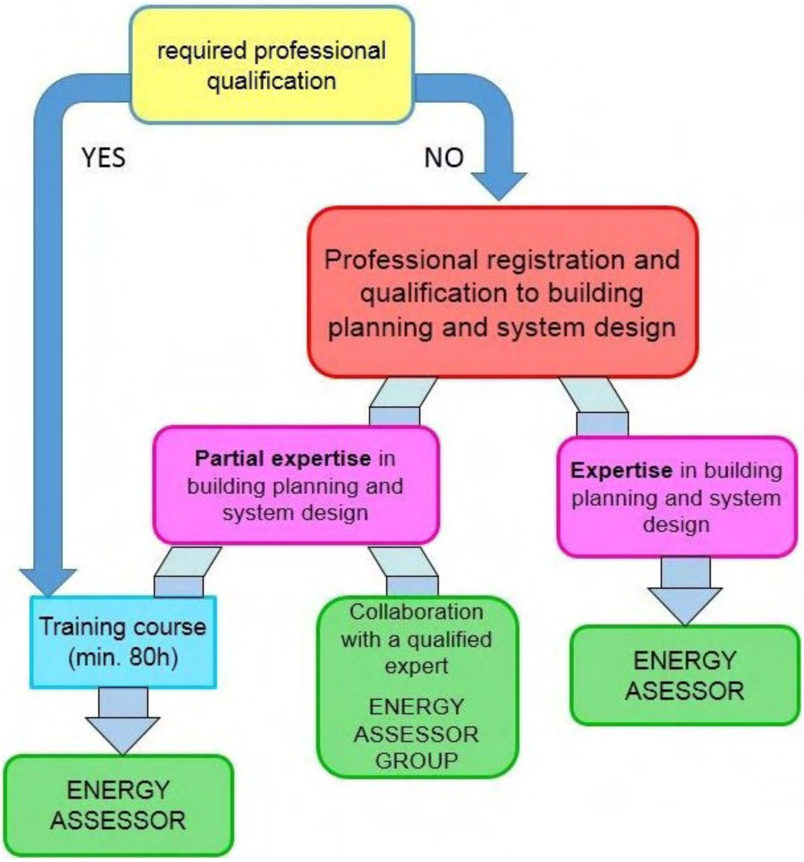


Figure 7: Training scheme for assessors.

Table 12: Training courses for assessors.

Regions and autonomous provinces	Training [1]	Training [2]	Training [3]	Training management [4]	Training management [5]	Examination board [6]	Examination board [7]	Examination board [8]
Abruzzo		●	●		●	●	●	●
Basilicata		●	●					
Bolzano	●			●			●	
Calabria		●	●					
Campania		●	●					
Emilia-Romagna		●	●		●	●		
Friuli Venezia-Giulia		●	●		●	●		
Lazio		●	●					
Liguria		●	●		●	●		●
Lombardia	●				●	●		
Marche		●	●					
Molise		●	●					
Piemonte		●	●		●	●	●	●
Puglia		●	●		●	●	●	
Sardegna		●	●					
Sicilia		●	●					
Toscana		●	●		●			
Province of Trento	●						●	
Umbria		●	●					
Valle d'Aosta		●	●		●	●		
Veneto		●	●					

[1] always compulsory
[2] not compulsory for designers or members of a professional order
[3] compulsory for other profiles only
[4] directly managed by regional / autonomous province
[5] managed by accredited external entity
[6] external QEs
[7] representatives of the region
[8] university

Missing information
Under definition

If a technician is not qualified to properly evaluate the building design and all its technical systems, he should work in collaboration with other qualified technicians so that the constituted group covers all required areas of professional expertise.

Those who, on the basis of educational qualifications, do require a training course must undergo a final examination which, if successful, will give them the right to issue EPCs (a flowchart is shown in Figure 7).

When issuing an EPC, the qualified experts must declare that they have no direct or indirect involvement in the design or construction process of the building to be assessed, nor with material and component suppliers, nor with any sort of benefit possibly obtained by the owner. In case of new buildings, the person in charge of the energy certification process must be nominated before the building works begin.

In some of the regions which have autonomously implemented the EPBD, different requirements are still presently in force, in particular regarding the obligation for all assessors to attend a training course and register in the regional registers. Tables 12 and 13 illustrate the various situations of regional registers.

Compliance levels by sector

Statistical data about the overall compliance levels recorded during the control phase of the EPC is currently not available.

Enforcement with building owners and real estate actors

In case of sale, lease or even property transfer without charge, the owner is required to provide the building/flat with an EPC. Failure to provide the document carries a penalty of between 3,000 and 18,000 € in case of a sale, and between 300 and 1,800 € in case of lease, enforced by the *Guardia di Finanza* (Financial Police).

In case of lease, the requirement to attach the EPC to the contract only applies to contracts for entire buildings. The payment of the administrative penalty, however, does not exempt persons from the obligation to subsequently submit a copy of the EPC.

The possession of the EPC is also a necessary condition in order to obtain access to the tax deductions schemes in force for energy improvements on existing buildings.

No statistical data is available on the number and amounts of penalties issued.

Quality Assurance (QA) of EPCs

The decree for the transposition of the Directive 2010/31/EU entrusts the control on the quality of issued EPCs to regions and autonomous provinces. At the moment, only a few institutions have started the task of controls, often still on an experimental basis. The methods of control are determined by the institution and may include formal checks and/or audits with substantial testing in situ.

The data available on the EPCs issued and the number of controls carried out in 2013 are reported in Table 14, totalling 28,025 controls.

Reliable data on controls results is available only for some regions. As an example, Tables 15 and 16 list the results of controls performed in the Piemonte and Liguria regions in 2013 respectively.

In case of a negative outcome of the control, the penalties range from 500 to 2,000 € to be paid by the assessor who issued the EPC.

Table 13:
Regional registers of energy assessors.

Regions and autonomous provinces	Registers of energy assessors		
	Available	Not available	Envisaged
Abruzzo	●		
Basilicata		●	●
Bolzano		●	
Calabria			●
Campania		●	
Emilia Romagna	●		
Friuli Venezia Giulia		●	
Lazio		●	●
Liguria	●		
Lombardia	●		
Marche		●	
Molise		●	
Piemonte	●		
Puglia	●		
Sardegna		●	
Sicilia	●		
Toscana		●	
Trento	●		
Umbria		●	●
Valle d'Aosta	●		
Veneto		●	

Table 14:
EPCs issued and controls performed – year 2013.

EPCs at national level (2013)	Number of EPCs	% on the total
Number of EPCs issued (year 2013)	419,650	-
Number of EPCs controlled through **random selection**	26,821	6.39%
Of which		
Number of EPCs -> option A control	26,449	6.30%
Number of EPCs -> option B control	4,059	0.97%
Number of EPCs -> option C control	283	0.07%
Number of EPCs controlled - selection **other than random**	1,204	0.29%
Number of EPCs controlled - overall	*28,025*	*6.67%*

Table 15:
EPCs issued and controls performed in the region of Piemonte – year 2013.

2013 EPC Controls Region of Piemonte	Number	%
Type of control	option a), point 1 annex II 2010/31/EU	
ACE/APE not conforming	2,214	24.62%
ACE/APE conforming	6,779	75.38%
Total controls performed	8,993	100%

Table 16:
EPCs issued and controls performed in the region of Liguria – year 2013.

EPC controls Region of Liguria	Year 2013
Total number of EPCs issued in the year	42,473
Number of EPCs randomly selected for control	200
Type of control	option c), point 1 annex II 2010/31/EU
Controlled EPCs	182
Positive outcome	137
Negative outcome	45
Cancelled EPCs	18

III.ii. Progress and current status on public and large buildings visited by the public

Overview

In Italy, public buildings (i.e., used by public administrations and open to the public) with a total useful floor area greater than 500 m^2 (250 m^2 since 7 September 2015) had to issue an EPC by 2 December 2013 and display it in a prominent place clearly visible to the public. There are no sanctions for non-compliant administrations. The format and content of the EPCs related to public buildings are the same as for private buildings.

All contracts, new or renewed, related to the management of heating systems or air-conditioning (AC) systems in public buildings, or in which the client is listed as a public entity, require the issuing of an EPC of the building or building unit concerned.

Where the EPC is available, it is required to post the certificate in a prominent place clearly visible to the public. In some regions (Abruzzo, Lombardia, Puglia, Valle d'Aosta) and in the autonomous province of Trento, it is mandatory that public buildings display a plaque with the energy efficiency rating outdoors.

In the framework of the collaboration between the Ministry of Economic Development and the State property Office, starting in the early months of 2013, Italy initiated the preparation of an inventory of property ownership and use of the central state public administration buildings. The inventory, still in the validation phase, produced to-date figures shown in Table 17. No data about the number of EPCs in public buildings actually produced and/or exposed is presently available.

Building area class	Number of buildings	Gross area (m²)	Thermal consumption (GWh)	Electric consumption (GWh)
A > 500 m²	2,904	13,763,975	1,398.2	695.6
250 m² < A < 500 m²	1,176	437,227	44.4	22.1

Above figures do not include: army buildings, church buildings, buildings protected by historical or architectural restrictions.

Presently, no data is available for local administrations building property

Source: ENEA extrapolations of State property Office *data*

Table 17: Buildings that are property of the central state public administration.

The maximum validity of the EPCs related to public buildings is 10 years (the same as for other buildings). The EPCs must be updated after any renovation or alteration modifying the energy class of the building or building unit is carried out.

No data about the cost of EPCs in public buildings is presently available.

Public buildings or buildings open to the public can be certified by experts with the same characteristics as for other buildings. If the technician is an employee of a public body or a body governed by public law operating in the energy and construction sectors, and he is acting on their behalf, the QE is automatically deemed to have no conflict of interest.

The EPC related to public buildings is subject to the same control system as provided for all other EPCs by the regions and autonomous provinces. Presently, there is no specific data regarding the non-compliance of EPCs of public buildings.

III.iii. Implementation of mandatory advertising requirement

The legislation in force provides that, in case of an offer for sale or lease, the corresponding announcements by all means of communication report the energy performance indexes of the overall building, or of the single unit and the corresponding energy class since 29 March 2011. The law specifies that sanctions could be issued after 6 June 2013. The management of sanctions is entrusted to the regions and there is no information available regarding any sanctions ever having been issued.

A fine between 500 and 3,000 € issuable to the party responsible for the announcement applies in the event of non-compliance. The same law (Presidential Decree 75/2013) provided that the update of national guidelines for the energy certification scheme shall include a model of notice of sale or lease for display in the real estate agencies, in order to make information on the buildings' energy quality supplied to citizens uniform.

III.iv. Information campaigns

The legislative decree transposing the EPBD entrusts to the Ministry of Economic Development the task of creating communication campaigns targeting the general public and construction and real estate markets on the topics of energy savings. The decree also gives to the regions and autonomous provinces the power to carry out information campaigns for raising awareness of the citizens concerning the issues of upgrading the energy efficiency of existing buildings. Communication campaigns can be in collaboration with the electricity and gas distribution companies involved in pursuing their own obligations (arising from the mechanism of white certificates).

Presently, the ministry, in collaboration with the ENEA, is preparing two information campaigns on energy certification: one for citizens tentatively titled 'Program of National Circulation EPC' and one addressed to the estate agencies tentatively titled 'Campaign Diffusion at EPC Network Estate Agents'.

Among the most recent regional information campaigns on issues of energy and energy certification, Figure 8 reproduces a poster of the region of Umbria (www.umbriapiu.it).

Tax deductions schemes dedicated to the energy renovation of existing buildings have recently been the subject of a communication campaign of the Italian government that included television commercials, radio and website info campaigns (www.casa.governo.it).
The TV spot is visible at the following link: www.casa.governo.it/tematiche/Spot.html

The main campaign on energy efficiency currently in progress was made by the state broadcaster company, RAI, which produced the TV spot 'Energy Efficiency: An Italian success (thanks to Europe)'. The spot underlines in particular the role Europe played in supporting the country in achieving relevant results over the past decade. The campaign started in April 2014 and the spot is visible online.[2]

A national communication plan is under preparation, in order to foster the best use of the funds foreseen by Decree 102/14 for energy efficiency information campaigns.

[2] *www.rai.tv/dl/RaiTV/programmi/media/ContentItem-024e265f-a24a-49b4-b0d2-b5aaf5a02e05.html#p*

III.v. Coverage of the national building stock

A preliminary estimate of the coverage can be outlined on the basis of the official data of the last census ISTAT 2011; civil housing units in Italy total more than 29 million, while the certificates issued until 31 October 2014, taking into account only the regions that provided data, totalled 3,637,166, of which more than 90% were in northern Italy and 40% were in the Lombardia region alone. The number of issued EPCs is not presently available for all regions (see Table 6).

Assuming that the EPCs were produced in the great majority of cases for individual homes, and considering the low incidence of issuance in absolute numbers for non-residential buildings (less than 150,000 units), it is thus possible to roughly estimate that, by the end of 2013, only approximately 13% of existing buildings had been energy certified. The EPCs issued in 2013 totalled 419,650. The situation is summarised in Figure 9.

Figure 8: Regional information campaign logo 'Umbria+'.

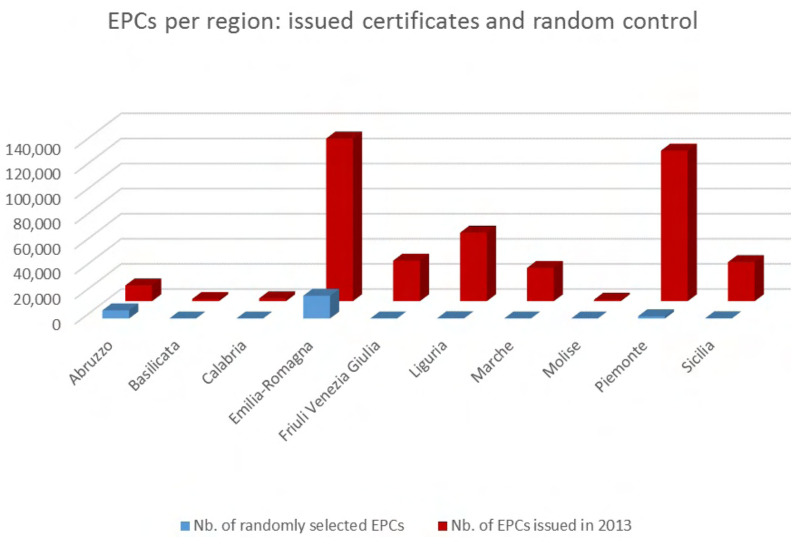


Figure 9: EPCs issued (red) and controlled (blue) per region.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

Boiler inspections were launched in Italy back in 1993, as required by Law 10/1991.

Recently, Decree 74/2013 set the basis for a new framework introducing new operating methods and frequencies of mandatory maintenance activities, standardised control procedures related to thermal systems and AC systems, a new common log book template for thermal and AC systems, and indicating regions and autonomous provinces as the competent authorities for controls (which was previously assigned to provinces and cities).

The law requires all heating systems with thermal output equal or greater than 10 kW[3] to undertake maintenance and inspection. Inspections include an energy efficiency assessment of the boiler, a power-sizing check and advice on possible measures to improve system efficiency.

Maintenance staff produce an inspection report and deliver it to the owner and also to the competent authority which is in charge of setting a regional inventory and of running periodic controls. Controls consist of documental checks on the reports and of on-site verifications. After on-site verification, a report is to be released and one copy attached to the log book. The following control intervals are foreseen:

> systems with liquid- or solid-fuelled generators with thermal output over 100 kW: every two years;
> systems with liquid- or solid-fuelled generators with thermal output between 20 and 100 kW: every four years;
> systems with gas generators with thermal output over 100 kW: every four years;
> systems with gas generators with thermal output less than 100 kW: controlled through a check of inspection reports.

Competent authorities are in charge of running compliance controls. Control procedures can be assigned to external controllers or qualified bodies meeting the independence, competence and training requirements set by Decree 74/2013. Regions and autonomous provinces have the task of setting a proper accreditation scheme and ensuring qualification and retraining. To do this, they can be assisted by the collaboration of the ENEA. On the other hand, maintenance operators are also trained through professional associations.

[3] *For boilers fed by solid or liquid fuels between 10 kW and 20 kW, the law does not specify a % of compulsory control frequency, leaving this decision to the regional authorities in charge.*

Figure 10: Local information campaign on control of heating systems for the municipality of Roma www.controlloimpiantitermici.com

Figure 11: Local information campaign on control of heating systems for the province of Milano www.provincia.milano.it/ambiente/energia/impianti_termici/calorefficienza

Local administrations have generally experienced difficulties in providing regular on-site controls. However, there are positive examples, where up to 5% of the total systems were checked every few years as required by the former legislation. Studies performed by some local administrations (e.g., the city of Florence) estimate that the potential energy savings are as high as 6% of the overall heating consumption.

There is however no data available concerning the cost-benefit from inspections at a national level. According to the consumer association 'Altroconsumo', the maintenance and inspection cost for small autonomous heating plants (below 35 kW) is on average above 100 €. Frequency and costs of maintenance depend on the power and fuel of the heating system.

Promotional activities

Competent authorities have the duty to promote information and public awareness campaigns. Figures 10 and 11 show two ongoing campaigns carried out by the municipality of Roma and the province of Milano, respectively.

Enforcement and penalties

The person in charge of the installation (owner or tenant of the property, or the administrator of the building) failing to follow the maintenance schedule laid down in the decree for the maintenance and control of the thermal efficiency of the heating system can be levied a penalty of between 500 and 3,000 €.

Similarly, any company not performing the assigned maintenance and inspection services will be levied a fine of between 1,000 and 6,000 €. The regional government is due to report the violation to the chamber of commerce for appropriate disciplinary measures.

Failure to perform maintenance and testing of energy efficiency of the heating system with the minimum frequency required by law voids the validity of the EPC of the building or housing unit.

Presently, there is no statistical or aggregate data available on a national scale about the penalties imposed. However, Decree 75/2013 foresees that by 31 December 2014, competent authorities will transmit to the Ministry of Economic Development and to the Ministry of the Environment a report with particular reference to the results of inspections carried out in the last two years. The report will be updated every two years.

Quality control of inspection reports

It is up to the competent authorities to start annual compliance check programs of the inspection reports. In case the inspection report bears indication of safety issues, the regional authority shall immediately inform the competent municipality and relevant health and safety body.

There is no aggregated quantitative data available on a national scale.

Inspection activity figures

There is no aggregated quantitative data available on a national scale for inspection activity. Only the province of Milano has published updated information on the last inspection campaigns. The report published by the province of Milano relates to the former procedural framework. Table 18 provides inspection figures, while Table 19 classifies inspection reports according to the type of action required.

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

Decree 74/2013 extended the mandatory operations of maintenance, inspection and control set for heating systems to AC systems. The inspection and control framework follow the same patterns and procedures provided for heating systems.

The law requires all AC systems with thermal power equal or greater than 12 kW to undertake compulsory maintenance and inspection. Inspections include an energy efficiency assessment of the generator, a check for proper power sizing and advice on possible measures to improve the system efficiency (based on a cost-benefit analysis).

Maintenance staff shall produce an inspection report and deliver it to the competent authority which is in charge of setting an inventory and running compliance controls similar to those set for heating systems. Inspections should cover 100% of the installed AC systems with thermal power higher than 100 kW every four years. Checks on inspection reports may fully substitute on-site visits for gas systems with power lower than 100 kW.

The procedure requires that the maintenance professional in charge of the system, during its energy efficiency inspections at mandatory minimum intervals (similar to those provided for heating systems), should intervene whenever energy efficiency parameters are lower by more than 15% compared to nominal data. The machines will have to be returned to the original parameters with a tolerance of 5%.

Competent authorities in each region are in charge of running compliance controls. Similar to the inspections for heating systems, control procedures can be assigned to external controllers or qualified bodies meeting the independence, competence and training requirements set by Decree 74/2013. An accreditation scheme for controllers and controlling bodies is not yet operational in most regions. It must be set in place by each regional authority, with qualifications and retraining ensured.

No data is yet available concerning cost-benefit from inspections at any level. Local administrations have generally experienced difficulties in providing regular on-site controls.

Promotional activities

The promotion is entrusted to the local authorities. Figure 12 reports the local information campaign carried out by the province of Savona, Liguria.

Enforcement and penalties

The enforcement and penalties for AC systems inspections are the same as those set for heating systems.

Inspection reports received	Number	Var. %
Campaign 2009/2011	173,251	-
Campaign 2011/2013	203,986	+ 17.7 %

Table 18: Province of Milano, heating system inspection campaigns.

Table 19: Province of Milano, control on heating system inspection reports.

Anomalies classification	Total	%
Safety issues (need for immediate action)	4,258	2
Combustion efficiency below the legal minimum	2,044	1
High priority	21,314	11
Medium priority	9,504	5
Low priority	149,371	81

Figure 12: Province of Savona, local information campaign on control of AC systems *www.tecnocivis.it*

Presently, there is no statistical or aggregate data on levied penalties available on a national scale.

It is up to the competent authorities to start annual compliance check programs of the inspection reports. At the end of 2014, only very few regions have started test-phase inspection and control campaigns on AC systems. There is no aggregated quantitative data available on a national scale.

3. A success story in EPBD implementation

In Italy, the, tax deductions available in 2014 have been in effect since 1 January 2007 without interruption, and they are designed solely for the energy refurbishment of existing buildings. The deductions are available for homeowners and tenants, and for businesses (deductions limited to buildings used for their activities).

The encouraged interventions concern the replacement of winter heating systems with condensing boilers or efficient heat pumps, replacement of lighting fixtures, the installation of solar thermal systems and insulation interventions of roofs, walls and floors. The so-called 'comprehensive renovation' (also covered) is expected to apply to an entire building, with no constraints on the technologies used, but with the need to certify (at the end of the works) that the overall energy performance is within the limits set by the state.

To be eligible for tax deductions, any intervention is bound to comply with certain performance requirements, which vary according to the type of operation and are set to be more demanding than the minimum requirements prescribed by law and pursuant to the decree of the adoption of the EPBD. In order to qualify, it is necessary to provide an EPC after the intervention.

The rate of the deduction, originally fixed at 55% of the expenditure, was further increased to 65%, in effect from 6 June 2013. Part of the cost incurred by the Italian government for granting the deduction is recovered from the generated stimulus to economic growth and from the potential tax evasion avoided in work commissioned to engineering and construction companies.

To take advantage of the deduction, it is necessary to communicate via the web a number of technical and economic data to the ENEA, which periodically issues a report on the costs and results of the deduction. The following data is from the report published in 2014, containing the overall data until the year 2012.

Main achievements for the year 2012:

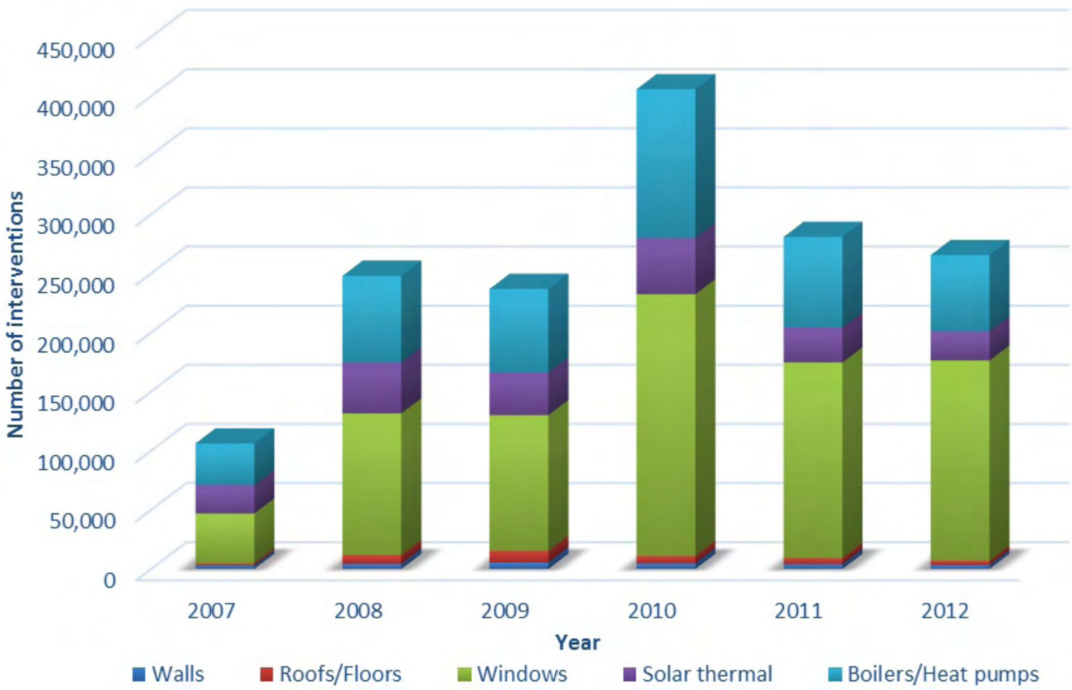
> 265,400 total applications;
> total investment of more than 2.8 M€;
> total value of the deducted amounts over 1.58 M€;
> overall energy savings in primary energy exceeding 1,260 GWh/year;
> avoided CO_2 emissions into the atmosphere of about 270,000 tons/year.

Main overall results (2007 – 2012):

> about 1.5 million applications;
> energy savings produced more than 9,000 GWh/year;
> environmental benefit in terms of avoided CO_2 emissions into the atmosphere more than 1,900,000 ton/year;
> approximately 6.2% of Italian estate property involved in a cycle of energy improvement (partial or total), which has been able to take advantage of tax deductions of 55% or 65%.

The highest number of interventions over the years has been the replacement of lighting fixtures, while the greatest contribution to energy savings achieved can be attributed to the interventions carried out on winter heating systems. The overall results are summarised in Figures 13 to 17.

Figure 13: Number of interventions per type of renovation: 2007 – 2012 trend.



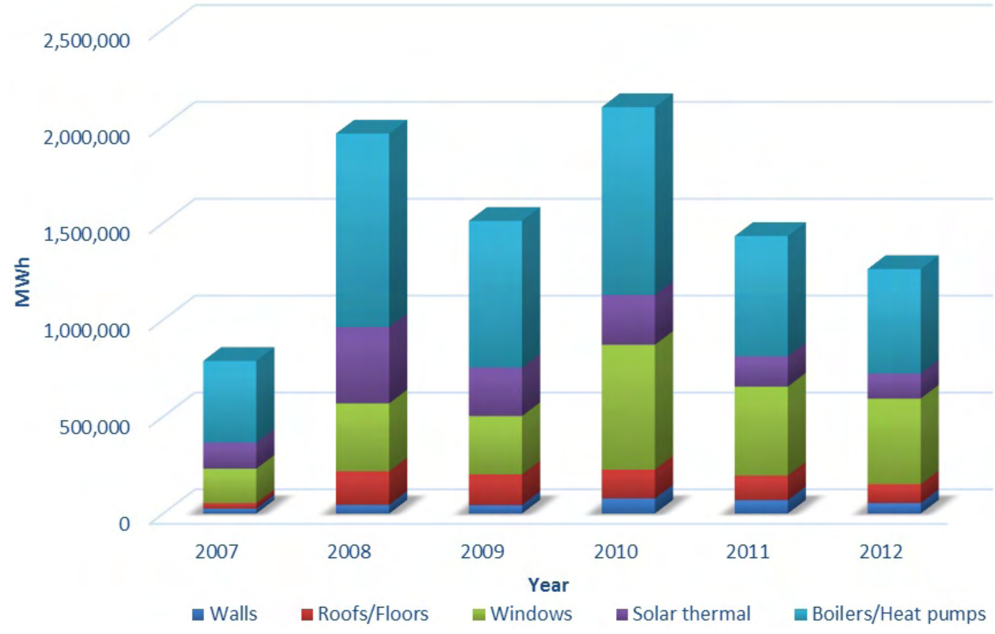


Figure 14: Energy savings per type of renovation (MWh/year): 2007 – 2012 trend.

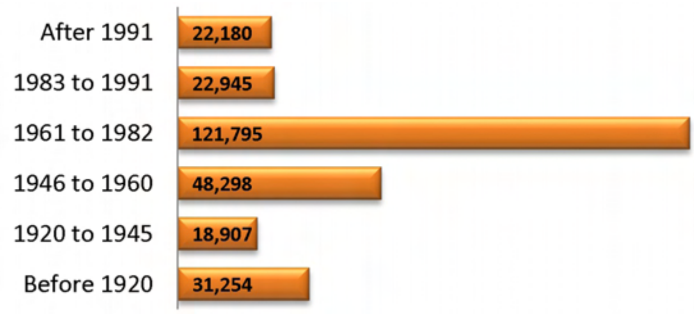


Figure 15: Buildings renovated in 2012 per year of construction.

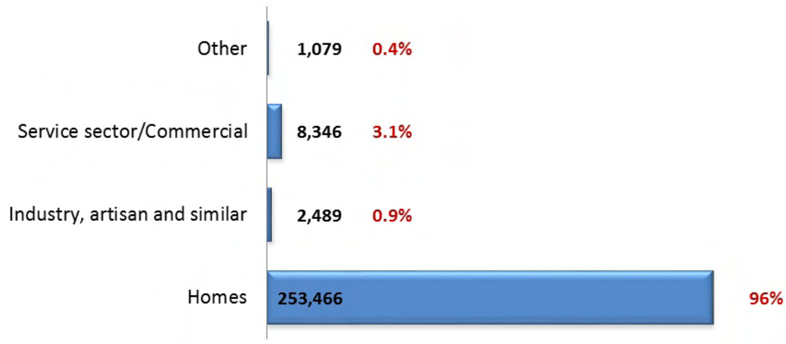


Figure 16: Buildings renovated in 2012 per use.

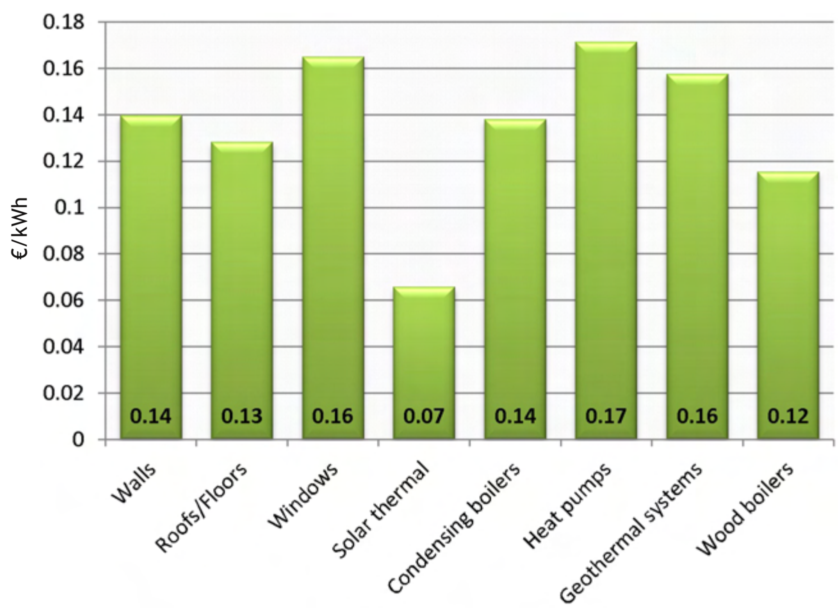


Figure 17: Average cost of saved kWh per type of renovation (€/kWh).

4. Conclusions, future plans

The new implementation decrees, which should be issued in 2015, will define the new methodologies for the calculation of the energy performance in buildings, the criteria to be met by NZEBs, and the new minimum requirements to be applied to new buildings and renovations, according to cost-optimal criteria.

The first estimates performed by the ENEA have verified that the cost-optimal requirements should make minimum overall performance significantly more stringent for new buildings. This result, combined with the increasing contribution of RES progressively required by the decree transposing the RES directive already in place (the next step of 1 January 2017 foresees that 50% of the needs for heating, cooling and hot water has to be provided through RES), will contribute to the gradual approach towards a desired NZEB-era, and to the establishment of a credible action plan for further construction of these buildings.

All the latest decrees issued by the government to transpose the EPBD foresee a gradual legislative convergence of regions and autonomous provinces to the national legislation. This work on legislation, along with the creation of national databases for EPCs and heating systems inspections reports, will also reduce fragmentation of data and facilitate the monitoring of the implementation of the EPBD.

Implementation of the EPBD in Latvia

STATUS IN DECEMBER **2015**

1.Introduction

In Latvia, the implementation of the Energy Performance of Buildings Directive (EPBD) is the overall responsibility of the Ministry of Economics. The Ministry of Economics develops and implements the national energy efficiency policy, including the transposition of the EPBD. The necessary laws and regulations for the transposition of the EPBD (Directive 2010/31/EC) that were adopted at the end of 2014 and are still in force are:

- *the Law on the Energy Performance of Buildings (LEPB) that was adopted in the Latvian Parliament Saeima and came into force on 9 January 2013;*
- *the amendments to the Latvian Building Norm LBN 002-01 "Thermal requirements of the buildings envelopes" (LBN 002-01), setting out new minimal requirements for energy performance of buildings, which came into force on 22 April 2014. These requirements were again readopted in the Latvian Building Norm LBN 002-15.*

This report presents an overview of the current status of the implementation of the EPBD in Latvia. It addresses the requirements for energy performance of buildings, for technical building systems, for Energy Performance Certificates (EPCs) and for inspection, experiences in EPBD implementation, as well as future plans.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Energy performance requirements for external building envelope structures have been set since 2003, through the LBN 002-01 that was then replaced in 2015 by LBN 002-15.

I.ii. Format of national transposition and implementation of existing regulations

Regulations

Minimum energy performance requirements are laid out in LBN 002-15 and Cabinet Regulation Number 907 of 28 September 2010 "Regulations Regarding the Survey, Technical Servicing, Current Repairs and Minimal Requirements for Energy Efficiency of the Residential House".

Requirements for EPCs, requirements for inspections, and requirements for Nearly Zero-Energy Buildings (NZEB) are set in Cabinet Regulation No. 383 of 9 July 2013 "Regulations regarding Energy certification of Buildings".

Energy performance methodology requirements are set in Cabinet Regulation No. 348 of 25 June 2013 "Building energy performance calculation method".

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Requirements for independent experts are set in Cabinet Regulation No. 382 of 9 July 2013 “Regulations Regarding Independent Experts of Energy Performance of Buildings”.

Climate conditions in Latvia are described in Cabinet Regulation No. 338 of 30 June 2015 “Regulations regarding the Latvian Building Norm LBN 003-15 - Construction Climatology” (LBN 003-15).

Minimum energy performance requirements

LBN 002-15 requirements determine normative and maximum permissible heat loss of building elements (U-values) and of whole buildings, for three types of buildings:

> residential buildings, hospitals, kindergarten;
> public buildings (excluding hospitals and kindergartens);
> industrial buildings.

The minimum requirements apply for newly built, reconstructed and renovated heated buildings, as well as for new heated spaces to be added to existing buildings when their temperature during the heating season is maintained at 8 °C, or higher. Since 2003, requirements include calculation of the temperature factor k, which takes into account conditions of different climate zones and different indoor temperatures, which means that each building has different minimum energy performance requirements. Latvia is divided into ten climate zones, as defined in LBN 003-15. The amendments to LBN 002-01 from 22 April 2014 establish the minimum requirements for the external envelope structures of buildings closer to the cost-optimal level (Tables 1 and 2).

In Latvia, minimum energy performance requirements are set for building elements which are part of the building envelope, and, until November 2015, there are no energy consumption level requirements applied for newly built, reconstructed and renovated heated buildings. Regulation No. 907 determines the minimum energy performance requirements for existing residential buildings, i.e., the permissible energy performance level of a building, to be met, if necessary, through the uptake of energy performance improvement measures. The regulation decrees that the residential building administrator or owners shall plan measures for improving energy efficiency, including renovation, if the average thermal energy consumption of the house, during the last three calendar years, has exceeded 200 kWh/m².year or 150 kWh/m².year, if the heat is only used for house heating. The calculation of the average heat consumption of the last three calendar years takes into account the effective area of the building to be heated.

Table 1: Change of requirements for the building envelope of residential buildings and approximate energy consumption for heating.

Envelope element	W/m².K	1980	1992	2003	2014 (values after cost-optimal study)
Roof		0.90	0.33	0.20k	0.15k
Floor		1.10	0.50	0.25k	0.15k
Wall		1.10	0.42	0.30k	0.18k
Window		2.40	2.20	1.80k	1.30k
Door		2.40	2.20	1.80k	1.80k
Thermal bridges	W/m.K	0.90	0.60	0.20k	0.10k
Energy consumption for heating	kWh/m².year	150 - 200	100 - 130	70 - 90	60 - 80

Table 2: Requirements (normative/ maximum) for the building envelope after the cost-optimal study.

Heat Transmission coefficients / Type of building	Residential, homes for elderly, hospitals and kindergartens	Public, excluding pensions, hospitals and kindergartens	Industrial
Envelope U_{RN} / U_{RM}	W/m²·K		
Roofs	0.15k/0.20k	0.20k/0.25k	0.25k/0.35k
Floors	0.15k/0.20k	0.20k/0.25k	0.30k/0.40k
Walls	0.18k/0.23k	0.20k/0.25k	0.25k/0.30k
Windows	1.30k/1.80k	1.40k/1.80k	1.60k/1.80k
Doors	1.80k/2.30k	2.00k/2.50k	2.20k/2.70k
Thermal bridges	W/m.K		
	0.10k/0.15k	0.15k/0.20k	0.30k/0.35k

k - temperature factor $k = 19/(\Theta i - \Theta e)$, depends on the indoor and outdoor air normative temperature values.

Note: The actual value for separate building elements may not meet the normative value, but the entire building must meet the total normative value.

Energy performance methodologies

The energy performance calculation methodology is applicable for new and reconstructed buildings, as well as for existing buildings, and is described in Regulation No. 348 of 25 June 2013.

The energy performance calculation methodology is based on the corresponding CEN/TR 15615:2009, on standard EN ISO 13790:2008 conditions, and it also includes references to the 16 other standards.

The energy performance calculation methodology includes primary energy factors of non-renewable energy, using the values specified in DIN V 18599-1: 2011-12. These values have been customised in accordance with the Institute of Physical Energetics experts' calculations according to Latvian conditions. In general, the methodology prescribes the way to determine energy performance of the building, including variable calculation components. For example, thermal comfort requirements are set by other legal regulations for labour protection and hygiene, depending on building type and usage, whereas infiltration and air exchange rates are set by other building norms, values for thermal bridges are set by ISO standards, and values for shading coefficients and other often used parameters are set by annexes to Regulation No. 348. This regulation also contains references to LBN 002-15 and LBN 003-15, to include minimum energy performance requirements and climate conditions in building calculations. There are no officially approved guidance documents for calculating the energy performance requirements, but training materials issued by universities and certification institutions of independent experts can be used.

The construction company and each expert individually are responsible for building in compliance with the normative requirements. Regulation No. 382 includes requirements for independent expert activities. This regulation provides the competence requirements for independent experts, the procedures for certification, the procedures for registering and monitoring, as well as the data to be included in the independent expert register and the procedures of use of such data, as well as a penalty point system. At this stage, Latvia does not have an actual control system for compliance with energy performance requirements. Still, for each significant public building project (more than 100 visitors per day), a compliance check for energy performance requirements is carried out. Also, in every project claiming European funding, energy performance compliance is required. In any other building, if a complaint is received, the certification body has to check the EPC, energy audit or inspection report received by the independent expert. In the case of a violation, the certification body could apply penalty points. If the independent expert has 10 or more penalty points, he/she may be suspended for up to one year. If the independent expert has between 7 and 9 penalty points, he/she is suspended for 6 months. Since 2009, more than 60 cases have been initiated and, in approximately 30 cases, the certification body decided to suspend the independent expert.

The EPC register was completed in 2015, but certain legislative improvements are still necessary. The EPC registration software system is planned to begin running on 15 January 2016[1]. The software will allow for the issuing of EPCs and inspection reports, will provide for yearly random compliance checks, will act as a platform for communication between certification bodies, independent experts, and building owners, and will provide EPC statistical data, as well as average levels of energy consumption. This software will be included in the Building Information System (BIS).

I.iii. Cost-optimal procedure for setting energy performance requirements

To fully comply with the requirements of Directive 2010/31/EU according to the Regulation (EU) No. 244/2012 and its guidelines, calculations were done at the end of 2013 to determine cost-optimal energy performance requirements for new and existing buildings. According to these calculations, the existing minimal requirements in most types of buildings and building elements did not meet Latvia's cost-optimal energy performance requirements. Amendments to LBN 002-01 from 22 April 2014 established new minimal energy performance requirements to move closer to cost-optimal levels, with an average improvement of 40% against 2003 requirements (see Table 2). The cost-optimal procedure also showed that the Latvian NZEB definition level is not achievable in an economically feasible way, so these requirements need to be reviewed.

[1] *https://bis.gov.lv/bisp/lv/epc_documents* and *https://bis.gov.lv/bisp/lv/expert_certificates*

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

In accordance with the LEPB, a NZEB is now defined as a building with a very high energy performance, using high efficiency systems for its energy supply. Detailed requirements for NZEBs are set out in Regulation No. 383, that states that new and renovated class A rated buildings are considered NZEBs if they meet the following requirements:

> the final energy demand for heating does not exceed 30 kWh/m^2.year, simultaneously ensuring indoor climate conditions in accordance with construction laws and requirements, as well as hygiene and labour protection requirements;

> the total primary energy consumption for heating, hot water supply, mechanical ventilation, cooling and lighting does not exceed 95 kWh/m^2.year;

> high-performance systems are used in the building, which:
  - provide at least 75% of ventilation heat recovery during the heating period;
  - provide at least partial use of renewable energy;
  - there is no low-efficiency fossil fuel heating system installed in the building.

According to the cost-optimal study, these requirements, set in 2013, are not attainable in an economically reasonable way. Therefore, Latvia is developing another study to produce a new NZEB definition and values in 2015.

Figures and statistics on existing NZEBs

Experience in the construction of low energy buildings in Latvia began in 2012, when the Ministry of Environmental Protection and Regional Development started a project called “Low energy buildings” (LEB) within the Latvian governmental programme “Climate Change Financial Instrument (CCFI)”.The LEB project supported the construction of new buildings and the reconstruction of existing ones to achieve target values. Within the LEB, 14 different projects were realised for different building types. Almost all projects were finished in 2013. Monitoring results of the implemented CCFI projects after one year of NZEB operation/exploitation (at the end of 2014) will be evaluated and will allow Latvian authorities to develop further targets for NZEB (Figure 1).

Figure 1: Images from Low Energy Buildings (LEB) financed by the “Climate Change Financial Instrument (CCFI)” Latvian governmental programme.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

In 2014, Latvia developed a long-term strategy for building renovation. This strategy[2] includes information about Latvian building stock statistics, policies and measurements for the promotion of building renovation and Latvian objectives for energy performance.

Since 2012, Latvia annually collects information about the energy performance of central government buildings. A list of the central government buildings that do not meet minimum requirements is published[3].

To meet the 3% renovation rate of the total floor area as mentioned in Article 5 of the EED, Latvia has since 2012 renovated 232,635.36 m^2 of central government buildings, which fulfils the Latvian 3% target rate until 2017. After 2017, Latvia is planning a programme for central government building renovation that should begin in 2016.

[2] https://ec.europa.eu/energy/sites/ener/files/documents/2014_article4_en_latvia.pdf
[3] www.em.gov.lv/files/majokli/DIR.pdf

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

Energy performance requirements for ventilation, cooling, lighting and hot water systems in Latvia are not yet exactly defined. The "Latvian Building Norms and Construction Law" gives specific system values, which affect energy performance ratings, but it does not specify the precise energy performance rating levels of those systems. The systems have to be designed in such a way that under normal operating conditions during the entire period of operation, energy consumption shall be as low as possible. Systems should also be designed and installed in such a way that their efficiency should not be below the applicable standards.

A section on equipment control and automation systems should be included in the Latvian plans for technical design of new buildings and renovation. EU funds and national competitions support the installation of intelligent energy metering and energy substation (heat and electricity) automation projects. Recently, the implementation of such system renovation projects has been increasing.

In 2012, Latvia carried out a cost-benefit analysis of smart metering implementation, for both electricity and gas sectors. The analysis showed that the introduction of smart metering is economically reasonable for some industrial customers in the commercial sector, but it is not justified for households.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

Energy performance certification of buildings is regulated by the LEPB and Cabinet Regulation No. 383 and is supervised by the Ministry of Economics.

The LEPB mandates that certification of the energy performance of residential or non-residential buildings must be undertaken in the following circumstances:

> a building under design, reconstruction or renovation, in order to approve it for use or sale;

> an existing building for sale, rent or lease, if certification of the energy performance is requested by the purchaser, tenant or lessee;

> an existing public building under state or local government ownership, the heating area of which exceeds 250 m².

How flats are certified in apartment buildings

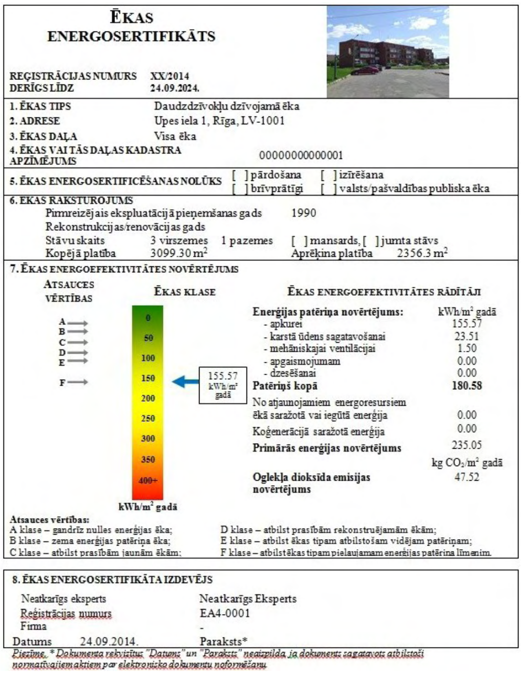
The LEPB mandates that certification for an individual building unit has to be performed only if thermal energy is accounted for individually, otherwise, a single EPC applies to the whole building.

Format and content of the EPC

The EPC format is set out in Cabinet Regulation No. 383. EPCs are all of the same format, although there are two kinds of certificates:

> EPCs for existing buildings (Figure 2);

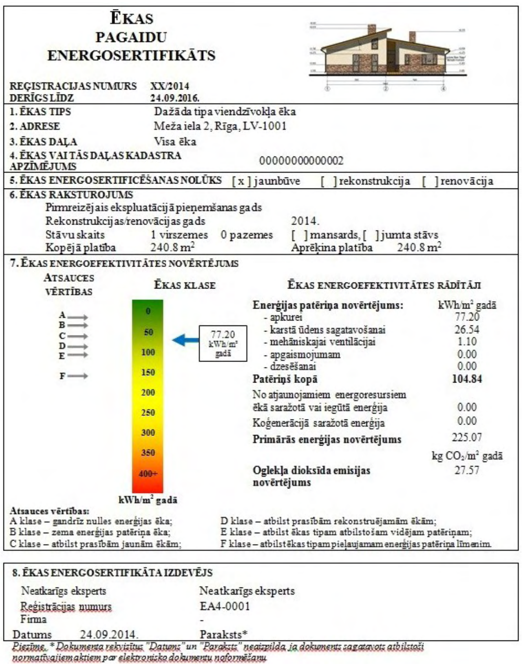
> temporary EPCs for new, reconstructed or renovated buildings (Figure 3).


ĒKAS ENERGOSERTIFIKĀTS
REĢISTRĀCIJAS NUMURS XX/2014
DERĪGS LĪDZ 24.09.2024.
1. ĒKAS TIPS Daudzdzīvokļu dzīvojamā ēka
2. ADRESE Upes iela 1, Rīga, LV-1001
3. ĒKAS DAĻA Visa ēka
4. ĒKAS VAI TĀS DAĻAS KADASTRA APZĪMĒJUMS 00000000000001
5. ĒKAS ENERGOSERTIFICĒŠANAS NOLŪKS [ ] pārdošana [ ] izīrēšana [ ] brīvprātīgi [ ] valsts/pašvaldības publiska ēka
6. EKAS RAKSTUROJUMS
Pirmreizējais ekspluatācijā pieņemšanas gads 1990
Rekonstrukcijas/renovācijas gads
Stāvu skaits 3 virszemes 1 pazemes [ ] mansards, [ ] jumta stāvs
Kopējā platība 3099.30 m² Aprēķina platība 2356.3 m²
7. ĒKAS ENERGOEFEKTIVITĀTES NOVĒRTĒJUMS
ATSAUCES VĒRTĪBAS: A, B, C, D, E, F
ĒKAS KLASE: 0, 50, 100, 150, 200, 250, 300, 350, 400+ kWh/m² gadā; 155.57 kWh/m² gadā
ĒKAS ENERGOEFEKTIVITĀTES RĀDĪTĀJI

Enerģijas patēriņa novērtējums:	kWh/m² gadā
- apkurei	155.57
- karstā ūdens sagatavošanai	23.51
- mehāniskajai ventilācijai	1.50
- apgaismojumam	0.00
- dzesēšanai	0.00
Patēriņš kopā	**180.58**
No atjaunojamiem energoresursiem ēkā saražotā vai iegūtā enerģija	0.00
Koģenerācijā saražotā enerģija	0.00
Primārās enerģijas novērtējums	235.05
	kg CO_2/m² gadā
Oglekļa dioksīda emisijas novērtējums	47.52

Atsauces vērtības:
A klase – gandrīz nulles enerģijas ēka; B klase – zema enerģijas patēriņa ēka; C klase – atbilst prasībām jaunām ēkām; D klase – atbilst prasībām rekonstruējamām ēkām; E klase – atbilst ēkas tipam atbilstošam vidējam patēriņam; F klase – atbilst ēkas tipam pieļaujamam enerģijas patēriņa līmenim.
8. ĒKAS ENERGOSERTIFIKĀTA IZDEVĒJS
Neatkarīgs eksperts Neatkarīgs Eksperts
Reģistrācijas numurs EA4-0001
Firma -
Datums 24.09.2014. Paraksts*
Piezīme. * Dokumenta rekvizītus "Datums" un "Paraksts" neaizpilda, ja dokuments sagatavots atbilstoši normatīvajiem aktiem par elektronisko dokumentu noformēšanu

Figure 2: Energy Performance Certificate for existing buildings.


ĒKAS PAGAIDU ENERGOSERTIFIKĀTS
REĢISTRACIJAS NUMURS XX/2014
DERĪGS LĪDZ 24.09.2016.
1. ĒKAS TIPS Dažāda tipa viendzīvokļa ēka
2. ADRESE Meža iela 2, Rīga, LV-1001
3. ĒKAS DAĻA Visa ēka
4. ĒKAS VAI TĀS DAĻAS KADASTRA APZĪMĒJUMS 00000000000002
5. ĒKAS ENERGOSERTIFICĒŠANAS NOLŪKS [x] jaunbūve [ ] rekonstrukcija [ ] renovācija
6. ĒKAS RAKSTUROJUMS
Pirmreizējais ekspluatācijā pieņemšanas gads
Rekonstrukcijas/renovācijas gads 2014.
Stāvu skaits 1 virszemes 0 pazemes [ ] mansards, [ ] jumta stāvs
Kopējā platība 240.8 m² Aprēķina platība 240.8 m²
7. ĒKAS ENERGOEFEKTIVITĀTES NOVĒRTĒJUMS
ATSAUCES VĒRTĪBAS: A, B, C, D, E, F
ĒKAS KLASE: 0, 50, 100, 150, 200, 250, 300, 350, 400+ kWh/m² gadā; 77.20 kWh/m² gadā
ĒKAS ENERGOEFEKTIVITĀTES RĀDĪTĀJI

Enerģijas patēriņa novērtējums:	kWh/m² gadā
- apkurei	77.20
- karstā ūdens sagatavošanai	26.54
- mehāniskajai ventilācijai	1.10
- apgaismojumam	0.00
- dzesēšanai	0.00
Patēriņš kopā	**104.84**
No atjaunojamiem energoresursiem ēkā saražotā vai iegūtā enerģija	0.00
Koģenerācijā saražotā enerģija	0.00
Primārās enerģijas novērtējums	225.07
	kg CO_2/m² gadā
Oglekļa dioksīda emisijas novērtējums	27.57

Atsauces vērtības:
A klase – gandrīz nulles enerģijas ēka; B klase – zema enerģijas patēriņa ēka; C klase – atbilst prasībām jaunām ēkām; D klase – atbilst prasībām rekonstruējamām ēkām; E klase – atbilst ēkas tipam atbilstošam vidējam patēriņam; F klase – atbilst ēkas tipam pieļaujamam enerģijas patēriņa līmenim.
8. ĒKAS ENERGOSERTIFIKĀTA IZDEVĒJS
Neatkarīgs eksperts Neatkarīgs eksperts
Reģistrācijas numurs EA4-0001
Firma -
Datums 24.09.2014. Paraksts*
Piezīme. * Dokumenta rekvizītus "Datums" un "Paraksts" neaizpilda, ja dokuments sagatavots atbilstoši normatīvajiem aktiem par elektronisko dokumentu noformēšanu

Figure 3: Temporary Energy Performance Certificate for new and renovated buildings.

For the certification of existing buildings, both a calculated energy rating (asset rating) and a measured energy rating (operational rating) must be determined. The EPC, valid for 10 years, must be issued by an independent Qualified Expert (QE).

For the certification of new, reconstructed or renovated buildings, a calculated energy rating (asset rating) must be determined, and the temporary certificate, valid for 2 years, must be issued by a QE.

The energy performance must be expressed using the following annual energy performance indicators:

> final energy consumption, in kWh/m^2.year;

> carbon dioxide emissions, in kg CO_2/m^2.year;

> primary energy consumption, in kWh/m^2 year.

The EPC must contain information about the total final energy consumption (MWh/year) and the overall energy performance indicator (kWh/m^2.year) for heating, cooling, Domestic Hot Water (DHW), lighting (optional for residential buildings), ventilation, and other needs (that must be indicated).

The classification system for the energy performance of buildings is determined in Regulation No. 383, which classifies buildings by the energy performance indicator for heating. Calculated energy performance indicators must be presented on an energy performance scale[4] (Figure 4), one side of which is rated 'very good' - class A - high efficiency class buildings, and the other one 'very bad' - class F. The energy performance calculation model has to be validated using measured energy consumption (the difference between the calculated and the measured energy consumption cannot be greater than 10%, or no higher than 10 kWh/m^2 under identical indoor conditions).

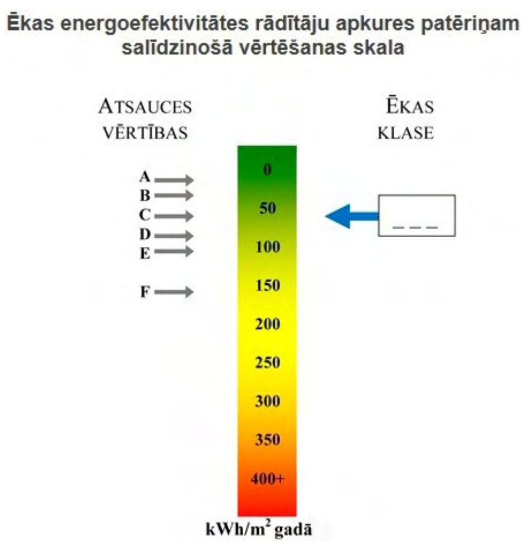


Figure 4: Building energy performance scale.

EPC activity levels

For new and reconstructed or renovated buildings, the EPC is mandatory and control is undertaken by the municipal construction inspection authority, when approving the building for use. For existing buildings, certification requirements are the joint responsibility of the buyer and the seller and no check is performed by any third party. The current compliance rate with energy performance certification requirements for existing buildings is considered poor, but is steadily improving. About 1,000 EPCs are issued yearly for new and existing buildings. Accurate data will be available after the EPC registration software is put into the production environment in 2016.

Typical EPC costs

The cost of the assessment of energy performance of buildings is not regulated. For typical apartment buildings (simple geometric shape, with district heating and natural ventilation), the EPC costs usually range from 300 € to 600 € for the whole building. For non-residential buildings, EPC costs range from 300 € to 700 € for the whole building.

Assessor corps

The requirements and certification procedures for QEs, the registration and monitoring procedures of QEs, as well as the content and procedures for the QE register, are determined by Regulation No. 382.

A QE certified for both types of EPCs must have a relevant university degree, theoretical knowledge and practical experience, and pass a proficiency exam. QEs must be either heating engineers and technicians, or building structural engineers. A temporary EPC can also be issued by QEs who have received a building practice certificate in the field of structural building design, in accordance with the procedures specified by regulations concerning construction.

The certification of QEs is performed by certification bodies. Certification bodies supervise the professional activities of the QEs.

The number of QEs is shown in Figure 5.

[4] *Classes and reference values are different for residential and non-residential buildings.*

Compliance levels by sector

In Latvia, EPCs have been issued since 2010. Right now, the compliance level by sector is rather low. Usually, QE services are used for issuing EPCs and energy audits for projects financed by European funds, where compliance checks of energy performance are required for every single project. Requirements for these projects are constantly growing and, through this process, the competence level of QEs is also increasing.

Enforcement with building owners and real estate actors

The requirement for issuing an EPC receives more support from professionals (e.g., QEs) than from the general public (owners, tenants, or buyers) who tend to see the EPC as another bureaucratic burden. Therefore, despite the legislation that allows tenants or buyers to ask for EPCs on a voluntary basis, they often do not, so energy performance certification of buildings still has only a minor effect on the real estate market. This is also because there are no penalties for owners of existing buildings. Latvia is, however, planning to develop a valid penalty system. There is hope that this situation could change after the implementation of the BIS, because this is planned to offer a specific information package for each individual address and, thus, in the future, purchasers and tenants will be able to see if a building has an EPC or not, before they make a decision.

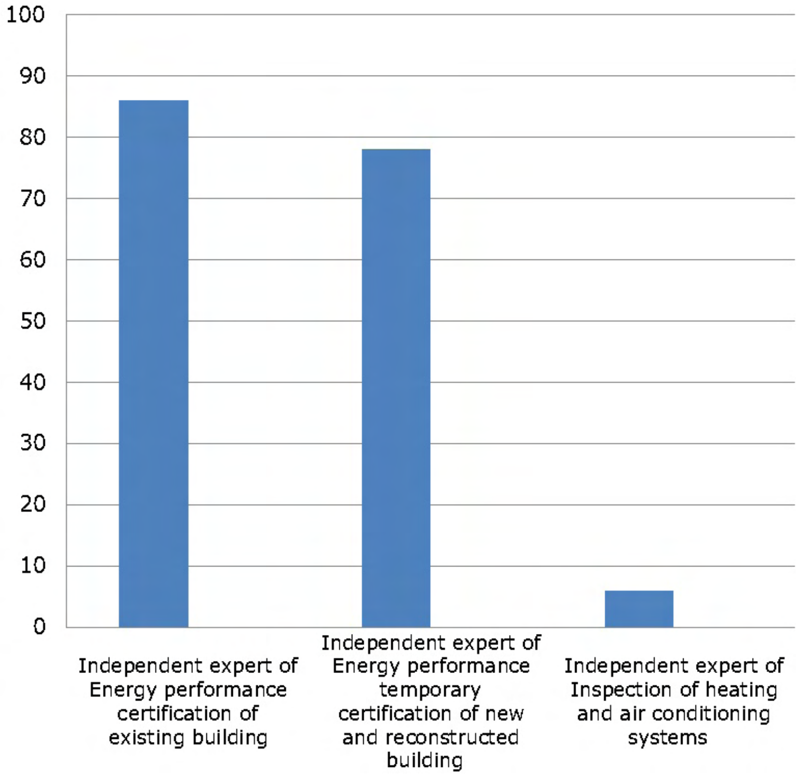
III.ii. Progress and current status on public and large buildings visited by the public

Overview

EPCs are mandatory for public central and local government buildings with a total floor area larger than 250 m^2. This requirement is valid, but not yet completely operational. Only approximately 20% of central government buildings have EPCs as of 2015. A renovation contest for central and local government buildings using EU funds is planned in 2016, and a valid EPC will be required. Until then, the Ministry of Economics is not requiring public central and local government buildings to have an EPC.

Information and requirements on experts, EPC format and quality control, as well as typical EPC costs are the same as for other EPCs previously described.

Figure 5:
Independent experts by category at the end of 2014.



III.iii. Implementation of mandatory advertising requirement

The LEPB decrees that advertisements for the sale, rent or lease of any building, or building unit, should display the energy performance indicators of the building, or building unit, if certification of the energy performance of the building has already been performed in accordance with the procedures specified in this Law. This requirement is not fully effective, because there is no penalty system. Latvia is developing a valid penalty system during 2016.

III.iv. Information campaigns

A campaign for the improvement of the energy performance of buildings in Latvia, the so-called “Living warmer” campaign (Figure 6), was launched on 25 February 2010, when the Ministry of Economy, Industry Associations and Business signed a cooperation memorandum at the conference “Housing renovation - Latvian investment in the future”.

The key objective of the Living warmer campaign is to inform households about the possibility and conditions of support from the EU 2007 - 2013: “Improvement of Heat Insulation of Multi-Apartment Residential Buildings” programmes. More than 186 informative events have been held throughout Latvia - a variety of public debates, seminars, conferences and exhibitions, involving more than 8,500 participants in total.

Figure 6:
The logo of the “Living warmer” information campaign.

The government has awarded a contract to promote best practices in the field of energy-efficient building construction, renovation and reconstruction since 2011 ("Energy efficient building in Latvia"[5]).

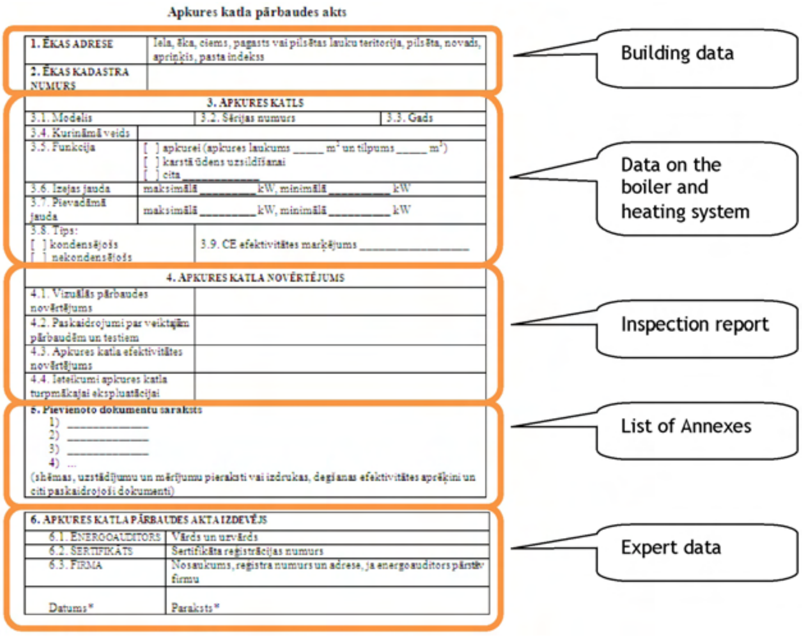
The *"Latvenergo"* Energy Efficiency Center[6] advises the public and private sector about the possibilities to improve the efficient use of electricity and the use of a variety of electrical appliances for individual use.

The Efficiency Information Center[7] (EEIC) of the Riga Energy Efficiency Agency provides visitors with free of charge information and advice about energy efficiency, including advice on preparing applications for renovation and energy audits. It also organises open days at renovated homes, as well as discussion seminars on the quality of the renovation.

The *Zemgales* Regional Energy Agency[8] provides advice, information and training services in the field of energy efficiency, and maintains a database of energy consumption, prepares regional and local planning documents in the energy sector and coordinates its implementation, while also attracting investments to improve energy efficiency.

The Latvian Climate Change Financial Instrument awarded a contract "Public awareness with regard to greenhouse gas emission reduction and the importance of opportunities" (Phases I and II) with the aim to inform the public about the opportunities to reduce greenhouse gas emission.

Figure 7: Boiler inspection report form.



III.v. Coverage of the national building stock

The total number of energy consuming residential buildings in Latvia is 352,400, with a total floor area of 86.9 million m^2, and the total number of non-residential energy consuming buildings is 34,300, with a total floor area of 27.0 million m^2.

By the end of 2014, approximately 1% of the building stock in Latvia has an EPC.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

Cabinet Regulation No. 383 determines that inspection of boilers and heating systems is mandatory for heating systems with a boiler with an effective rated output over 20 kW, as well as for Air-Conditioning (AC) systems with an effective rated output over 12 kW.

The number of heating system inspections is fairly low due to low interest from building owners. After the BIS platform becomes operational, this should improve.

Apartment buildings in Latvia are generally not equipped with AC systems for cooling. When they are installed, the total power of the AC systems in separate rooms usually does not exceed 12 kW. So, the number of AC systems requiring inspection is small.

Arrangements for assurance, registration and promotion of competent persons

Cabinet Regulation No. 383 provides that an independent expert auditor shall assess the boiler together with the heating system, shall provide an opinion regarding the boiler's efficiency, and shall provide recommendations about possibly replacing it, or other possible changes to the heating system and alternative solutions to reduce energy consumption and carbon dioxide emissions. The independent expert shall then draw up an inspection report on the inspection of the heating system, including the inspection results and recommendations for improving the inspected systems, provided that the

[5] *www.energoefektivakaeka.lv*

[6] *www.latvenergo.lv/lat/klientiem/EEC/par_eec*

[7] *www.rea.riga.lv/par-mums/rea-eeic*

[8] *www.zrea.lv*

implementation costs of the relevant measures are cost-effective during the anticipated (planned) period of service.

The inspection of boilers must be done in accordance with standard LVS EN 15378:2009 L "Energy performance of buildings: Inspection of boilers and heating systems" (Figure 7).

The inspection of AC systems includes an evaluation of effectiveness and recommendations. The independent expert then makes an inspection report. The format of the inspection report (deed) for AC systems is prescribed in Annex G of the standard LVS EN 15240:2009 L "Ventilation for Buildings - Energy performance of buildings: Guidelines for the inspection of air-conditioning systems".

Qualifications and entrance requirements

An independent expert must have the required theoretical knowledge and practical experience, and also pass a proficiency exam.

In order to undertake heating system inspections, the independent expert must have a relevant university degree providing knowledge in the following fields:

> boilers and heating systems;
> measurements, and adjustment of equipment.

The inspection of boilers can also be performed by professionals who have received a building practice certificate in the area of construction of heating and ventilation systems, in accordance with the procedures specified by regulations on construction.

The number of independent experts is shown in Figure 5.

Independent experts for AC system inspections must have a relevant university degree providing knowledge in the following fields:

> AC equipment and systems;
> measurements, and adjustment of equipment.

AC system inspections can also be performed by professionals who have received a building practice certificate in the area of construction of heating and ventilation systems, in accordance with the procedures specified by regulations on construction.

The certification of independent experts for inspection of heating and AC systems is performed by the accredited "Certification Body of The Latvian Association of Heat, Gas and Water Technologies Engineers". The certification body supervises the professional activities of the independent experts.

Quality control of inspection reports

Because the BIS is still in the process of implementation, there are no statistical data yet available about inspection reports issued every year. No penalties have yet been levied on independent experts of the inspection of boilers and heating systems in Latvia.

Costs and benefits

The cost of the inspection has not been regulated. For typical apartment buildings (usually of a simple geometric shape, with district heating and natural ventilation), the inspection costs of the heating system range from 100 € to 200 €.

The cost of the AC inspection is not regulated but its range is also typically between 100 € and 200 €.

3. A success story in EPBD implementation

Cost-optimal calculation results show that the cost-effective measures for existing multi-apartment buildings are facade insulation, attic insulation and window replacement.

Based on the cost-optimal calculations for existing single-family houses, the insulation of the attic and roof are refundable.

The cost-effective measures for existing school buildings are the insulation of external walls, the insulation of the attic and plinth, as well the replacement of windows and doors. However, insulation of the roof was found to be cost-effective only in one case study.

Cost-effective measures for existing kindergarten buildings are thermal insulation, insulation of the plinth, and replacement of windows.

In existing office buildings, cost-effective measures are found to be the insulation of exterior walls, and the insulation of the loft and the plinth.

The cost-optimal measures for multi-apartment buildings are insulation of the outer walls of the buildings, additional insulation of the plinth, replacement of windows and insulation of basement ceiling.

The results of the cost-optimal calculations at the level of individual elements demonstrate that the current requirements for new, reconstructed or renovated buildings are below the cost-optimal level.

The conclusions and proposals of the cost-optimal study helped to establish new minimal requirements for buildings and building elements that were included in LBN 002-01.

4. Conclusions, future plans

Latvia will develop further policies and take measures to increase the number of Nearly Zero-Energy Buildings (NZEBs). Taking into account that Latvia has no prior experience of NZEB construction, the process of defining targets is still in the research stage. Monitoring results of the realised/implemented projects after one year of NZEB implementation (at the end of 2014) will be evaluated and will allow Latvia to develop further targets for NZEBs.

Latvia will efficiently implement the "Programme for renovations of Multi-apartment Housing, public buildings and industrial buildings for energy efficiency measures and renewable resources" during the EU planning period 2014 - 2020, finding the most effective financial mechanisms (e.g., loans, grants) for the implementation of the Programme.

Latvia shall implement the Building Information System (BIS), where information on Qualified Experts (QEs), Energy Performance Certificates (EPCs), and inspection reports will be monitored and accumulated. The analysis of BIS data will help to identify unrepresentative performance indicators and select cases for detailed examination.

Latvia will review the existing classification system of energy performance of buildings set out in Regulation No. 383, according to the cost-optimal calculations.

Implementation of the EPBD in Lithuania

STATUS IN DECEMBER **2014**

1. Introduction

The Energy Performance of Buildings Directive (Directive 2010/31/EU - EPBD) sets out numerous requirements including the certification of buildings' energy performance, inspection regimes for boilers and Air-Conditioning (AC) systems, and requirements for new Nearly Zero-Energy Buildings (NZEBs). The EPBD also sets minimum energy performance standards for buildings undergoing renovation. Together, the Energy Efficiency Directive (EED) and the EPBD provide a framework to reduce energy use in buildings, thereby delivering a range of economic, environmental, societal and energy security benefits. The Ministry of Environment and the Ministry of Energy are jointly responsible for the transposition and implementation of the EPBD in Lithuania.

The EPBD and national calculation methods of cost-optimal levels of minimum energy performance requirements were transposed into Lithuanian legislation in time, and now Lithuania is in the process of implementing its requirements. The main requirements were introduced into Lithuanian legislation through the Law on Construction and the Law on Energy, and are further detailed in technical regulations, splitting energy efficiency requirements into all steps of planning, designing and constructing buildings.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Energy certification as a mandatory requirement for new buildings came into force on 1 January 2007. New buildings (building units) must be certified after construction has been completed. The energy performance class of new buildings (building units) may not be lower than B, when the building permit is granted after 1 January 2014. The permit for construction will not be issued if the energy efficiency class of the designed building is not in line with mandatory requirements. After the building is finished, it must fully comply with the requirements.

When buildings (building units) are offered for sale or for rent, the energy performance indicator, which is part of the Energy Performance Certificate (EPC) of the building (or building unit) should be stated in advertisements in commercial media. This requirement came into force on 9 January 2013.

Renovated or refurbished buildings, when the cost of renovation works amounts to more than 25% of the building's value, must conform to the following energy performance requirements:

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Eglė Pliuskuvienė,
The Housing Energy Efficiency Agency (BETA)

NATIONAL WEBSITES

www.am.lt, www.enmin.lt, www.spsc.lt, www.betalt.lt, www.ena.lt, www.vei.lt

a) For permits for construction works obtained before 1 January 2014, the energy performance class after major renovation must not be lower than D.
b) For permits for construction works obtained after 1 January 2014, the energy performance class after major renovation must not be lower than C.

The requirements for energy performance class are not obligatory for existing buildings or building units for sale or rent, but the evaluation procedure and certification requirements for existing buildings and following major renovation are in force since 1 January 2009.

The energy performance class of large buildings or building units with a heated area (total useful floor area) over 500 m^2 occupied by a public authority and frequently visited by the public, after major renovation, must not be lower than D. This requirement came into force on 9 January 2013.

I.ii. Format of national transposition and implementation of existing regulations

The main provisions on the energy performance of buildings are described in the Law on Construction and the Law on Energy of the Republic of Lithuania. The calculation procedure is defined in Building Technical Regulation STR 2.01.09:2012 "Energy Performance of Buildings; Certification of Energy Performance", adopted on 21 August 2012 by Order No. D-1-674 of the Minister of Environment. The Building Technical Regulation came into force on 9 January 2013 and is an amended version of a previous regulation. The new version includes many essential amendments, including an inter alia definition of low energy buildings - buildings of energy efficiency class B, A, A^+ and Nearly Zero Energy Buildings (NZEB) as class A^{++} buildings.

The building energy performance class is determined in accordance with the values of the following 8 parameters:

1) the calculated specific heat loss of the building envelope;
2) energy consumption for heating the building;
3) building airtightness;
4) technical indicators of mechanical ventilation, including heat recovery system;
5) thermal properties of partitions between the floors and spans;
6) building energy performance indicator C_1 value, describing the non-renewable primary energy efficiency of heating, ventilation, cooling and lighting;
7) building energy performance indicator C_2 value describing the primary non-renewable energy efficiency for Domestic Hot Water (DHW);
8) building energy consumption of renewable resources.

All parameters are equally important, and no priority is given to one of them when determining the energy performance class. However, the best classes require calculation of more parameters than the lower classes. For example, for energy classes A^{++}, A^+, A and B, it is mandatory to calculate both the C_1 and C_2 parameters, but for any other energy class it is only mandatory to calculate C_1:

> A^{++} class: $C_1 < 0.25$ and $C_2 \leq 0.70$;
> A^+ class: $0.25 \leq C_1 < 0.375$ and $C_2 \leq 0.80$;
> A class: $0.375 \leq C_1 < 0.5$ and $C_2 \leq 0.85$;
> B class: $0.5 \leq C_1 < 1$ and $C_2 \leq 0.99$;
> C class: $1 \leq C_1 < 1.5$;
> D class: $1.5 \leq C_1 < 2$;
> E class: $2 \leq C_1 < 2.5$;
> F class: $2.5 \leq C_1 < 3$;
> G class: $C_1 \geq 3$.

For example, for classes up to B, thermal bridges can be calculated in a precise way, or simply characterised by using tabulated default values from STR 2.01.09:2012. For A, A^+ and A^{++} classes, thermal bridges must be calculated individually. Passive solar protection devices must be calculated for all classes. Calculation of the portion of energy consumption from renewable resources is possible for all classes, but mandatory only for the A^+ and A^{++} classes.

The system allows for setting up requirements for all types of buildings and intended uses, and even for various sizes and shapes of buildings, without setting out absolute values for primary energy consumption, which would vary significantly for different indoor temperatures (e.g., +5 ºC for storage buildings and +20 ºC for residential buildings). When calculating the C_1 parameter values, all the minimum requirements are to be respected. Furthermore, the system allows for increased requirements for all performance classes without changing the classification and calculation methods. Such changes of requirements have taken place twice in Lithuania since Directive 2002/91/EC was implemented. The system allows for setting minimum requirements for certain parameters and certain classes. It provides opportunities for a continuous but flexible system respecting central aspects for certain classes. See other sections of this report for examples.

The calculation procedure in STR 2.01.09:2012 is based on the methodology included in standards EN 15217:2005 and EN 15603. The tabulated values in STR 2.01.09:2012 have been updated and enhanced. The calculation software tool has been updated according to the above changes as well. The tool also allows separate calculation for several parts of the building with different requirements.

I.iii. Cost-optimal procedure for setting energy performance requirements

The new Building Technical Regulation STR 2.01.09:2012 includes the requirements for cost-optimal levels of minimum energy performance requirements for all categories of buildings, new and existing. The requirements conform to the requirements established for energy class C buildings.

New buildings

The cost-optimal requirements for new, single-family, multi-family, office and education buildings are based on the 'financial perspective' calculation using a real discount rate of 3% (based on calculations from 1,080 cases).

According to the results of the calculation, the difference between cost-optimal levels of new buildings and normative requirements of the Regulation No. 244/2012 delegated by the EU Commission range approximately between -34% up to 2016 (Class B), and -10% after 2016 (Class A).

The requirements for cost-optimal levels of minimum energy performance conform to the requirements established in the national regulation for class A buildings. The national regulation decrees that the energy performance class of new buildings and/or building units must not be lower than B when the construction permit is granted after 1 January 2014, and it must not be lower than A when the construction permit is granted after 1 January 2016.

Requirements for new residential building envelope heat transfer coefficients (U, W/m^2.K) and thermal resistances (R, m^2.K/W) were set out many years before the EPBD came into force. The requirements of different regulations are compared in Table 1.

STR 2.01.09:2012 normative requirements for thermal insulation of residential building envelopes are presented in Table 2.

STR 2.01.09:2012 sets out the overall U-factor U(A) (W/m^2.K) values for calculation of specific heat losses for

Building envelope element	Till 1992	From 1992	From 1999	From 2005	Class A From 2016	Class A^{++} From 2020
Roofs	0.85 (1.2)	0.25 (4.0)	0.18 (5.6)	0.16 (6.3)	0.10 (10)	0.08 (12.5)
Walls	1.27 (0.8)	0.30 (3.3)	0.26 (3.8)	0.20 (5.0)	0.12 (8.3)	0.10 (10)
Floors	0.71 (1.4)	0.30 (3.3)	0.26 (3.8)	0.25 (4.0)	0.14 (7.1)	0.10 (10)
Windows	2.5 (0.40)	1.9 (0.53)	1.9 (0.53)	1.6 (0.63)	1.0 (1.0)	0.70 (1.4)
Doors	2.2 (0.45)	2.0 (0.50)	1.9 (0.53)	1.6 (0.63)	1.0 (1.0)	0.70 (1.4)

Table 1: Development of heat transfer coefficients (U, W/m^2.K) and thermal resistances (R - m^2.K/W) for new residential buildings.

Building element	Normative U-value, W/m^2.K			
	Class B	*Class A*	*Class A$^+$*	*Class A^{++}*
Roofs Floorings in contact with outdoor air	0.16	0.10 κ	0.10 κ	0.080 κ
Building elements in contact with ground Floorings over unheated basements and crawls	0.25	0.14 κ	0.14 κ	0.10 κ
External walls	0.20	0.12 κ	0.13 κ	0.10 κ
Windows and transparent building elements	1.6	1.0 κ	1.0 κ	0.70 κ
Doors and gates	1.6	1.0 κ	1.0 κ	0.70 κ

Where $\kappa = 20/(\theta_i - \theta_e)$, is the temperature correction factor, with θ_i the indoor air temperature in °C, and θ_e the outdoor air temperature or design temperature of adjacent spaces in °C. The temperature of unheated spaces is determined separately. If the indoor air temperature $\theta_i = 20$ °C and the outdoor air is $\theta_e = 0$ °C, then $\kappa = 1$.

Table 2: STR 2.01.09:2012 normative requirements for thermal insulation of residential building envelopes.

Table 3: Overall U-factor $U_{(A)}$ (W/m².K) values for calculation of specific heat losses of energy performance class A buildings according to STR 2.01.09:2012.

Building envelope elements	Residential buildings	Non-residential buildings	
		Public buildings*	Industrial buildings**
Roofs	0.10	0.11	0.16 κ
Building envelope elements in contact with ground	0.14	0.16	0.25 κ
Floorings over unheated basements and crawls			
External walls	0.12	0.15	0.20 κ
Windows and transparent building envelope elements	1.0	1.3	1.4 κ
Doors and gates	1.0	1.3	1.4 κ

*, ** Definitions provided through the Regulation on classification of buildings.

buildings of various purposes with energy performance class A, as presented in Table 3.

Existing buildings

New legal requirements for energy performance for existing buildings after major renovation are established in Regulation STR 2.01.09:2012. These requirements were implemented from 1 January 2014.

The requirements for existing single-family, multi-family, office and education buildings after major renovation on cost-optimal levels are also based on the 'financial perspective' calculation using a real discount rate of 3% (based on calculations from 720 cases).

According to the results of the calculation, from 1 January 2014 the difference between the cost-optimal level of existing buildings and normative requirements varies approximately from -4.8% to -13%. Thus, the requirements for cost-optimal levels of minimum energy performance conform to the requirements for buildings of class C. A one-year transitional period was set up to achieve allowable limits: the energy performance class of renovated buildings and/or building units must not be lower than D when the permit for construction works was granted before 1 January 2014, and it must not be lower than C for permits granted after 1 January 2014.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The main purpose of the prepared national plan was to describe the key steps to increase the number of high energy performance buildings and NZEBs in Lithuania. The national plan was not adopted as a separate document but consists of important parts of several legal acts.

First, the new calculation methodology according to the EPBD requirements was prepared and came into force in February 2012. The calculation software tool was corrected according to the changes in the calculation methodology as well. The default data in the software tool's selection tables was enlarged accordingly. Classification was enhanced, introducing additional A+ and A++ classes.

Based on the definition of NZEB that allowed the use of the existing classification system, the corresponding calculation methodology and software tools were set up in STR 2.01.09:2012: "*Nearly-Zero Energy Buildings - buildings which meet the requirements of the A++ energy efficiency class; that is, buildings with a very high energy performance, where energy consumption is almost zero or very low; most of the energy consumed is covered by energy from Renewable Energy Sources (RES), including RES produced on-site or nearby*".

The total amount of renewable primary energy consumed in a building should be more than half of the primary energy consumed for the building's heating, cooling and ventilation systems. Regulation STR 2.01.09:2012 defines this requirement as in the formula in Box 1.

STR 2.01.09:2012 includes a plan with milestones, which was updated and made publicly available for contractors, investors and future owners:

- From 2014 the energy performance class of new buildings or building units must not be lower than B;
- From 2016 the energy performance class of new buildings or building units must not be lower than A;
- From 2018 the energy performance class of new buildings or building units must not be lower than A+;
- From 2021 the energy performance class of new buildings or building units must not be lower than A++.

$$\frac{\text{The total amount of renewable primary energy consumed in building}}{\text{The amount of non}-\text{renewable primary energy consumed for heating}+\text{for cooling}+\text{for ventilation system's electric ventilators}}\geq 1$$

Box 1: Requirements for NZEB as defined by Building Technical Regulation STR 2.01.09:2012.

Additional compulsory trainings of certification experts were planned and carried out, emphasising the need for dissemination of knowledge.

Cost-optimal levels were calculated for new and existing residential houses with one or two apartments, multi-story residential buildings, and educational and administrative buildings, according to the requirements of the Commission Delegated Regulation (EU) No. 244/2012 and Guidelines 2012/C 115/01. Determination of the cost-optimal level for NZEB was not the main purpose of these calculations, but the findings show that, in Lithuania, the same goals determined for NZEB could be achieved by using biofuel energy for heating and hot water. However, not every player in the construction market could use biofuel boilers, as the central heating system network has been installed and is still in use in many Lithuanian towns.

To determine cost-optimal levels suitable for all Lithuanian construction market players, only such facilities/selections/variants which could be used throughout Lithuania were evaluated.

According to the results of the calculations, it can be concluded that the total costs of construction and energy usage for NZEBs, based on the 2012 economic indicators, are much higher than cost-optimal levels.

Figures and statistics on existing NZEBs

By the end of 2014 approximately 90,700 EPCs had been issued in Lithuania. There are no buildings with A^{++} energy performance class (in other words, NZEB), but there are 6 EPCs registered with A^{+} energy performance class and 29 EPCs with A energy performance class (by the end of 2014). All EPCs are collected in the central database and published on the website www.spsc.lt. The certificates for classes A, A^{+} and A^{++} are published in a separate section of the website, for better visibility of high performance buildings.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public building

Deep renovations are specifically encouraged by the Energy Efficiency Directive (Directive 2012/27/EU - EED) through the requirement to establish long-term strategies for the renovation of the national building stock covering all building types, including residential and non-residential buildings, whether in private or public ownership.

Regarding implementation of Article 4 of the EED, the long-term plan for the renovation of the national building stock was adopted on 10 March 2015 as part of the National Energy Efficiency Action Plan (NEEAP). The long-term plan covers all five subjects which are under the obligation of the EED: an overview of the national building stock, cost-effective approaches to renovation, policies and measures stimulating deep renovations, a forward-looking perspective to guide decisions of individuals and the construction industry, as well as expected energy savings and other benefits.

The targets of the long-term plan for 2020 are:

1) to renovate 3,500 - 4,000 multi-apartment buildings (9% - 11% of the multi-apartment building stock);
2) to renovate 700,000 m^2 of the building stock owned by the central government (5% - 6% of the central government building stock).

It has been calculated that after implementing these measures, 785 - 885 GWh of heating energy should be saved (based on calculations from 2013) or 199,000 - 225,000 tonnes of CO_2 equivalent.

The targets of the long-term plan for 2030 are:

1) to renovate more than 4,000 multi-apartment buildings (10% - 11% of the multi-apartment building stock);
2) to renovate no less than 800,000 m^2 of the building stock owned by the central government (6% - 7% of the central government building stock).

It has been calculated that after implementing these measures 228,000 tonnes of CO_2 equivalent will be saved.

Regarding implementation of Article 5 of the EED, the programme for improving energy efficiency in public buildings was adopted by the Government on 26 November 2014. The target of the programme is to improve energy efficiency in public buildings that are used for administrative, cultural, educational, recreational, medical and other purposes. The programme briefly describes the situation of the existing buildings. According to information from the state enterprise Centre of Registers[1], 13,123 public buildings which are owned by the government and municipalities were registered up to 1 January 2014. The total area of these buildings is 14,8 million m^2, which is around 35% of all buildings owned by the central government and municipalities. Around 5,500 of these buildings (5.9 million m^2) are owned by the central government and 7,600 (8.9 million m^2) by the municipalities. The majority of these buildings were built between 1900 and 1990. Currently, these buildings do not comply with the energy efficiency requirements, and around 2,300 GWH is used for heating in these buildings. Two major 2020 sub-targets are set in the programme: the renovation sub-target for public buildings owned by the government is 470,000 m^2 (for which the Ministry of Energy is responsible) and the renovation sub-target for public buildings owned by the municipalities is 230,000 m^2 (for which the Ministry of Environment is responsible). The primary yearly energy savings from these measures are calculated as 60 GWh and 14,000 tonnes of CO_2 equivalent will be saved by 2020. It is clearly stated that only the buildings which have an energy performance certificate with energy performance class below C can participate in this programme.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The Building Technical Regulation STR 2.09.02:2005 “Heating, Cooling and Air Conditioning” is applied to design and construction of heating, hot water, AC and ventilation systems in buildings. All minimum requirements set for heating, cooling, hot water and ventilation systems are described in this regulation and are in line with the Regulation (EU) No 305/2011, and are mandatory for new, refurbished, replaced and upgraded Technical Building Systems (TBS).

The requirements lay down the basic principle that TBS must be designed in accordance with the intended use of the building, and they also contain the process requirements.

Systems must use a minimum amount of energy but reduction of indoor air quality is not acceptable as a means to save energy.

Building system characteristics must be calculated individually according to the energy performance requirements for the whole building or building unit.

Construction works and their heating, cooling, lighting and ventilation systems must be designed and built in such a way that the amount of energy they require should be lower than the legal requirements, taking into account its pattern of occupancy and of the climatic conditions of the location. All these systems, as parts of the building, must satisfy the basic requirements for construction works for an economically reasonable expected working life.

If there are special requirements for microclimate and air quality in buildings, the parameters for systems design are taken from hygienic, technological and normative regulations in the national legislation. When designing heating, ventilation and AC systems, the requirements for all parts of the building should be considered in the calculations: building location, thermal, airtightness, architectural and constructional characteristics, materials for structure and interior design, heat emission, moisture and pollution from occupants, equipment, etc., climate conditions and indoor air quality, as well as other factors and specific building purpose requirements.

II.ii. Applicability to new, replacement and upgraded systems in existing buildings

Since 2014, Lithuania has been applying updated system requirements for new, replaced and upgraded systems in existing buildings. They became stricter for buildings and building units and should be applied as they are technically, economically and functionally feasible (Table 4).

If a building has a mechanical AC system with recuperation system, energy efficiency requirements set out in regulation STR 2.01.09:2012 apply only to higher classes.

[1] *www.registrucentras.lt*

System element	Other classes	Class A	Class A+	Class A++
The efficiency coefficient of the recuperation system shall not be less than:	No requirements	0.65	0.80	0.90
The amount of energy used by the fans of the recuperation system shall not be higher than:	No requirements	0.75 Wh/m³	0.55 Wh/m³	0.45 Wh/m³

Table 4: Minimum requirements for TBS for high-performing buildings.

II.iii. Provisions for installation, dimensioning, adjustment and control

During the construction process, the designer is responsible for the entire process. It is not possible to recognise a building as fit for use without control of all systems in use in the building.

II.iv. Encouragement of intelligent metering

The Law on Heat Sector of the Republic of Lithuania requires measurements to be performed through one centrally installed heating meter for the whole building.

Implementing the EED Article 9, Part 3, which states that individual meters should be installed for end-users, Lithuania initiated a research study to clarify whether it is physically possible and economically feasible to install individual meters to all end-users. The study is planned to be finished at the end of February 2015.

II.v. Encouragement of active energy-saving control (automation, control and monitoring)

The Law on the Heat Sector (Article 33) states that the maximum rate of heat consumption in multi-apartment buildings must obey the following provisions:

1. The National Commission for Energy Control and Prices shall determine and, if necessary, change the maximum heat consumption rates for multi-apartment buildings and other spaces. These rates are published and available to the public. They are applied to multi-apartment buildings, which inefficiently consume energy and do not meet the minimum energy efficiency requirements. Government authorities determine whether a multi-apartment building consumes energy efficiently and/or if mandatory energy efficiency requirements are satisfied.
2. The municipal authority may impose more stringent maximum heat consumption rates for multi-apartment buildings and other premises than the National Commission for Energy Control and Prices, if the saved expenses for heating costs after the implementation of energy efficiency measures cover consumers' investment costs for energy saving measures. Energy expenses for heating, which are saved after the implementation of energy efficiency measures, are determined in accordance with the procedures approved by the Ministry of Energy and the Ministry of the Environment.
3. The municipal authority has the right to oblige the owners of multi-apartment buildings, apartments and other premises which exceeded the maximum heat consumption rate to renovate the building's heating and/or hot water systems and/or perform other renovation/modernisation actions in accordance with the mandatory requirements within twenty-four months, as described in the Governmental procedures, and thus to ensure compliance with minimum energy performance requirements of multi-apartment buildings.
4. Owners of multi-apartment buildings and/or other premises have the right to use the support procedure established by the Government in the renovation/modernisation programme of multi-apartment buildings and other funds to implement the obligations of Part 3 of this article.
5. The Heat supply and consumption rules were approved by the Minister of Energy on 25 October 2010. They describe the installation and maintenance of heat meters, modernisation of heat substations, reconstruction of heat devices, installation and maintenance of hot water meters, reconstruction of hot water devices, building's heating and hot water systems' maintenance coverage and quality requirements, as well as other issues.

Pastatų energinio naudingumo sertifikatai

Duomenys atnaujinti: 2014-10-02. Paieškos data: 2014-10-02.

Versija spausdinimui

Paieška: Visi laukai | Ieškoti | Rodyti visus

Rasta įrašų: 81768 Puslapis: 1 iš 8177 Rodyti įrašų/psl.: 10

	Sertifikatas Išdavimo data Galiojimo data	Unikalus Nr. Adresas	Pastato paskirtis	Energinio naudingumo klasė	Naudingasis plotas (m²)	Energijos sąnaudos (kWh/m²/metai)	Energijos sąnaudos šildymui (kWh/m²/metai)*	Šilumos šaltinis	Vardas Pavardė	Atestatas	BS**
Išrašas	GM-0132-1754 2014-07-31 2024-07-31	1399-8034-6012 Vismaliukų g. 34, Vilnius, Vilniaus m. sav.	Garažų, gamybos ir pramonės paskirties pastatai	A	1956	35	4	Šiluminis siurblys	Ilona Kojelienė	0132	
Išrašas	GV-0084-0103 2014-07-07 2024-07-07	4400-2581-1749 S.Šilingo g. 141B, Vilnius, Vilniaus m. sav.	Gyvenamosios paskirties vieno ir dviejų butų pastatai	A	103	46	19	Dujinis katilas, automatinis reguliavimas	Karolis Banionis	0084	
Išrašas	GV-0084-0102 2014-07-07 2024-07-07	4400-2581-1805 S.Šilingo g. 141A, Vilnius, Vilniaus m. sav.	Gyvenamosios paskirties vieno ir dviejų butų pastatai	A	103	47	20	Dujinis katilas, automatinis reguliavimas	Karolis Banionis	0084	
Išrašas	SN-0214-0281 2014-05-28 2024-05-28	4400-2978-7800 Verslo g. Nr. 11, Klaipėda, Klaipėdos m. sav.	Sandėliavimo paskirties pastatai	A	1741	53	47	Šilumos tinklai, automatinis reguliavimas	Rolandas Andrijauskas	0214	
Išrašas	SN-0116-0891 2014-05-08 2024-05-08	4400-2941-7383 Alšėnų g. 14, Kampiškių k., Kauno r. sav.	Sandėliavimo paskirties pastatai	A	15824	35	28	Šiluminis siurblys	Audrius Bagdanavičius	0116	
Išrašas	PR-0151-0142 2014-04-02 2024-04-02	4400-2346-0608 Pramonės pr. 4D, Kauno m., Kauno m. sav.	Prekybos paskirties pastatai	A	1598	41	4	Dujinis katilas, automatinis reguliavimas	Gintautas Grušauskas	0151	
Išrašas	SN-0333-1561 2014-01-06 2024-01-06	4400-2817-8856 1B, Ukmergės r. sav., Jačionių k., Ukmergės r. sav.	Sandėliavimo paskirties pastatai	A	5161	31	24	Šiluminis siurblys	Robertas Varasimavičius	0333	
Išrašas	MK-0005-0228 2012-12-19 2022-12-19	4400-2515-8447 Merkinės g. 2B, Alytus, Alytaus m. sav.	Mokslo paskirties pastatai	A	374	42	22	Šiluminis siurblys	Albinas Dobilas	0005	
Išrašas	KG-0395-0029 2012-11-12 2022-11-12	4400-2212-9617 Bajorų kelias 9, Vilniaus m, Vilniaus m. sav.	Kiti gyvenamosios paskirties pastatai (namai)	A	2305	60	17	Šilumos tinklai, automatinis reguliavimas	Ina Kichtenkienė	0395	
Išrašas	GV-0343-0002 2011-12-06 2021-12-06	4400-2054-4727 Žuvininkų 41, Vilnius, Vilniaus m. sav.	Gyvenamosios paskirties vieno ir dviejų butų pastatai	A	203	116		Šildymas elektra, automatinis reguliavimas	Milda Pruckuvienė	0343	

[1 2 3 4 5 6 7 8 9 10] Toliau : Pabaiga

(top) Figure 1: Central register of EPCs in Lithuania.

(above) Figure 2: Format of EPCs in Lithuania.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

All new buildings and building units must be certified after construction is completed, or when the buildings or building units are offered for sale or for rent. More than 90,700 EPCs were issued in Lithuania (at the end of 2014) since the system was implemented in January 2007.

In Lithuania all EPCs are collected in the central database and register. The database and register are continuously updated according to the requirements of the Building Technical Regulation. Every Qualified Expert (QE) has an obligation to send all issued EPCs to the central database.

More than 80% of registered certificates were issued since January 2013, after new requirements for certification of energy performance of buildings came into force. On average, 100 - 150 certificates are issued daily, i.e., about. 3,500 certificates monthly.

Figure 3: Public building with energy performance class A.

The central register is published on the website www.spsc.lt and can be used by related institutions, specialists and individuals (Figure 1). Since July 2014, all data were also transferred to the Real Estate Property Register and Cadastre.

How flats are certified in apartment buildings

For new multi-apartment buildings, an EPC is necessary for acceptance of a building as fit for use, so there is no need to certify separate apartments. The same applies to buildings after major renovation. In the case of sale or rent of existing buildings, it is possible to certify a separate apartment, if the whole building is not yet certified. For apartments in existing buildings, it is possible to issue a typical EPC without detailed calculations for the specific apartment.

Format and content of the EPC

The EPC of a building or building part must include the following data: a unique number of the building, address, purpose, useful area, energy performance class and estimated sum of energy inputs per m² of useful floor area of the building (primary and final energy), data on the main energy source and energy consumption for heating (primary and final energy), reference number of the EPC, date of issue and expiry date of the EPC, name, certificate number and signature of the expert who issued the EPC (Figures 2 and 3). Every EPC must also include detailed calculation results and recommendations for improvement.

EPC activity levels

By the end of 2014, 90,700 EPCs had been issued in Lithuania. Collection and registration of EPCs in the central database allows for quality control, statistical analysis and monitoring processes. Approximately 82,400 registered EPCs concern residential buildings (including EPCs for apartments in multi-family houses) and 8,300 EPCs non-residential buildings (Figure 4). Of these, 29 EPCs were issued with energy performance class A, 6 EPCs with energy performance class A^+, and no EPCs with energy performance class A^{++} (at the end of 2014). Most EPCs with high energy performance classes A and A^+ were issued for residential buildings. The energy consumption for heating of these houses, according to registered EPCs, varies between 23 kWh/m^2.year and 25 kWh/m^2.year.

Typical EPC costs

In Lithuania there are no fixed or pre-defined prices for certification of energy performance of buildings. The EPC costs are regulated by the market and vary between 100 € and 5,000 € depending on type, location, complexity, size, construction details and many other factors of the building. For an EPC of an apartment in a multi-apartment building, the certification costs are approximately 100 €, and for a typical simplified EPC of an apartment in an existing building, with well-known typical poor energy performance and energy consumption, the certification costs are approximately 5 €. The certification costs of a simple single-family residence vary between 100 € and 270 €. The fixed registration fee for an EPC is 6 € and part of the fee is used to finance Quality Assurance (QA).

Assessor corps

The experts training programme, material for expert certification, rules, and procedures for experts and their responsibilities were updated in 2012 and 2014. The new training programme and methodical material for QEs were prepared and adopted by the Ministry of Environment. Expert training and certification organisations remain the same as designated in 2012.

Instead of 5 years validity, now the license of a QE is valid for an unlimited period, but the expert must undertake an additional 20 hours of training and pass an exam every 5 years. In Lithuania there are no requirements that a QE must issue a minimum number of EPCs.

The main qualification requirements for experts for building certification are the same for all types of buildings: an engineering diploma with 3 years of experience in construction, a special 32-hour training course and exam, practical experience of certification of 3 buildings. The Experts Training Programme and software tool were developed and adopted by the Minister of Environment in 2006 and updated in 2011, 2013 and 2014.

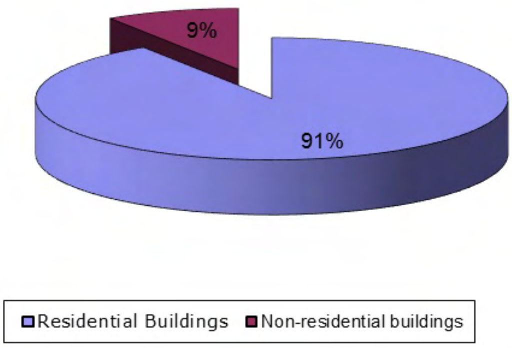


Figure 4: Certified residential and non-residential buildings (building units) in Lithuania 2007-2014 (status at the end of 2014).

In Lithuania there is an updated, publicly available database and official register of QEs. At the end of 2014, Lithuania had approximately 350 QEs with valid certificates for certification of energy performance of buildings, and about half of these QEs are actively working in the market. In Lithuania only a QE can issue an EPC and is responsible for an objective certification process (Figure 5).

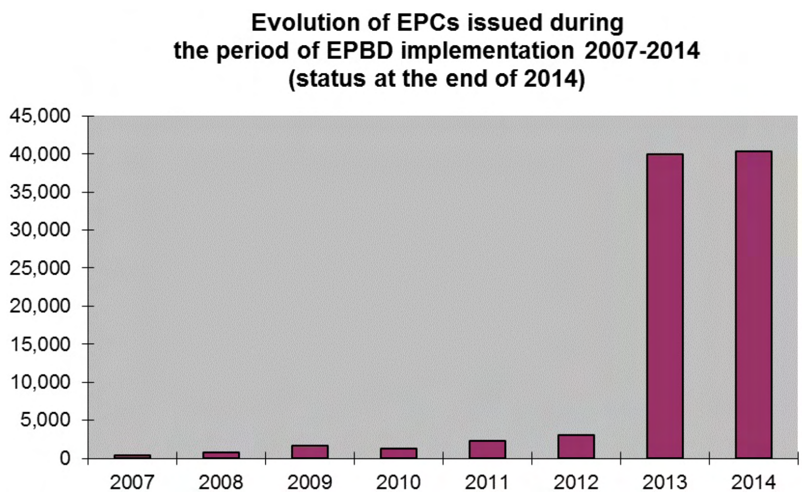
Figure 5: Qualified Expert certificate.

Compliance levels by sector

For new buildings an EPC is necessary for acceptance of a building as fit for use and is always controlled by the commission of acceptance of buildings as fit for use. The same is applicable for buildings after major renovation. In the case of sale or rent of existing buildings, EPCs are carefully checked by a notary during the signing of real estate contracts.

That is why the number of EPCs significantly increased in January 2013, after new requirements for certification of energy performance of buildings came into force (Figure 6). Newly constructed buildings and buildings after major renovation cannot be accepted by the commission if the energy performance class, as evidenced by an EPC, is lower than required. That is why there is a 100%

Figure 6: Evolution of EPCs issued in Lithuania 2007-2014.



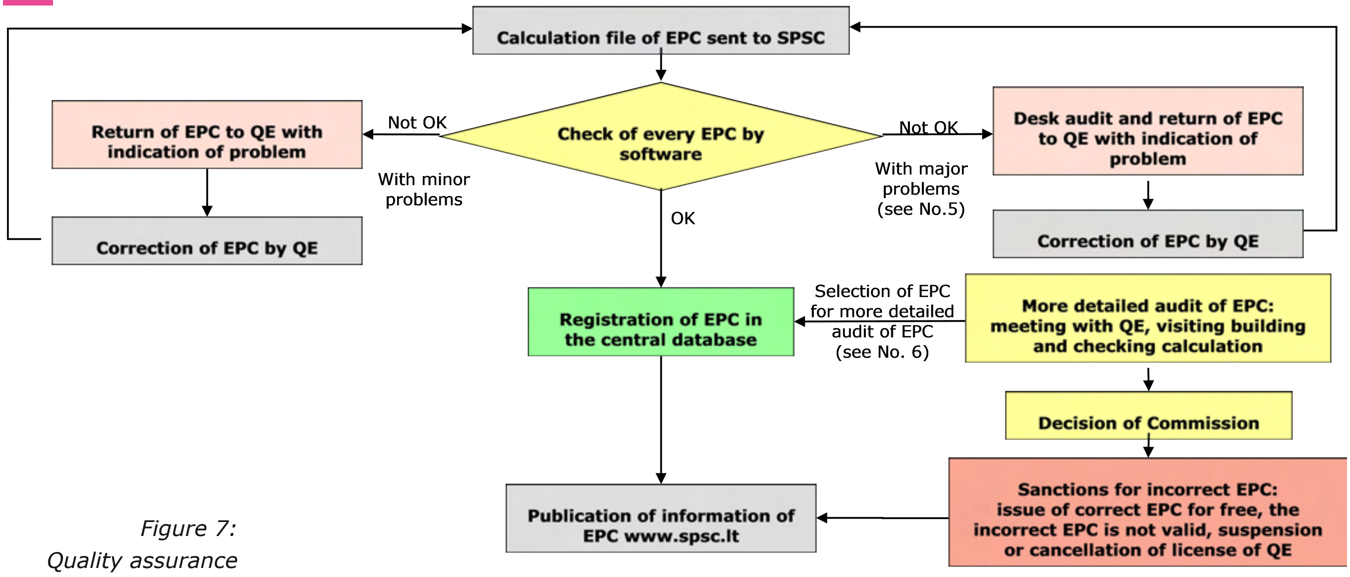


Figure 7: Quality assurance scheme in Lithuania.

compliance with the requirement to issue an EPC for every new building and every major renovation. In approximately 85% - 90% of the EPCs for existing buildings, the energy performance class is lower than required by the regulations.

Quality Assurance (QA) of EPCs

Lithuania has the same Quality Assurance (QA) system for different kinds of buildings. All EPCs have been collected in the central database and register since 2007/2009 (for new and existing buildings, respectively). The following details of every received EPC are checked by software: input data, calculation software version used, validation of QEs' certification and QEs' training.

EPCs are selected for a desk audit when the values are out of range, or when the EPC has a very high energy-performance class. A more detailed audit is required following client complaints, if the QE has submitted a number of EPCs that require correction, or at random according to the targeted percentage (not less than 0.5% of all issued EPCs).

Possible sanctions for incorrect EPCs include a warning, the obligation to issue a correct EPC for free, invalidation of the EPC, suspension of the QE's certification, or cancellation of the QE's certification. There are no financial or legal penalties for incorrect and/or insufficient certification works for QEs.

In 2013, 39,955 EPCs were registered in Lithuania and 587 EPCs were returned to the QEs for correction due to mistakes and/or inaccuracies. Eight (8) EPCs were controlled through on-site detailed visits.

The QEs were informed and/or warned about mistakes and were asked to re-issue a correct EPC without charge.

This QA scheme is quite simple and effective (Figure 7).

Figure 8: EPC on display in an existing public building.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

According to the requirement of the Law on Construction of 9 January 2013 for buildings with a total useful floor area over 500 m² constructed for hotel, administrative, trade, services, catering, transportation, cultural, educational, healthcare or leisure purposes, occupied by the public and frequently visited by the public, energy performance certification is mandatory. An EPC, no older than 10 years, must be placed in the building in a prominent place clearly visible to the public (Figure 8).

Compliance with this requirement is controlled by the municipality that carries out supervision of building maintenance.

For new public buildings, as well as for existing buildings undergoing major renovation, an EPC is always controlled by the Commission of acceptance of buildings. Notaries also ensure there is an EPC during signing of real estate contracts for public buildings.

From 9 July 2015, the threshold of 500 m² will be lowered to 250 m².

Format and content of the EPC

In Lithuania, the EPC, the assessors, the costs and the quality control scheme for public buildings and large buildings visited by the public are the same as for residential and other non-residential buildings.

Activity levels

At the end of 2014, approximately 8,300 EPCs have been registered for non-residential buildings. Certification of energy performance of public buildings is mandatory in Lithuania. An average of 20% of the controlled buildings are public buildings.

III.iii. Implementation of mandatory advertising requirement

According to the Law on Construction in Lithuania of 9 January 2013, when existing and new buildings or building units are offered for sale or for rent, the energy performance indicator of the EPC of the building or building unit, as applicable, should be stated in the advertisements in commercial media.

At the moment there are no legal or financial penalties established or applied in Lithuania, and the control mechanism is not developed. The Ministry of Environment is responsible for the whole process and is seeking to influence property owners and real estate agencies through several publications and information campaigns.

Detailed official information, texts and tools are available on the national websites. Primary information and related legislation are already available on the national websites[2].

III.iv. Information campaigns

The Lithuanian Housing Strategy was approved by the Lithuanian Government on 21 January 2004. One of the goals of this document is to ensure efficient use, maintenance and major renovation of the existing housing and efficient energy use. With the aim to accelerate the insulation of multi-apartment houses and the modernisation of their energy systems, the Programme for the Modernisation of Multi-apartment Houses was approved by Resolution No. 1213 of the Government of the Republic of Lithuania on 23 September 2004. It is being revised, envisaging additional financial and other measures aimed at encouraging apartment owners to renovate multi-apartment houses and involving low-income population in the implementation of such projects.

The Public Company Housing Energy Efficiency Agency (BETA) gives special attention to publicity while developing multi-apartment building renovation (modernisation) programmes. The main goals of the publicity campaign are to encourage flat owners to join the programme, increase public awareness of the programme, ensure that information will be effectively provided to all target groups seeking to take an advantage of the programme's support, and develop positive public opinion about the programme. The primary target group are the final beneficiaries, being residents of apartments, chairmen of multi-apartment associations and administrators, as well as the programme administrators appointed by the municipality.

The secondary target group are associations related to the renovation process, local and national authorities, independent experts, opinion leaders and media, among others. The most important focus is on the final beneficiaries during this communication process.

The most important activities of the campaigns consist of organising:

> seminars for residents, for project managers, for chairmen of multi-apartment associations, for investment planners, for engineers, for contracting companies, etc.;

> an annual conference to summarise the results achieved during the year; the conference is organised by the municipal mayors and administrators of the projects that are being implemented;

> 'Renovation days' in different cities of Lithuania; representatives of the Ministry of Environment and Housing Energy Efficiency Agency meet with residents and other participants in the renovation process in different cities.

Other activities include:

> a free consultation line;

> a temporary website for each activity;

> printed hand-outs (leaflets and posters);

> a detailed guide (handbook), describing all the steps in the entire renovation (for project managers);

> a long-term media project on the most popular internet portal www.delfi.lt;

> an intensive information campaign in regional media;

> articles in national and specialised media.

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[2] *www.am.lt, www.spsc.lt, www.betalt.lt, www.enmin.lt*

III.v. Coverage of the national building stock

More than 81,000 EPCs were issued in Lithuania since the system was implemented in January 2007.

There are more than 759,500 buildings with 1,075,000 building units in Lithuania at the end of 2014, and more than 38,000 multi-family buildings with more than 800,000 apartments in them. The classification of buildings according to intended use has been changed several times, so no clear data is available on how many buildings or building units should have an EPC. With existing data, the EPC coverage of the building stock cannot be calculated.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

To implement Articles 15, 16, 18 and Annex II of the Directive 2010/31/EU for domestic heating systems and Air-Conditioning (AC) systems in buildings, the following orders were adopted:

1. The Lithuanian Minister of Energy and Minister of Economy approved on 10 December 2012 the Order No. 1-256/4-1205 “On the Approval of the Regulations” which describes compliance with the energy efficiency requirements of both heating and AC systems and the alternative measures for verification that are applied in Lithuania.

2. The Minister of Energy of the Republic of Lithuania approved on 26 March 2013 the Order No. 1-67 “On the Approval of Methodologies” which describes the inspection methodologies of both heating and AC systems applied in Lithuania.

Alternative measures are applied to all household customers, as well as other users, when:

1) the heating system is in operation with more than 20 kW but not more than 100 kW of rated power output;
2) the AC systems are in operation with more than 12 kW but not more than 100 kW of rated power output.

Alternative measures do not restrict opportunities for household customers and other users to choose the method of compliance verification established in Lithuania.

The Minister of Energy approved the Order No. 1-67 “On the Approval of Methodologies” on 26 March 2013, which describes the inspection methodologies of both heating and AC systems applied in Lithuania.

According to this regulation, heating and AC system inspections and the application of alternative measures are presented in Table 5.

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

Compliance is checked using methodologies for heating and AC systems inspection approved by the Minister of Energy. These methodologies cover the measurement and estimation of the essential energy efficiency parameters of heating and AC systems. These parameters are determined to minimise the resources and costs needed for compliance inspection.

The operating parameters of the systems determine the energy efficiency of the systems’ operation. These parameters

Table 5: Map of application of inspections or alternative measures.

	Heating systems, rated output power		Air-Conditioning, rated output power	
	> 20 – 100 kW	> 100 kW	12 – 100 kW	> 100 kW
Household customers (HC)	Alternative measures are applied for all HC, though HC has the right to choose regular inspection. The inspections for HC are provided free of charge and the payment is made from the budgetary money.			
Other users (OU)	Alternative measures are applied for all OU. If OU is not applying these measures, it must do a regular inspection. If alternative measures are applied, OU has the right to additionally order a regular inspection. The payment for regular inspections is made by OU.	Regular inspections are applied for all OU. The payment is made by OU.	Alternative measures are applied for all OU. If OU is not applying these measures, it must do regular inspection. If alternative measures are applied, OU has the right to additionally order a regular inspection. The payment for regular inspections is made by OU.	Regular inspections are applied for all OU. The payment is made by OU.

should not be underperforming the parameters of the design values of the systems or economically-validated values of the other parts of the systems which determine the energy efficiency of the heating or AC systems (hereinafter - the limit values). The limit values are compared with the actual values of the operating parameters and in this way the weaknesses of the systems are determined and recommendations for improvement are suggested.

The limit values or references to regulations or technical documents where these values are described are given in the methodologies mentioned above. The limit values need to be consistent with the values that can be achieved following the manufacturer's recommendations and considering the heating system and boiler type or AC systems, the rated output power, the actual loading rate during the heating season, the operating conditions and the duration of the operation of systems, while following the requirements set out in the legislation of Lithuania.

The scheme that determines the frequency of heating system inspections for household , as well as for other users is presented in Table 6.
AC inspections for household customers, as well as for other users, are applied every third year, independently from the rated output power.

Based on this methodology, the inspection results are presented in the inspection reports. Two typical inspection reports are approved in this methodology - one for heating and another for AC systems. Two copies of each inspection report are made - one for the user, and another is kept in the inspectorate under the Ministry of Energy.

The inspectorate is responsible for organising and controlling the inspection of compliance of heating and AC systems in Lithuania. The Ministry of Energy controls the inspectorate, by approving a typical form which the inspectorate provides every year.

Arrangements for assurance, registration and promotion of competent persons

The inspectors who perform the inspection must be independent from the users, as well as from the designers of the systems or related components, manufacturers, assemblers, supervisors, power suppliers and other persons who may have an impact on their professional decisions.

Promotional activities

The information about regulations of inspections, inspectors' trainings and certification, registered inspectors, efficient fuel and energy consumption is publicly available on the website of the inspectorate. The inspectorate regularly reviews and renews this information.

Enforcement and penalties

The inspectorate is responsible for penalties for the inspections, and is planning to adopt a procedure for these penalties.

Quality control of inspection reports

Seven (7) physical and juridical persons and enterprises are qualified to inspect heating systems. Approximately 40 physical and juridical persons and enterprises are qualified to inspect AC systems.

The inspectorate issues certificates to operate energy systems and controls the activities described in the certificate.
A total of 6,102 inspections of heating systems were carried out in 2013. Of these inspections, 4 heating systems were independently controlled.

Costs and benefits

Lithuania is planning to establish a fixed cost for an inspection in the near future. According to research undertaken in 2012 by the Lithuanian Energy Institute on the implementation of the EPBD, the costs for the inspection of heating systems may vary from 350 to 430 € depending on the power of the heating system, whereas for AC systems costs are calculated at approximately 345 €.

IV.ii. Report on equivalence

Alternative measures are applied for all household customers independently from the systems rated output power. Alternative measures do not restrict opportunities for all household customers to choose the compliance verification that has been established in Lithuania.

In 2012, the Lithuanian Energy Institute conducted research on the implementation of the EPBD, to compare the benefits of periodic inspections of

Table 6: Inspection periods for heating systems.

Heating systems, rated output power		
> 20 – 100 kW	> 100 kW	
Every fifth year	Gas fuel	Other fuel
	Every fourth year	Every second year

heating and AC systems and alternative measures. The results of the research were used as a reference for the regulations.

In brief, the study reported that alternative measures - consultations and information campaigns for system users - can be equivalent to a regular inspection, if users have enough knowledge about their building or heating system at home. Natural gas or oil boilers installed in the heating systems of larger public buildings do not only have devices to measure fuel consumption, but often also devices to measure produced heat. The average thermal efficiency of such boilers can be easily calculated, providing information on making the balance between the consumed fuel energy and the produced heat. The alternative to such regular inspection of heating systems could be a mandatory requirement to measure the produced heat. In this case, monitoring the boiler's thermal efficiency can be undertaken by the supervision specialist, or even by the boiler operator himself, if he is appropriately trained. Such monitoring of the boiler's thermal efficiency is considered to be more effective than regular inspection every 2 to 4 years, which only gives a momentum thermal efficiency measurement, corresponding to a particular boiler operating mode during the routine inspection.

An alternative method could evaluate the actual annual average thermal efficiency of the boilers. Another reason to adopt an alternative method is that the heating systems are not technically adjusted for the required measurements. For example, necessary sampling holes for smoke analysis are not installed, and measurement devices which would be metrologically tested for recording system operating parameters are also not installed. In addition, during the regular system inspections, inspector‘s proposals to change or upgrade system‘s facilities or other parts come as recommendations, and therefore the building owner is not obliged to consider them.

The study also showed that inspection of heating systems equipped with less than 100 kW heating rated power pay off only if defects identified during the inspection are removed and recommendations are implemented (the heating system's efficiency would increase by at least 4.5%) while for wood-fuelled heating systems even more so (by no less than 10%). The inspection costs for AC systems with a cooling capacity from 12 to 100 kW pay off if efficiency is improved by at least 2.3% to 13%. Increased efficiency improvement is required for less powerful heating and AC systems. These results for heating and AC systems are unlikely, therefore alternative measures are chosen for these systems.

The inspectorate organises and controls the application of alternative measures to assess and improve the energy efficiency of heating and AC systems, the overall result of which should match regular compliance inspection. The system user decides on their own whether to follow the recommendations or not, as there is no enforcement. Among other things, the inspectorate evaluates the match between the overall results of alternative measures and results of regular inspections, and improves the alternative measures and/or creates new measures if the overall result from the alternative measures is not equivalent to the results from the regular inspections. Annual reports from the Inspectorate shall describe the actual achievements of the alternative measure, assess its overall results and show that they will at least match those of a regular inspection scheme.

Detailing of activities to improve energy performance of heating systems

The inspectorate provides regular consultations via telephone or internet.

Impact and equivalence assessment

The state enterprise Centre of Registers provides sufficient information on buildings, but insufficient information on boilers and replacement rates. Therefore, the inspectorate needs to gather information through a questionnaire which is publicly available on its website. So far, there has been very little public interest in filling in this questionnaire.

Costs and benefits

Alternative measures are carried out without costs. The costs are incorporated into the work done by the inspectorate, which is financed by the country's budget.

3. A success story in EPBD implementation

The main task of the Programme for the Modernisation of Multi-apartment Houses was to provide support to home-owners of multi-family buildings with the implementation of energy efficiency measures. The Programme began at the end of 2005.

The participants in the programme were apartment owners, the Housing Energy Saving Agency, municipalities, commercial banks, housing loans insurance companies, housing administration companies, engineering consultant companies (which prepare energy audits and investment proposals), contractors, etc.

The following are some of the measures funded by the programme to increase energy efficiency: replacement of windows, replacement of doors, insulation of ceilings/roofs, insulation of walls, installation of solar panels and wind mills, replacement of energy related equipment, replacement of elevators and electrical wiring in shared areas (stair wells, basements).

Therefore, the Lithuanian Government negotiated the establishment of the JESSICA Holding Fund to offer an attractive financing scheme to accelerate the major renovation process. Lithuania is one of the first countries in the European Union to use the JESSICA initiative for the improvement of energy efficiency in multi-apartment buildings. Originally, the fund size was projected at 227 M€ (127 M€ from the ERDF, as well as 100 M€ of the Lithuanian national budget). The overall aim of the JESSICA Fund is to contribute to increased energy efficiency in the housing sector by offering long term loan financing at preferential terms and conditions.

In 2010, a JESSICA financing mechanism was developed, by which the state will support about 30% of the rehabilitation project value from 2011 onwards: 100% support for technical documentation preparation and expenses for supervision of construction works if D class (according to the EPC classification) will be achieved, 15% support for energy efficiency measures implementation if D class (according to the EPC classification) will be achieved, and 100% support for low income families.

Beginning in 2013, the Lithuanian Government decided to accelerate the renovation process. Building upon the existing national programme for energy efficiency, a new model for renovation of multi-apartment buildings has been developed (the loan charge lies on the project administrator, the resident does not hold the financial burden).

In 2013, the additional incentive funded by the Special Climate Change Programme, to complement the JESSICA programme in the form of an additional 10% investment grant, was approved in case energy consumption is reduced by at least 40%. The total subsidy for renovation is 40%. In the context of the scheme, the state provides 100% of reimbursement for the loan repayment instalments for low-income families from its own budget and 100% reimbursement for the preparation and administration of paperwork. The JESSICA loan (maturity up to 20 years at a fixed annual interest rate of 3%) is offered to the owners of apartments or other premises in multi-apartment buildings, provided they commit themselves to implement energy efficiency measures and other measures set forth in the investment plan.

Renovation of each multi-flat building begins with the audit, calculation and issue of an EPC. The EPC is issued by attested certification experts using the calculation software tool, followed by recommendations to increase energy efficiency. Recommendations and EPC data are later used to draft the Investment Plan for renovation. Renovation of each multi-flat building ends up with the issue of a new EPC -to check whether the measures set out in the Investment Plan have been implemented and the planned performance actually achieved. Only an EPC with a positive evaluation allows for the final payments to be made, so energy efficiency certification and the EPC play a highly important role in the process of successful renovation.

The average price for multi-apartment building renovation is 200,000 €. This usually includes extra insulation of the envelope -roof and walls, replacement of windows and entrance doors, heating system‘s modernisation and rebalancing, and installation of thermostatic valves. The value of signed contracts currently stands close to 150 M€, which makes up to 8.3% of return in the whole construction sector of the country in the last year (Figure 9).

The programme has already achieved significant results – approximately 700 multi-apartment buildings have begun the renovation process (during 2013-2014), which is about 40% more than in the previous period (2005-2012). Ninety thousand (90,000) individuals would benefit from improved living standards, with 87,500 MWh of energy saved per year.

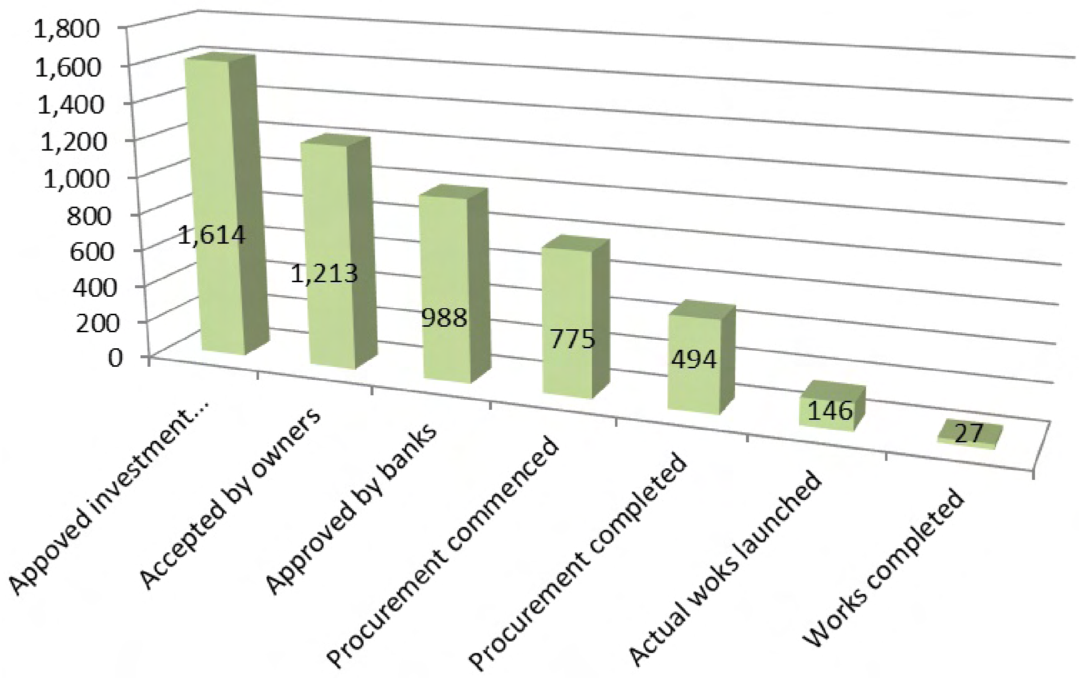

Figure 9: Progress of renovation process from 1 January 2013 from 6 June 2014.

4. Conclusions, future plans

The building sector has become one of the priority areas for Lithuania in trying to meet its ambitious climate and energy targets for 2020. Several legislative initiatives have been introduced for building renovation. One of them - the cost-optimal energy performance requirements - was introduced into national legislation and is used for new buildings as well as for renovation activities.

Calculation and design methods are well-developed and are being continuously upgraded, but there is still need for training of designers and building users and owners. The Ministry of Environment supports and promotes many private and public initiatives, e.g., passive house and renovation of multi-apartment buildings in the framework of different programmes, informal training of the workforce by suppliers of construction products and systems and others.

Stepping into the final phase - mandatory A performance class for new buildings - information campaigns and public discussions on all important aspects with all stakeholders have become more important and will be improved upon in the near future.

It is worth repeating that a publicly available national plan (STR 2.01.09:2012) was adopted by 2012, with a stepwise approach to arrive at Nearly Zero-Energy Buildings (NZEBs), increasing the required energy performance class for new and reconstructed buildings and buildings after major renovation. The plan is well-known by investors, contractors, owners and institutions.

A central database of Energy Performance Certificates (EPCs) is recently integrated with the real estate property cadastre and very informative public register.

Regarding inspections of heating and Air-Conditioning (AC) systems, Lithuania is planning to revise the system to make it easier to understand and implement.

Implementation of the EPBD in Luxembourg

STATUS IN JULY **2015**

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1. Introduction

In Luxembourg, the implementation of the Energy Performance of Buildings Directive (EPBD) is the overall responsibility of the Ministry of the Economy with the General Directorate of Energy as the managing body. The EPBD was implemented by regulations based on the "loi du 5 août 1993 concernant l'utilisation rationnelle de l'énergie" (referred below as "law 1993"). This law is the legal basis to set up the requirements for the energy performance of buildings. In 1995 Luxembourg implemented the first mandatory requirements for residential and non-residential buildings with a regulation which set up requirements for new buildings and for the renovation of building elements of existing buildings. The regulation fixed a maximum average U-value for the whole building, taking into account several aspects, e.g., the ratio volume/surface and the inside temperature of buildings.

In 2008, the requirements for residential buildings were modified in order to transpose the EPBD in national law ("règlement grand-ducal modifié du 30 novembre 2007 concernant la performance énergétique des bâtiments d'habitation" - referred below as "RGD 2007"), and the Energy Performance Certificate (EPC) became mandatory for residential buildings. A timeline for the improvement of the energy performance of residential buildings was defined in 2012. The implementation of the EPBD, including the mandatory issue of EPCs for non-residential buildings, came in force in 2011 ("règlement grand-ducal modifié du 31 août 2010 concernant la performance énergétique des bâtiments fonctionnels" - referred below as "RGD 2010"). In 2015, a first step for reinforcing the energy performance of new non-residential buildings was also decided.

The concept of Nearly Zero-Energy Buildings (NZEBs) for residential buildings was defined in a draft regulation introduced in the regulatory procedure in July 2015, and will become mandatory for all new buildings (including public buildings) from 1 January 2017. For non-residential buildings, work on the exact NZEB definition and time of entry into force (planned for 2019) is still in progress. The detailed information and application of the nearly zero-energy standard can be found in the national plan for NZEBs which was sent to the European Commission in July 2013.

The cost-optimal study of energy performance requirements was established in 2014 in accordance with the EPBD, proving that for residential buildings, the energy performance requirement in force in 2014 (standard C-B) meets the cost-optimal requirements set by the EPBD. In respect to non-residential buildings, the requirement which is in force in 2015 (C-C) is cost-optimal as well.

Furthermore, the obligation to indicate the energy performance class in advertisements has entered into force and is widely used. Additionally, controls of energy performance certificates (EPCs) ensure the quality of the issued certificates.

Finally, a guide with refurbishment recommendations has been established.

Since 2012, the Ministry of the Economy has been working to set up a database to collect all established EPCs. This database shall also provide an overview of the existing building standards, enabling the design of well-targeted refurbishment strategies.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

The energy performance requirements for new as well as existing buildings in both the residential and non-residential sectors are fully implemented. The RGD 2007 and the RGD 2010 implement among others:

> a methodology to calculate the energy performance of buildings;
> minimum requirements for new buildings, extensions and renovated building elements of existing buildings;
> the EPC.

Since 2012, Luxembourg has mainly implemented:

> a roadmap towards NZEBs;
> an obligation to indicate the energy performance of buildings in advertisements;
> a timetable to reinforce energy performance requirements for residential buildings;
> a first step on the timetable to reinforce energy performance requirements for non-residential buildings;
> a cost-optimal study;
> an obligation for experts to upload their energy performance certificates of residential buildings in a database;
> a modification of the supporting financial scheme concerning residential buildings.

No distinction has been made between public and private buildings in respect to energy performance requirements. Nevertheless, the public sector will have a leading role and will set the example.

I.ii. Format of national transposition and implementation of existing regulations

The energy performance calculation of new and existing residential buildings is based on energy needs and includes heating, Domestic Hot Water (DHW), ventilation and auxiliary needs.
The calculation results are expressed in terms of absolute levels of primary energy needs, heating energy demand and CO_2 emissions. The calculation methodology presets an indoor thermal comfort, and considers, among others, infiltrations, thermal bridges, shading devices and ventilation units, to achieve a high quality of indoor air. Infiltration rates as well as thermal bridges can be chosen among predefined values (a detailed calculation is also possible). In passive and low energy buildings, infiltration tests have to prove the chosen infiltration rate. Shading devices have to be defined both separately for each window and globally for all surrounding shading.

In case of non-residential buildings, the energy performance calculation is based on energy needs for new buildings and energy consumption for existing buildings. In addition to the calculation of needs for residential buildings (heating, DHW, ventilation and auxiliary needs), the calculation methodology for both new and existing buildings includes the calculation of energy needs (consumption) for air-conditioning (AC), lighting, humidification and dehumidification. The results are expressed as a ratio to a reference building of the same type, as defined in the annex of the RGD 2010, where 26 categories of technical equipment and envelope characteristics of the reference building are defined. In 2011 the 100% mark represented the minimum requirement for new non-residential buildings. Since 1 July 2015, new requirements entered into force (85% for primary energy and 80% for heating energy demand). This means that no building permit is granted for new buildings situated above these marks. For existing non-residential buildings, the scale of classification ranges from 0% to 400%, where 100% represents a typical existing building of the same type. The calculation methodology for new non-residential buildings follows the same basic principles as the calculation methodology for residential buildings with a few adaptations concerning shading devices.

In addition to the energy performance, the RGD 2007 and the RGD 2010 set up new minimum requirements (U-values among others) for residential and non-residential buildings. The U-value requirements are applicable to new residential buildings, non-residential buildings and public buildings, as well as to renovated parts and extensions of all building types. Global requirements, e.g., the heating energy demand and the primary energy need, have also been set up for new residential and non-residential buildings, as well as for big extensions (for residential buildings: only heating energy demand) - see Tables 1 and 2.

In general, since 1996 the energy performance requirements for all building components and all building types have been tightened. The government expects the new rules, which are laid down in the RGD 2007, to reduce the energy needs of residential buildings as shown in Figure 1.

Through a modification of the RGD 2007 in 2012, Luxembourg is gradually increasing the energy performance requirements of residential buildings (primary energy needs of the building) and the thermal insulation requirements (heating energy demand of the building) following a timetable which runs up to 2017 (Figure 2). As of 2017, the A-A standard, which has also been defined, in principle, as the NZEB standard (draft regulation) will be mandatory. For non-residential buildings, the energy performance requirements were reinforced as of 1July 2015, increasing from the D-D (primary energy needs and heating energy demand) level required since 2011, to C-C level.

A draft regulation modifying the RGD 2007 provides for the definition of the NZEB which is intended to become mandatory for all new residential buildings on 1 January 2017. The NZEB for non-residential buildings is envisaged to become mandatory from 1 January 2019 (the exact timeline and definition are still worked on).

I.iii. Cost-optimal procedure for setting energy performance requirements

Luxembourg submitted the cost-optimal study to the European Commission in April 2014. Eight (8) types of buildings (4 non-residential and 4 residential) have been simulated with 11 different energy performance levels and 30 technical system packages. The results of the study for different kinds of buildings can be summarised as follows:

> For new residential buildings, the cost-optimal level is already reached with the primary energy performance requirement currently in force as well as for the heating energy requirement.

> In the case of renovations on existing residential buildings, the requirements are also considered to be cost-optimal.

> For new non-residential buildings, the tightening of energy performance requirements from class D to class C are also cost-optimal.

> The building requirements currently in force for existing non-residential buildings (undergoing renovation) already comply with the cost-optimal standards, but the study revealed that the cost-optimal level varies substantially depending on the kind of building.

Table 1:
Minimum U-values (W/m^2.k) in place in 2014 for residential and non-residential buildings (values in brackets: U-values until 2008).

Building component	To outdoor air	To weakly heated spaces	To soil or unheated spaces
Wall and floor	0.32 (0.40)	0.5	0.40 (0.50)
Roof and ceiling	0.25 (0.30)	0.35	0.30 (0.40)
Domes	2.7	2.7	2.7
Window or balcony door including frame	1.50 (2.00)	2.00	2.00 (3.00)
Door including frame	2.00 (2.00)	2.50	2.50 (3.00)

Table 2:
Energy performance in buildings –requirements 2008-2014– residential (above) and non-residential (below).

The principles of legislation - REQUIREMENTS			
	Before 1.1.2008	After 1.1.2008	After 1.1.2011
ENERGY EFFICIENT	RGD 22.11.1995	RGD 30.11.2007	RGD mod. 30.11.2007
	U-Values	* Minimal values ° U-Values ° Tightness ° Pipes ° Ventilation * Heating energy index * Primary energy index	
ENERGY EFFICIENT	RGD 22.11.1995	RGD 30.11.2007	RGD 2010
	U-Values	U-Values	* Minimal values ° U-Values ° Sun protection ° Tightness ° Thermal bridges ° Pipes and storage ° Ventilation ° Regulating & measurement devices * Heating energy index * Primary energy index

Figure 1:
Reduction of energy needs over time.

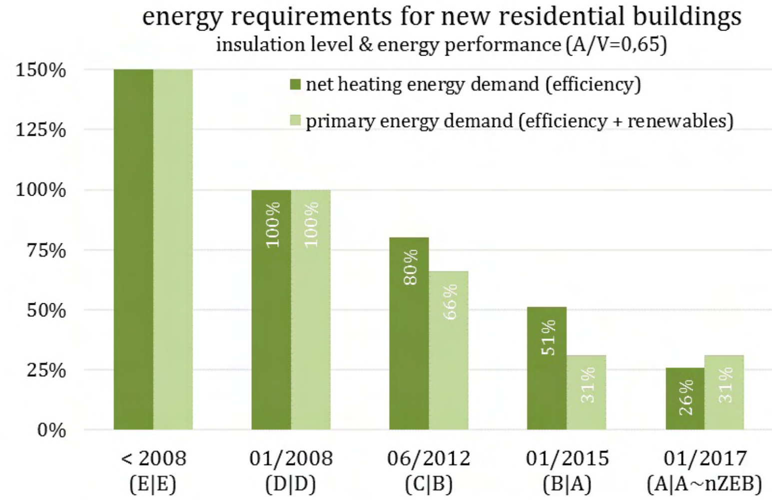
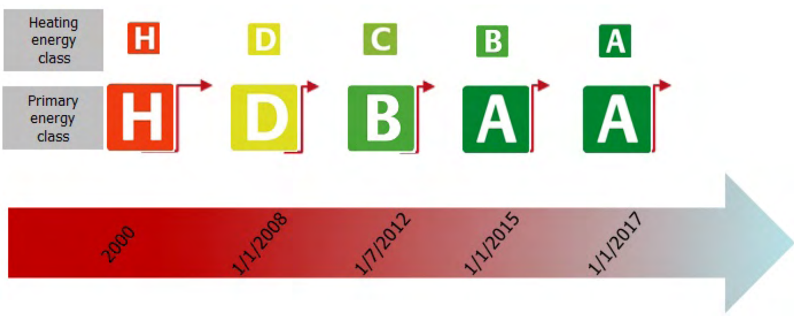


Figure 2:
Timeline of strengthening energy performance requirements for new residential buildings.



- For residential and non-residential buildings the actual requirements for technical installations are already cost-optimal.

The described change (from D-D standard to C-C standard) for new non-residential buildings leads to approximately 15% savings in primary energy needs and 20% savings in heating energy demand. The corresponding values, which became mandatory requirements in 2015, meet the cost-optimal criteria.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

The RGD 2007 and the RGD 2010, amended through a regulation in 2014, provide in their definitions the outline of the NZEB concept that will become mandatory for all new buildings (residential, non-residential and public). The draft regulation modifying the RGD 2007 states that for residential buildings the NZEB-standard will become mandatory from 1 January 2017, while for non-residential buildings, the exact timeline and definition are to be adopted in 2015/2016.

The calculation of NZEBs will follow the same rules as the calculation of 'normal' buildings with a few adaptations concerning on-site renewable energy production (e.g., photovoltaics). In principle, the nearly zero-energy standard will be a highly energy-efficient building. The current proposal for residential buildings foresees the A-A standard in principle with on-site renewable energy production which could be partly incorporated in the energy balance. The fine-tuning of the exact calculation methodology and the NZEB definition for non-residential buildings is still in progress.

To prepare the sector for NZEBs, the government decided to reinforce energy performance requirements. From 2017, all new residential buildings will have to fulfil in principle the A-A standard which is aimed to represent the NZEB standard once the proposed regulation enters into force.

Statistics of existing NZEBs are not available yet but, as it is envisaged that with the new draft regulation from 2017 the A-A requirement will represent in principle the NZEB standard, the percentage of residential buildings which meets the NZEB standard is expected to rise in the forthcoming years. The construction rate in Luxembourg is very high (~2%/year) and this is an additional factor for a high market penetration rate of NZEBs. In this respect, many buildings currently being built are already aiming at the A-A standard even though the energy efficiency requirements for new buildings were only set at the C-B level on 1 July 2012 and at the B-A level on 1 January 2015.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

In response to Article 4 of the Energy Efficiency Directive (EED), Luxembourg is still working on the fine-tuning of the national long-term strategy for mobilising investment in the renovation of the national stock of residential and non-residential buildings. This strategy shall be based on information about national buildings and especially on data about the buildings' energy performance. The national database on EPCs is being finalised and is expected soon; once in operation, the information contained in it is expected to give a more precise overview of the characteristics of residential buildings. Non-residential buildings will be incorporated in the database at a later stage.

With regards to EED Article 5, Luxembourg has the intention to renovate each year 3% (~4,000 m^2) of the national buildings owned and occupied by the central government and does not opt for the alternative approach provided for. The public building administration in charge of the management and maintenance of the buildings owned by the government has established an inventory of all these governmental buildings and has set up a priority list, including EPC values and other criteria. The inventory was sent to the Commission in early 2014. Currently, the said administration is also developing an internal plan and organising its multi-annual budget in order to ensure the annual 3% renovation target.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

Requirements for technical building systems (TBS) are set in a few regulations:

- *"règlement grand-ducal modifié du 27 février 2010 concernant les installations à gaz"* (further the "gas regulation");

> *"règlement grand-ducal du 7 octobre 2014 relatif a) aux installations de combustion alimentées en combustible solide ou liquide d'une puissance nominale utile supérieure à 7 kW et inférieure à 20 MW b) aux installations de combustion alimentées en combustible gazeux d'une puissance nominale utile supérieure à 3 MW et inférieure à 20 MW"* (further the "oil and wood regulation");
> *"règlement grand-ducal du 2 septembre 2011 relatif a) aux contrôles d'équipements de réfrigération, de climatisation et de pompes à chaleur fonctionnant aux fluides réfrigérants du type HFC, HCFC ou CFC, b) à l'inspection des systèmes de climatisation"* (further the "AC regulation");
> RGD 2007;
> RGD 2010.

The above regulations cover gas, wood and oil fired boilers, AC systems, heat pumps and ventilation systems. The Ministry of Sustainable Development and Infrastructures and the Ministry of the Economy share the responsibility in respect to these regulations.

In 1989, Luxembourg established a mandatory acceptance procedure for new buildings, and regular inspections of oil and gas fired boilers in existing buildings. For gas fired boilers, this system became mandatory in 2000 and for wood fired boilers in 2014. The acceptance procedure and the regular inspection of AC systems have been mandatory since 2009 in residential as well as non-residential buildings. Each new oil, wood or gas fired heating system in new and existing buildings is submitted to an acceptance procedure. The acceptance procedure checks the conformity of the security equipment, the location, the smoke evacuation, the combustion quality and efficiency. Dimensioning is not checked at this stage, but is checked within the periodic inspection. Since Luxembourg imports nearly all appliances and equipment, European standards and standards of the countries of origin are applicable in Luxembourg.

The RGD 2007 and the RGD 2010 set some energy performance requirements concerning pipe work insulation, ventilation and AC systems. Pipe work insulation requirements depend on the diameter of the pipes, with larger pipes requiring better insulation than smaller pipes.

The RGD 2007 defines energy performance requirements for ventilation systems (heat recovery ≥ 75%, specific fan power better than 0.50 $W/m^3.h$ and 0.60 $W/m^3.h$, respectively). Similarly, the RGD 2010 includes requirements for the energy performance (heat recovery ≥ 60%, air speed and efficiency requirements depending on the size of the system, alternatively specific fan power (SFP) requirements), the proper installation and dimensioning (requirements on the form of the air ducts), and other regulation requirements (regulation on humidification and dehumidification) for ventilation units.

The financing mechanism in place for technologies based on Renewable Energy Sources (RES - solar panels, heat pumps, wood fired boilers, etc.) also sets different energy efficiency requirements. Consequently, e.g., solar panels have to be certified by an independent institution, be equipped with a calorimeter, and their minimal collector surfaces must be set to 9 m^2 for plane collectors and 7 m^2 for tubular collectors in order to be considered eligible for financing. Heat pumps have to fulfil, among others, efficiency requirements (COP > 4.3 for ground source heat pumps and > 3.1 for air/water heat pumps). Wood fired boilers have to fulfil, among others emission (CO, NO_x, particulate matter) and efficiency requirements.

Furthermore, large installations must comply with certain requirements set by the environmental and safety impact authorisation procedure; such requirements depend on the scale and type of the installation. They can be grouped into general security requirements, technical requirements and energy performance requirements (best available technology) - e.g., see Table 3.

II.ii. Applicability to new, replacement and upgraded systems in existing buildings

Technical requirements set in the different regulations are applicable for new and existing installations (replacement or upgrade). Gas, wood and oil fired boilers are subject to a conformity control of the installation. During this conformity control a list of requirements is checked (correct installation and functioning) as described in Table 3.

	Gas fired boilers	Oil fired boilers	Wood fired boilers
Combustion efficiency	≥ 89% (4-25 kW) ≥ 90% (26-50 kW) ≥ 91% (50-3,000 kW) ≥ 91% (≥ 3,000 kW)	≥ 90% (7-50 kW) ≥ 91% (> 50 kW)	≥ 85% (7-1,000 kW) (≥ 70-85% for small, single room combustion plants, depending on type and fuel) ≥ 90% (≥ 1,000 kW)
Combustion quality (CO)	≤ 300 ppm ≤ 50 mg/m³ (≥ 3,000 kW)	≤ 1,350 mg/m³ (< 1000 kW) ≤ 80 mg/m³ (≥ 1,000 KW)	Depending on installation age, fuel and installation power, CO value can vary between 250 to 4,000 mg/m³ (< 1,000 kW) From 01.01.2016: 400 mg/m³ (< 1,000 kW) 150-250 mg/m³ (≥ 1,000 KW and depending on fuel)
Combustion quality (Dust)	≤ 5 mg/m³ (≥ 3,000 kW, sewage gas and biogas)	Soot level 1 or 2 (< 1,000 kW) Soot level 1 (≥ 1,000 kW)	≤ 60-100 mg/m³ (< 1,000 kW, depending on fuel) From 01.01.16 ≤ 30 mg/m³ (< 1,000 kW) ≤ 20 mg/m³ (≥ 1,000 kW)
Combustion quality (NOx)	≤ 100-150 mg/m³ (≥ 3,000 kW) depending on operating temperature	100-185 mg/kWh (< 1,000 kW, depending on plant power) ≤ 180-250 mg/m³ (≥ 1,000 kW) depending on operating temperature	≤ 250-500 mg/m³ (≥ 1,000 kW, depending on fuel)
Combustion quality (SO_2/SO_3)	/	/	Fossil solid fuels: 350 & 1,000 mg/m³ (≥ 1,000 kW), depending on combustion technology
$O_{2\text{-Ref}}$	3%	3%	13% (< 1,000 kW) 11% (biomass, ≥ 1,000 kW) 7% (fossil solid fuels, ≥ 1,000 kW)

Table 3: Requirements of heating systems.

II.iii. Provisions for installation, dimensioning, adjustment and control

The gas regulation, among other requirements on the installation, provides for the exploitation, the control and the regulation of gas fired boilers and particularly where energy performance, requirements on combustion efficiency and quality are concerned. During inspection, the dimensioning of the heating system is evaluated and recommendations are given in order to improve the energy performance. Similar provisions are defined in the oil and wood regulation for oil and wood fired boilers.

The AC regulation provides for energy performance, correct installation (liquid fluid leakage ≤ 5%/year) and dimensioning, as well as regulation requirements for AC systems.

II.iv. Encouragement of intelligent metering

In 2011, a study on the introduction of smart meters in Luxembourg was carried out. A structure was formed, bringing together the grid operators, the regulatory authority of Luxembourg and the Ministry of the Economy. The 2007 laws on the organisation of the electricity and gas markets were amended in 2012 in order to define a timeframe for the introduction of a common smart metering platform for natural gas, electricity and water. The deployment of smart meters should start in 2015 and equip at least 95% of all final consumers with smart meters by 2020. Seven grid operators are to carry out the implementation of smart meters in Luxembourg.

II.vi. Encouragement of active energy-saving control (automation, control and monitoring)

The RGD 2007 and the RGD 2010 require an update of the issued EPCs with measured energy consumptions after 4 years.
The RGD 2010 sets supplementary requirements for the installation of measurement (individual measurement recommendations of some appliances and general measurement requirements) and regulation equipment (regulation of heating systems with exterior temperature, local temperature regulation possibilities, time regulation for pumps, etc.) for new non-residential buildings. The RGD 2010 also recommends, and in some cases requires, the installation of measurement equipment for existing non-residential buildings in general and for different appliances individually.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

As the managing body, the General Directorate of Energy designed, developed and currently supports the entire certification system, with the help of external experts if needed. A national database is being developed, which collects all EPCs (existing and new) issued by the experts for residential buildings, and shall allow drawing statistics on the national building stock. In a later phase the database can be extended to non-residential buildings. At this time it is the raw data of the database that is mainly available. The operational work is still in progress.

How flats are certified in apartment buildings

The EPC is always established for whole buildings. In apartment buildings, no separate EPC is issued for each apartment but an original of the certificate must be assigned to each owner of an apartment.

Format and content of the EPC

The EPC assigns an energy performance label (A-I) to new and existing residential and new non-residential buildings. For existing non-residential buildings the EPC assigns an energy performance ratio (0-400%, with the 100% mark representing a typical existing building of the same type with a specific energy consumption corresponding to the weighted sum of the typical specific energy consumption for each type of zone). Besides detailed information about the energy indicators and general information of the building and its technical equipment, the EPC also contains cost-effective measures for improving the energy performance of the building.

EPC activity levels

Although Luxembourg currently has no official statistics about the certificates issued per building type, the upcoming national EPC database shall provide this kind of data.

Assessor corps

Qualified Experts (QEs) are the only people recognised to issue EPCs and to carry out energy performance calculations. There are nearly 1,000 registered experts qualified to issue EPCs. They are either members of the Chamber of Architects and Engineers (OAI), or other experts who fulfil

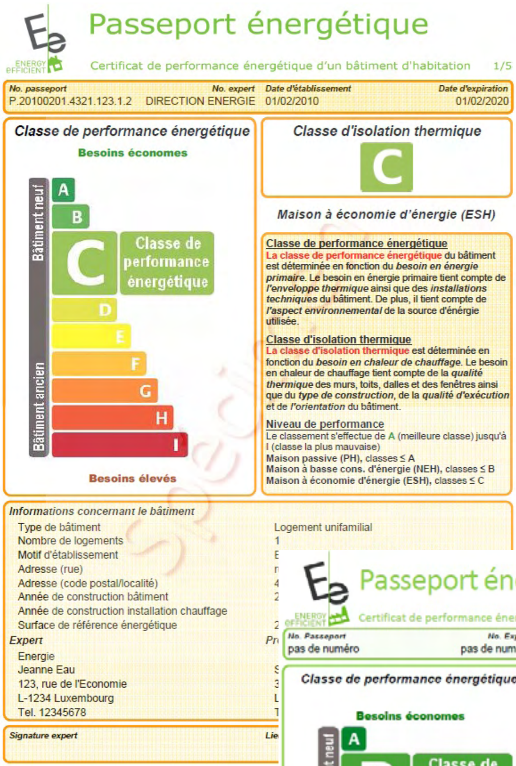


Figure 3: EPC of residential buildings (1st page).

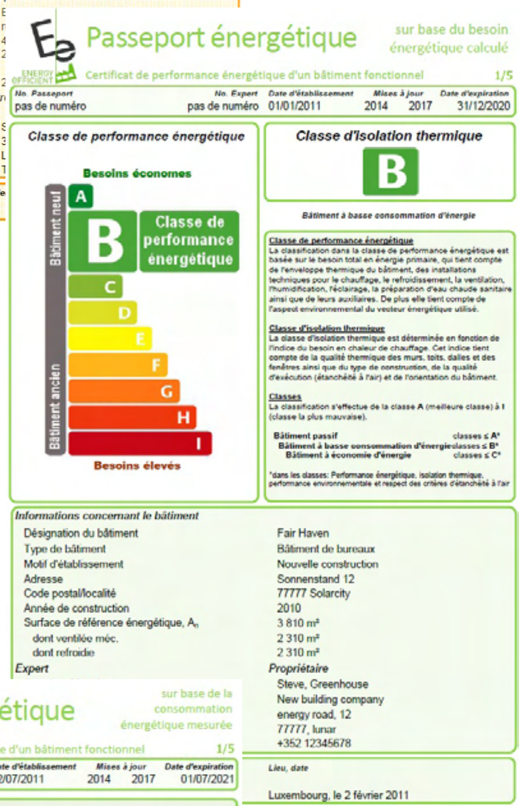


Figure 4: EPC of new non-residential buildings (1st page).

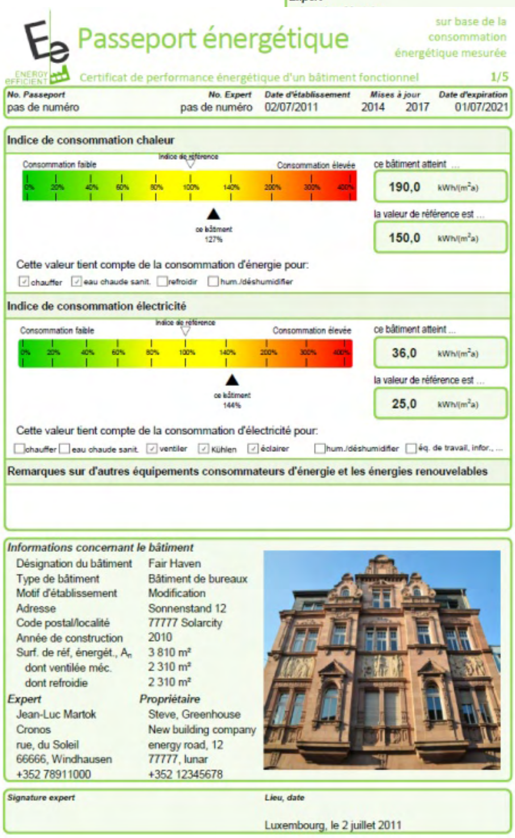


Figure 5: EPC of existing non-residential buildings (1st page).

the criteria. Architects or engineers who are members of the OAI already fulfil the necessary conditions. In addition, the Minister of the Economy can, under certain conditions, authorise other experts to carry out the calculation and issue an EPC for residential (new and existing), and existing non-residential buildings. Before admission, these experts have to fulfil, among others, educational (in principle at least 3 years university education in architecture or engineering, or equivalent) and independency criteria. There is no exam to become a QE.

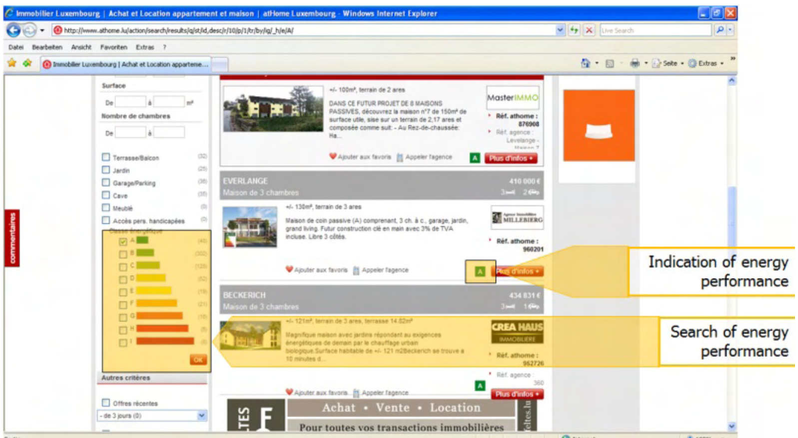
The government has set up non-mandatory courses to ensure the quality of the issued EPCs. The offer of courses for further education in the field of energy performance of buildings has increased substantially over the last years. Courses for certified passive house planners, craftsmen and energy consultants are organised both by private companies and public institutions.

"myenergy" (www.myenergy.lu), the national structure for the promotion of energy efficiency and renewable energy, offers a voluntary certification to experts which is aimed to ensure quality of their issued EPCs.

Compliance levels by sector

For new buildings and buildings undergoing modification, the authority which grants building permits also controls if the building meets the required energy performance set by the national regulations. No building permit is granted without an EPC. In case of a sale or a rental, the original EPC or a copy of it has to be transmitted to the future owner or tenant. In respect to selling a building, the notary checks if the EPC has been issued and the sale can only proceed when a valid EPC is available. In case of an application for subsidy for an energy efficient building or for the refurbishment of an existing one, the EPC, as part of the application, is controlled by the competent administration. Subsidies can be refused if the EPC has not been correctly calculated according to the relevant regulations.

Figure 6: Website with energy performance indicators search criteria.



Quality Assurance (QA) of EPCs

The Ministry of the Economy organises, normally once a year, a series of controls of issued EPCs, to verify their compliance with the legal requirements. In 2013, forty-three (43) EPCs have been controlled. These controls comprise two levels. The first level consists in a plausibility check of the calculated values[1], whereas the second level is a deeper analysis of the EPC containing non plausible elements. Penalties in the form of a limited-time suspension were imposed on 2 experts who were also required to order, at their own cost, a new EPC from a different expert, and to deliver it to the client. All the data entered in the controlled EPCs is checked.

The EPC database, currently under development, shall ensure a better quality control. For each EPC, the database shall check automatically the plausibility and assign a plausibility score giving the opportunity to randomly preselect EPCs for a deeper control, to be carried out by external experts.

III.ii. Implementation of mandatory advertising requirement

A modification of the RGD 2007 and the RGD 2010 has introduced the obligation to insert the overall energy performance class (primary energy) and the heating performance class in advertisements in all commercial media (paper, internet, etc.).

This obligation came into force on 1 July 2012. A large number of advertisements comply with this obligation - Figure 6, but it is currently difficult to draw conclusions on its effectiveness. Compliance is checked at random by the ministry which is firstly focussing on raising awareness in the relevant sectors, and is secondly considering setting up a quality charter to be signed by the main real estate agents association. Penalties are foreseen in case advertisers do not comply with the regulation.

III.iii. Information campaigns

After the new regulation on energy performance in residential buildings came into force in 2008, the Ministry of the Economy initiated an information campaign about the new regulation and especially

[1] *The software which is provided by the Ministry of the Economy for issuing EPCs for residential buildings contains an automatic plausibility check of the entered data. The expert is able to see the results of this plausibility check and can modify the data.*

about the new EPC. A flyer was distributed to all households in Luxembourg and posters were placed on public spaces and buses. myenergy is very active in this field, promoting the EPC on the radio, in the press, as well as with flyers and posters. Awareness raising work is ongoing.

The government created a virtual online desk (www.guichet.lu) where people may get information on all kinds of procedures. This online desk includes a section with all the necessary information on energy performance certification of buildings, authorised experts and governmental subsidies. A section of this virtual online desk is dedicated to energy experts[2] which provides detailed information on the EPC regulation and on the procedure to become an accredited expert. A list of all experts who have completed the non-mandatory training courses offered by the Ministry of the Economy is published on this website. The website also offers the possibility to register online for training courses. Most of the recognised experts take the course.

Detailed information on energy efficiency in buildings and on EPCs is also available on the myenergy website. During the last years, myenergy was present in many events, fairs, seminars and workshops, disseminating information about the certification process and promoting awareness among citizens regarding the added value of building energy performance certification that is based on clear and reliable information.

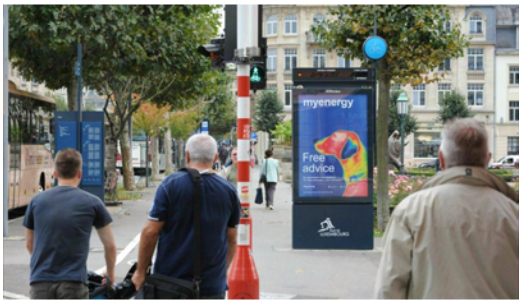
In order to reach people directly, myenergy has set up a network of so called “myenergy info points” over the country. In these info points, the citizens can get professional and objective information about energy performance and certification, for free.

In order to boost energy renovation in residential buildings, and to upgrade the EPC market penetration in the existing buildings’ sector, the actual financing scheme for energy efficient refurbishment is linked to the EPC. If the refurbishment results in at least C-class rating and the improvement covers at least two classes, the owner of the house can, on top of the basic financial support which is a fixed amount per square meter of the refurbished building elements, also receive a bonus (for C-class: 10% bonus, for B-class: 20% bonus, for A-class: 30% bonus).

The government has implemented significant incentives for the energy efficient renovation of existing buildings and for the construction of low energy and passive buildings. The EPC must be presented in order to get financial support, (in case of a refurbishment and in order to get a bonus, both the EPC before and after the refurbishment must be presented). In December 2012, a new regulation was adopted for the period 2013-2016 linking the level of subsidies given to energy efficiency improvements and the use of energy from RES in the residential sector. Technologies linked to RES eligible for support include wood-fuelled boilers and geothermal heat pumps.

Figure 7: Example of a commercial advertisement.

Figure 8: Example of a commercial advertisement.



Figures 9 - 10: Promotional material used by myenergy.

[2] *www.guichet.public.lu/experts-energie*

III.iv. Coverage of the national building stock

No official statistics exist on the EPC coverage of the national building stock. However, the national EPC database shall soon provide data in this respect. The number of buildings in Luxembourg is 131,100.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

IV.i. Progress and current status on inspections of heating systems

Overview, technical method and administration system

The inspections of heating systems are regulated by the gas, oil, and wood regulations mentioned above. After the acceptance procedure, a periodic control of the heating system (every four years for gas fired heating systems and every two years for oil and wood fired heating systems) is mandatory. The results of these certifications and inspections are currently stored in a central database. Besides information on the user and the inspector of the heating system, the inspection certificate for oil and wood fired heating systems includes the following information: location of the boiler, fuel-type, nominal power of the installation, the inspection results, as well as recommendations.

Depending on the fuel type used, it may also contain information about the black carbon index, residual fuel in the exhaust gas, carbon dioxide emissions, nitrogen and ammonia emissions, temperature of exhaust gas, combustion efficiency and particulate matter.

The Environmental Administration manages the implementation of inspection of heating systems on behalf of the Ministry of sustainable Development and Infrastructures as well as the Ministry of the Economy.

Arrangements for assurance, registration and promotion of competent persons

The regular controls are made by installers who have successfully completed special training and own the necessary tools that allow them to perform the inspection in a professional and cost-effective manner. The authorisation to carry out the inspections has a validity of 5 years and it can only be renewed if a special, updated training course is completed.

Promotional activities

The Ministry of sustainable Development and Infrastructures created a flyer and a specific website (www.heizungscheck.lu) dedicated to inform the public on legal aspects of the inspection of heating systems. This will be presented and distributed to the public on fairs and through other media.

Enforcement and penalties

The gas regulation is based on the law 1993 and the oil and wood regulation on the "loi modifiée du 21 juin 1976 relative à la lutte contre la pollution de l´atmosphère" (referred below as "law 1976"). These laws provide for penalties for cases of non-compliance. These laws also set penalties for non-compliance with requirements of the regulations derived from them. If a craftsman fails to follow the reception procedure or an owner fails to do an inspection, sanctions as defined by the basic laws (for criminal offences up to 25,000 € and 2 months imprisonment) can be applied. The relevant ministries have in the past repeatedly sent reminder letters to owners who failed to meet their obligations. The Chamber of Handicrafts regularly exhorts its members to respect

Figure 11: Promotional logo for the inspection of heating systems.

HEIZUNGSCHECK
LUXEMBURG
einfach, schnell & aufschlussreich

Figure 12: Flyer on the inspection of heating systems.

the legal procedures. There are no records of any penalties levied.

Quality control of inspection reports

The heating installation has to comply with the requirements and the reception procedure is not completed until the installation meets all standards.

The periodic inspections are performed by installers, whereby the installation operator can select an installer of his choice. The reports have to be sent to the administration within 10 days from the inspection in the case of gas fired boilers, or 15 days in the case of oil and wood fired boilers. Inspection reports are then controlled and centralised in a database which is operated by the government. All inspection reports are controlled on their conformity and in case of non-conformity sanctions (criminal offences) as defined in laws 1993 and 1976 can be imposed.

Inspection activity figures

By mid 2014, about 460 controllers were accredited by the Chamber of Handicrafts and had the necessary qualifications to revise and inspect heating systems. The authorisation to carry out these inspections is valid for 5 years and can only be renewed if an update course is completed. During 2013, 20,500 inspection reports have been registered.

No survey has been carried out about costs of inspections, but they are nevertheless estimated to be between 100 € and 300 €. Costs have to be paid by the owners of the heating systems.

IV.ii. Progress and current status on AC systems

New AC systems are subject to the same reception procedure as heating systems by the experts of the Chamber of Handicrafts. The national authority in charge is the Environmental Administration.

In existing buildings, inspection of AC systems is performed by certified refrigeration mechanics. It includes the dimensioning and the overall efficiency, to be checked every 5 years, and the leak-tightness of the installation according to the periodicity prescribed by the relevant European Regulation[3], taking into account the charge and global warming potential of the refrigerant used.

Experts are certified by the Chamber of Handicrafts after having completed special training courses. Certifications issued in other Member States can be recognised by the Chamber of Handicrafts. The authorisation to carry out these inspections is valid for 5 years and can only be renewed if an update course is completed.

The inspection of AC systems is continuously promoted via the Chamber of Handicrafts and the Environmental Administration. Special promotion sessions specifically addressing the changes introduced by the new European Regulation on F-gases (see above) are scheduled, in line with the national F-gas law of Luxembourg which will enter into force in the near future.

The F-gas law and related regulations define sanctions for non-compliance with existing European and national legal requirements and include administrative procedures, e.g., the cancellation of an authorisation, fines of up to 500,000 € and/or imprisonment of up to one year, depending on the kind and severity of the infringement. Compliance is checked by the Environmental Administration. So far, no administrative sanction has been issued in the context of AC systems registration and inspection.

Refrigeration mechanics authorised to carry out inspections have the obligation to send to the Environmental Administration a report of the inspections performed during a particular year, by 31 March of the following year. These reports are kept in a database and undergo a quality and compliance check. Dimensioning and efficiency reports may include recommendations. If necessary, e.g., in case of missing reports or excessive leakage, the Environmental Administration may contact the owner of an installation and, in severe cases, initiate administrative procedures or impose penalties. In 2013 the number of cooling installations controlled was 674.

By mid 2014, about 386 controllers were accredited by the Environmental Administration and had the necessary qualifications to revise and inspect AC systems. In 2013, 723 AC inspection reports were registered, part of them from inspections carried out in 2012. The number of cooling installations newly registered in 2013 was 203, with the other 520 corresponding to inspections of existing installations.

[3] *Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006).*

3. A success story in EPBD implementation

In Luxembourg, the EPC is used as a sales argument to sell or rent buildings. In case of a sale, the EPC is required by notaries in order to proceed with the sale. Even before it became mandatory to specify energy classes in advertisements, many real estate market players made use of the EPC to promote their buildings, especially the highly energy-efficient ones. In the media, on websites of building companies or other websites and on posters, the energy performance of buildings is often highlighted. A few websites even integrated the class of energy efficiency of buildings as search criteria. This, in combination with the timeline for reinforcing the energy performance requirements for residential buildings, created a high market pressure causing private and public building companies to start building with high energy standards which often exceed the level of the mandatory energy performance requirements. For example, the public social building promoters decided to build only A-class buildings in the future.

All these circumstances created a high demand for further education, making it possible for private companies and public institutions to create additional courses for engineers, architects and craftsmen, e.g., the certified Passive House planner course or the certified Passive House craftsman course. This experience from the residential sector can serve as background and motivation for similar initiatives for the non-residential sector. Thus, the obligation to show the energy performance classes in advertisements is not just a formal administrative requirement, but has also become a real selling argument. myenergy, the national energy agency, is promoting among others energy efficient and renewable energy themes through a nearly nationwide network of info points where people can get basic advice free of charge, the need for which is rising steadily due also to the high market penetration of the EPC.

4. Conclusions, future plans

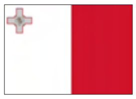
Luxembourg has fully transposed the Energy Performance of Buildings Directive (EPBD) and is getting prepared for the mandatory construction of new residential Nearly Zero-Energy Buildings (NZEBs) from 2017 (draft regulation), by defining a timetable of energy performance standards until 2017. The first step of the timeline for new non-residential buildings has been defined and the next steps will be clarified in 2015. As of 1 July 2015, new non-residential buildings have to meet the C-class standard (until 1 July 2015, the D-class standard was mandatory). In the residential sector, a deeper analysis has been made in order to compare the buildings' energy needs against real energy consumption. For the non-residential sector it is currently assessed whether the asset rating could be extended to existing buildings.

The national Energy Performance Certificates (EPCs) database will be finalised soon, and this will help organise control of EPC compliance in a more efficient way and draw better statistics of the national building stock. A plausibility check of each EPC will be integrated in the database. This will allow to identify with more precision what the experts need in terms of additional education and training and raise the quality of issued EPCs.

A new green building certification system (LUNAZ) will be finalised which will use the experience gained in the field of EPCs. This new certification will be directly linked to the results of the EPC and will additionally address the sustainability of the materials used (grey energy of materials) and other social and environmental criteria. The result will be expressed in a class system from A to I in the same way as for the EPC. It is foreseen that subsidies will be granted for residential buildings that will meet a certain class.

Implementation of the EPBD in Malta

STATUS IN DECEMBER **2015**



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1. Introduction

In Malta, legislation and regulation relating to energy efficiency in buildings imposed limited extra measures due to the prevalent mild climate and relatively low energy use in buildings. The Energy Performance of Buildings Directive (Directive 2002/91/EC and its recast, Directive 2010/31/EU - EPBD) was transposed through a number of statutory instruments over the period 2006-2015.

Legal Notice 238 of 2006 set out minimum requirements on the energy performance of buildings. These were the first ever legally binding regulations relating to overall energy performance of buildings in Malta. Requirements for energy performance certification were set out under Legal Notice 261 of 2008. This legal notice, which transposed the Directive 2002/91/EC into national legislation through the provisions of the 'Malta Resources Authority Act (CAP 423)', also set out requirements for the inspection of heating and Air-Conditioning (AC) systems. Following the Directive 2010/31/EU, Legal Notice 376 of 2012, titled 'Energy Performance of Buildings Regulations 2012' was issued in October 2012 through the provisions of the 'Building Regulation Act (CAP 513)' and the 'Malta Resources Authority Act'. This transposed Directive 2010/31/EU into law and superseded all previous legal notices. This legal notice has been instrumental in implementing energy performance requirements in Malta.

This report illustrates the process by which Malta implemented the EPBD. It also gives a detailed picture of the status of implementation of the EPBD up until late 2015. The aspects described in this report include the systems for energy performance certification of buildings, training of energy performance assessors, current energy performance minimum requirements, cost-optimal studies carried out and emanating proposals, steps taken towards upgrading minimum requirements, inspection of heating and AC systems, training of inspectors, quality control and auditing, information campaigns, incentives and subsidies.

Since October 2012, the responsibilities for the EPBD implementation lay with the Building Regulation Office (BRO) and the Building Regulation Board (BRB), within the Ministry of Transport and Infrastructure.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

Prior to the first steps towards the implementation of the EPBD, no particular legislation treated energy efficiency in buildings in Malta. This was partially due to the mild climate and the traditional vernacular buildings, which due to their high thermal mass and other design features are not particularly avid energy users. Legal Notice 238 of 2006 introduced minimum requirements for all buildings (Figure 1). These minimum requirements tackled various aspects ranging from construction of the building envelope to lighting systems and other technical components. In view of Malta's warm climate, these minimum requirements introduced limits for the size and positioning of glazing to reduce overheating (Table 1). Requirements to limit thermal losses through the building fabric included maximum thermal transmittance values for all building elements. The adopted requirements for walls reflected the local practice of constructing external cavity walls with two 150 mm thick stone leafs. This practice was at the time being replaced by a system of a single hollow concrete block wall and therefore was reducing the thermal performance of the building envelope.

Due to the lack of freshwater available on the island and the dependency on groundwater and desalinated water, the requirements also included mandatory rainwater conservation through the compulsory construction of water cisterns and use of the rainwater for flushing and irrigation purposes in all new buildings.

Figure 1: National requirements for all new buildings.

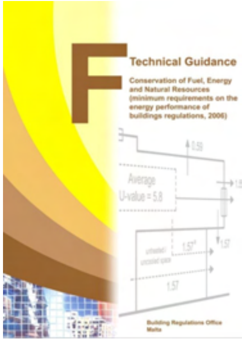


Figure 2: Maximum thermal transmittance factors for all buildings.

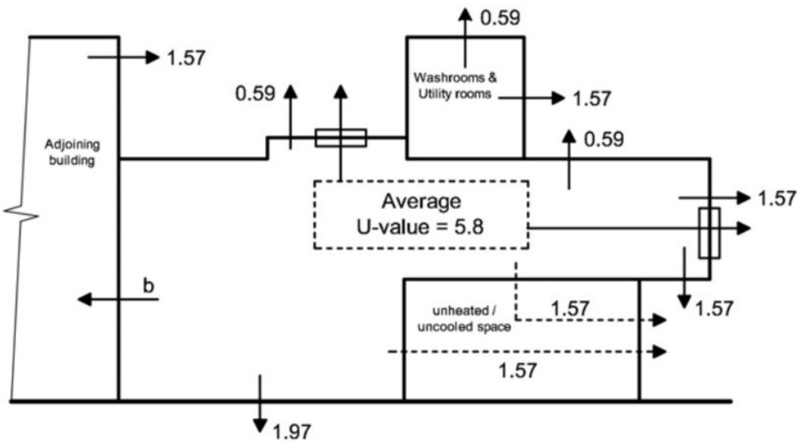


Table 1: Provisions on minimum requirements for the limiting of overheating enable compliance by limiting glazing areas according to orientation (table F.4 of the building regulations).

Maximum allowable area of glazing — **Table F.4**

Orientation of opening	Maximum allowable area of opening (%) using a minimal correction factor of 0.95 for glazing/blind combination
N	25
S	20
NE	17
E/SE/SW/NW	12
W	9
Horizontal (rooflights)	7

Note:

The maximum allowable area of glazing for windows with an orientation falling in between the compass directions indicated in the table may be calculated by interpolating the values shown above.

I.i. Progress and current status

The minimum energy performance requirements that were introduced in 2006 for all new residential and non-residential buildings, were in the form of technical guidance documents. These minimum requirements take a broadly elemental approach to energy performance and are identical for both residential and non-residential buildings. The minimum requirements are also applicable to existing buildings where these are subject to major renovations. The latter was clearly defined in the "Energy Performance of Buildings Regulations LN 376" of 2012 which superseded previous legislation. Where existing buildings undergo such renovation, the minimum energy performance requirements for the renovated parts of the building are the same as those for new buildings.

I.ii. Format of national transposition and implementation of existing regulations

Legal Notice 376 of 2012 issued by the Ministry of Resources and Rural Affairs kept the same provisions for energy performance in buildings requirements adopted in 2006, and transposed other provisions of the Directive 2010/31/EU, including cost-optimal framework and development of plans for Nearly Zero-Energy Buildings (NZEBs).

The minimum requirements are applicable to all new buildings, as well as those undergoing major renovations.

The minimum requirements include provisions on the following aspects:

> maximum thermal transmittance factors for all elements to prevent the passage of heat through the building fabric (Figure 2);

> requirements to calculate the effect of thermal bridges and limits to prevent excessive heat loss through such thermal bridges;

Table 2: Provisions for the controls of heating and cooling systems (table F.5 of building regulations).

Size of plant for which separate metering would be reasonable — **Table F.5**

Plant item	Rated input power (kW)
Boiler installations comprising one or more boilers or CHP plant feeding a common distribution circuit	50
Chiller installation comprising one or more chiller units feeding a common distribution circuit	20
Electric humidifiers	10
Motor control centres providing power to fans and pumps	10
Final electrical distribution boards	50

- indoor air quality is ensured by minimum background ventilation rates, which are usually provided in the form of trickle vents, however no separate provisions for building infiltration rates are present;
- limits on the glazed areas to limit the passage of heat, while providing flexibility for designers to increase these glazed areas by further improving thermal performance of individual items of the building envelope;
- overheating mitigation from solar gains by limiting glazed areas according to orientation (Table 2), while retaining flexibility by allowing designers to use alternative methods of calculation to take into consideration elements such as shading devices. With regards to the latter, the designer is permitted to increase maximum glazing areas if such areas are shaded and only the limits for thermal transmittance apply;
- controls on artificial lighting systems;
- conservation and use of rainwater collected on the roofs and sites;
- controls and insulation of heating and cooling systems.

Since Malta adopted, at that time (2006), an elemental approach towards building envelope energy performance and not an overall energy demand approach, compliance to the minimum energy performance requirements does not consist of calculations with set thermal comfort parameters. After 1 January 2016, the different overall performance benchmarks for different categories of residential units and other building types enter into force through new legislation issued at the end of 2015.

The BRO is responsible for setting Quality Assurance (QA) procedures and strategy. The Malta Environment and Planning Authority has been involved in the strategy and procedures for QA. These strategies have been designed to tackle any issues identified at very early stages in building design. As such, the BRO is in some cases consulted by the Malta Environment and Planning Authority during early stages of design of new buildings.

I.iii. Cost-optimal procedure for setting energy performance requirements

Malta has carried out cost-optimal studies for residential and non-residential buildings. The studies for residential buildings identified 7 reference typologies for new buildings and 14 for existing ones, taking into consideration a wide spectrum of building typologies and construction systems. Existing reference buildings included a variety of constructions built over the last century, thus mirroring practically all parts of the current building stock.

Energy efficiency measures applied to the reference buildings included measures related to heating, cooling, Domestic Hot Water (DHW) and lighting, together with contribution from Renewable Energy Sources (RES). Cost-optimality studies included the application of 225 permutations of energy efficient packages for each residential reference building.

An elemental analysis was carried out to determine the cost-optimal level of building elements (e.g., parts of the building fabric), or systems in major renovations or replacement.

Results showed that the then current minimum requirements were cost-optimal for some elements (e.g., roofs), while lower than cost-optimal level for other elements (e.g., glazing). Where it is possible to install solar RES, these are cost-optimal in all situations affecting overall energy demand considerably.

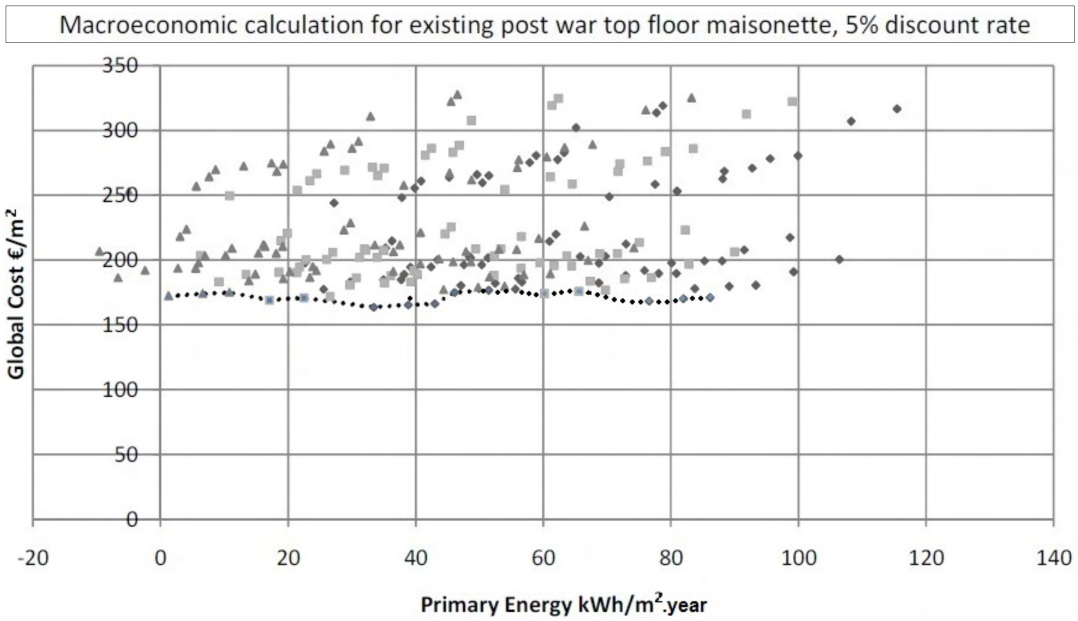


Figure 3: Graph showing primary energy against global cost for a reference house.

For the vast majority of cases, the new residential reference buildings with cost-optimal overall energy demand in kWh/m^2.year was found to be lower than that for the reference buildings built according to then current minimum requirements. The gap between current minimum requirements and cost-optimal levels due to the building fabric and building systems was found to be slightly above the 15% threshold. Amendments to current minimum requirements were being prepared, which include a total building energy performance indicator together with limits for elements. By means of statutory instruments introduced in late 2015, these new revised minimum requirements enter into force as of 1 January 2016.

For non-residential buildings, studies have also shown that the new reference buildings with cost-optimal overall energy demand in kWh/m^2.year are more energy efficient than the reference buildings built according to current minimum requirements. The overall gap between current minimum requirements and cost-optimal levels due to the improved fabric and systems varies between 20% and 45%, according to the building typology. Proposals for the improvement of current minimum energy performance requirements were formulated.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

Legal notice 376 of 2012 requires a shift towards NZEBs by 2018 for new buildings occupied and owned by public authorities, and 2020 for all new buildings. Studies to develop a NZEB plan for Malta, undertaken recently, where carried out in close coordination with the studies carried out for cost-optimality. A number of energy efficiency measures were applied in packages to reference buildings in such a way to achieve nearly zero energy levels. Such packages were analysed from a financial point of view to determine which measures are capable of achieving these two energy levels at the lowest cost over the building life-cycle. NZEB levels were shown to be tighter than cost-optimal levels.

Over the past few years, the Malta Resources Authority in collaboration with the BRB and the BRO have been responsible for drawing up the National Energy Efficiency Action Plan (NEEAP), together with other national plans in order to ensure an increase in the number of NZEBs, and to increase the integration of RES in new buildings and buildings undergoing major renovation. The latter is considered essential in reaching NZEB levels locally.

A NZEB plan has been developed and approved with input from all authorities concerned. The plan defines and sets parameters for NZEBs in Malta. The NZEB definition is based on requirements for the overall primary energy balance. For residential buildings, this varies from 55 kWh/m^2.year to 115 kWh/m^2.year. The overall energy demand is calculated according to the national calculation methodologies, thus creating a level of correlation between minimum requirements and energy performance certification methodologies. The NZEB plan includes requirements for the integration of RES for all buildings (Figure 5).

The plan outlines existing incentives and schemes and those that are shown to be able to create the best possible environment to achieve NZEB levels.

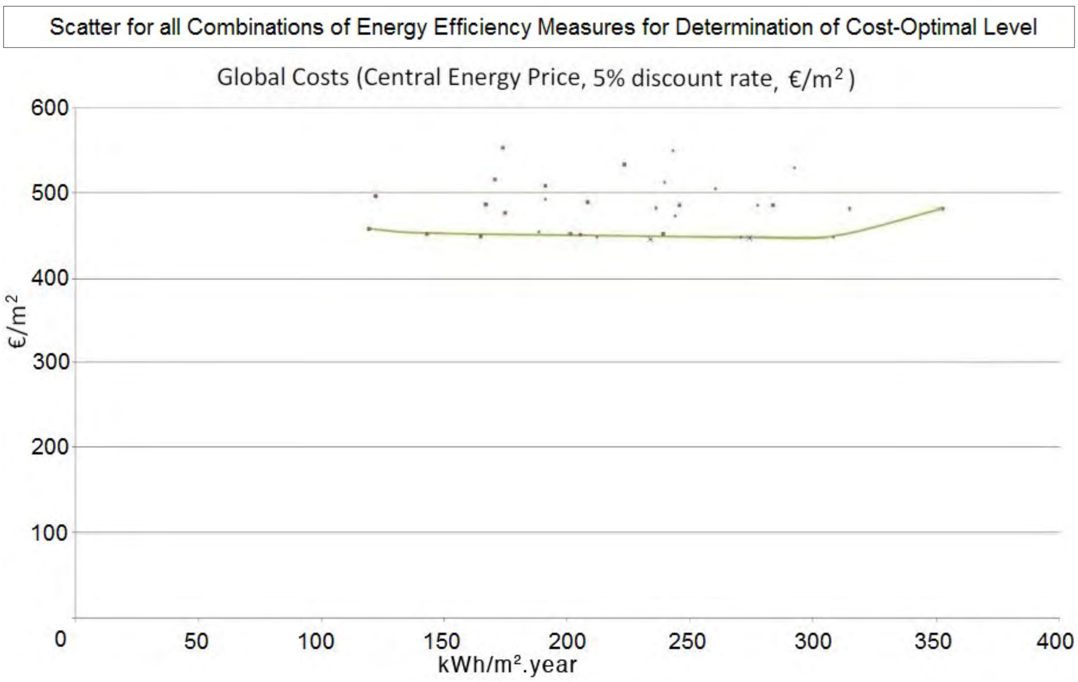


Figure 4: Graph showing the cost-optimal range for an office (central energy price, 5% discount rate).

The role of the central government in setting an example for the construction of NZEB has been particularly concentrated in the construction of low-energy schools and educational buildings. This sector has traditionally set an example in Malta where, in the post-war period, the use of natural light and ventilation in schools was shown to be capable of reducing energy use drastically. A number of schools on the island have shown that it is possible to create positive energy buildings, particularly with the integration of solar RES within the building, or nearby. Non-state schools have also shown a capability to attain low energy levels, where 13 church schools have undergone renovations and integrated RES, reducing delivered energy demand by 647 MWh annually.

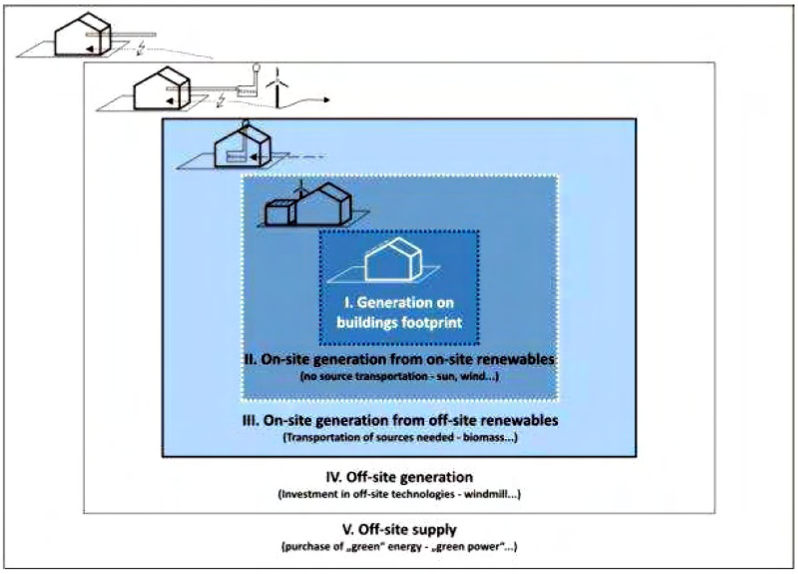
In the private residential sector, 27% of new houses in 2012 have a primary energy demand of less than 60 kWh/m^2.year.

Financial incentives in the form of grants and feed-in tariffs have been adopted over the last few years and have been targeted at those measures capable of achieving NZEB levels. A scheme is being implemented to create financial incentives for achieving NZEB levels. Positive fiscal measures and advantageous bank loans for retrofitting energy efficient buildings have also been available over the past few years.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

In line with Article 4 of the Energy Efficiency Directive (Directive 2012/27/EU - EED), data has been collected and compiled about buildings occupied by the central government. This included on-site surveys, such that the latest available information about energy characteristics was collected. Energy audits have been carried out on most of the buildings occupied by the central government, making information about energy use and intensities available. Analysis of this data has shown that 77% of buildings have an actual delivered energy use of less than 107 kWh/m^2, which is considered as good practice. Buildings with higher energy use will be prioritised for renovation, which will achieve minimum savings of 555 MWh of delivered energy.

Figure 5: Possibilities for the defining inclusion of renewable technologies in proposed NZEB plan.



II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

Energy efficiency requirements for Technical Building Systems (TBS) were introduced along with the first issue of minimum energy performance requirements. These included requirements for the control of heating systems, the control of cooling systems, conventional hot water storage systems, artificial lighting systems, display lighting in buildings and conservation of rain water.

A new set of minimum energy performance requirements for TBS have been drawn-up and will come into force from January 2016 (Figure 6). These are based on the UK building services compliance guides (both residential and non-residential buildings). The BRO has commissioned this new document to address in a better way the EPBD requirements, namely the requirement for proper installations, adjustments and controls of the TBS. This document will be part of the new minimum energy performance requirements in Malta.

Figure 6: Technical Document F - part 2 - Minimum requirements for building services.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Energy Performance Certificates (EPCs) were first introduced in Malta by means of Legal Notice 261 of 2008, and were made mandatory for houses when built, sold or

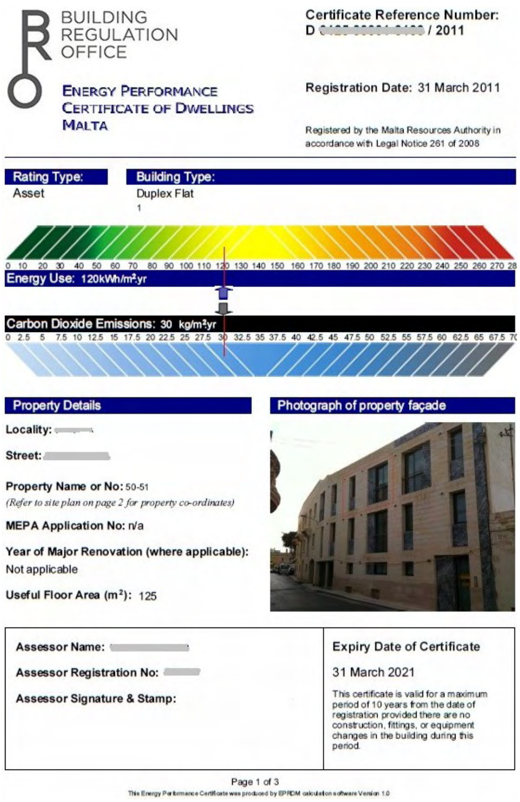


Figure 7: 'Asset' energy performance certificate for houses.

rented after 2 January 2009. For all other buildings, an EPC was made mandatory as from 1 June 2009. A seller or landlord is required to produce an EPC (Figure 7), and to hand it over to the prospective buyer or new tenant at the date of entering the contract of promise of sale or rent agreement at the latest.

A methodology called 'Energy Performance of Residential Dwellings in Malta (EPRDM)' has been developed and is the only approved methodology for the issue of EPCs for houses.

Where a building is not yet constructed, the EPC is based on a 'design rating', while EPCs for completed buildings are based on an 'asset rating' (Figure 8). In either case, the EPC is valid for 10 years from the date of issue. All EPCs are stored in a single central database, with 10,580 certificates issued up to the end of 2015. In the case of multi-family buildings, a certificate is issued for each residential unit as an individual entity.

An EPC is accompanied by recommendations applicable specifically to the building in question. These recommendations are not generated automatically, but drawn up individually by the assessors, who are all building or engineering professionals, or accredited assessors in other EU countries. Such recommendations provide the actual benefit in improving the overall energy performance of the building stock in the long term.

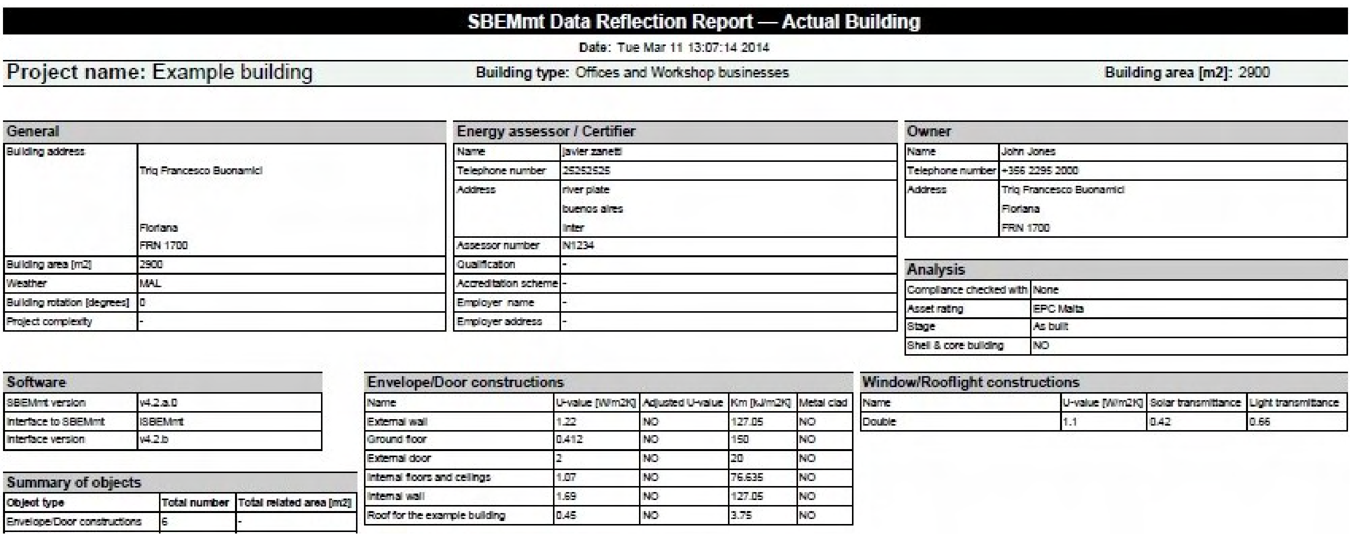
In case of houses, a schedule of specifications and building characteristics is included within the EPC. When a building under construction is certified, the assessor is involved at design stage, giving valuable advice regarding energy efficiency, which in small projects would otherwise not be available.

The owner of a residential unit (single-family house or apartment) being sold typically pays from 225 €, in case of an apartment, to 450 €, in case of more complicated houses, for the issue of an EPC. This fee includes the registration charge levied by the BRO, which covers part of the expenses used to run and update the EPC web portal and certificate auditing systems.

An owner who fails to produce the certificate to the authorities within 60 days from when requested to do so, can incur a fine of between 500 € and 1,500 €. No fines have been issued to date as strategy is aimed towards compliance.

In Malta, prospective assessors have to successfully undertake a period of training on the assessment of the energy performance of buildings constructed in Malta and the methodology adopted for certification of buildings. The training

Figure 8: Extract from data reflection report submitted by assessors and received by BRO. This document gives detailed information about the building which is useful for quality assurance purposes.



SBEMmt Data Reflection Report — Actual Building

Date: Tue Mar 11 13:07:14 2014

Project name: Example building — Building type: Offices and Workshop businesses — Building area [m2]: 2900

General

Building address	Triq Francesco Buonamici Floriana FRN 1700
Building area [m2]	2900
Weather	MAL
Building rotation [degrees]	0
Project complexity	-

Energy assessor / Certifier

Name	javier zanetti
Telephone number	25252525
Address	river plate buenos aires inter
Assessor number	N1234
Qualification	-
Accreditation scheme	-
Employer name	-
Employer address	-

Owner

Name	John Jones
Telephone number	+356 2295 2000
Address	Triq Francesco Buonamici Floriana FRN 1700

Analysis

Compliance checked with	None
Asset rating	EPC Malta
Stage	As built
Shell & core building	NO

Software

SBEMmt version	v4.2.a.0
Interface to SBEMmt	iSBEMmt
Interface version	v4.2.b

Summary of objects

Object type	Total number	Total related area [m2]
Envelope/Door constructions	6	-

Envelope/Door constructions

Name	U-value [W/m2K]	Adjusted U-value	Km [kJ/m2K]	Metal clad
External wall	1.22	NO	127.05	NO
Ground floor	0.412	NO	150	NO
External door	2	NO	20	NO
Internal floors and ceilings	1.07	NO	76.635	NO
Internal wall	1.69	NO	127.05	NO
Roof for the example building	0.45	NO	3.75	NO

Window/Rooflight constructions

Name	U-value [W/m2K]	Solar transmittance	Light transmittance
Double	1.1	0.42	0.66

course and course content is subject to approval by the BRB. Successful participants have to obtain an overall pass mark of at least 80% after having attended at least 80% of the course lectures. Most of the course participants have qualified and registered to become assessors. Assessors for building energy performance registered in other EU Member States (MSs) can register directly with the BRO. Most of the assessors for non-residential building certification are also assessors for the residential buildings, with just over 180 assessors in total. Training is currently underway with 150 new assessors expected to be registered by the end of 2015.

Enforcement of the system has been carried out since the system was launched. To better enable enforcement, a joint action has been initiated by the BRO and the Authority responsible for the issue of building permits, whereby planning applications may be viewed in the very early stages, to ensure that all EPC requirements have been met. Statistics for compliance by sector are not available.

Auditing of the EPCs has been entrusted to the Malta Competition and Consumer Affairs Authority (MCCAA). A statistically significant sample of certificates is routinely audited on a yearly basis. For 2014, a sample of just over 300 EPCs was audited. A smaller sample is audited to a higher detail and may include location visits. EPCs may also be audited if values are out of range, if issued on the same address as other certificates, or if they are the first certificates issued by a specific assessor, or following complaints from clients. Policy has been targeting at the re-issue of certificates if these are found to be lacking, with levy of re-issue fee.

III.ii. Progress and current status on public and large buildings visited by the public

Information sessions and seminars have been delivered regarding the requirements for the issue of EPCs for buildings larger than 500 m^2 occupied by a public authority and frequently visited by the public. Up to 2014, 52 EPCs have been issued for central government buildings. A number of other entities are in the process of commissioning an EPC during 2015. A list of all buildings occupied by the government has been compiled. Available data includes floor areas of the buildings and the actual energy use. Enforcement of the display of the EPCs in public buildings is being carried out according to this data, and QA is carried out as part of the overall auditing system.

III.iii. Implementation of mandatory advertising requirement

As from 2012, legislation requires the owner or agent of a building offered for sale or rent to display the energy performance indicator of the EPC in commercial media. Information sessions and day conferences have been carried out with the association of real estate agents, to inform estate agents of these requirements. The BRO is in the process of intensifying operations to increase uptake of energy performance indicators in commercial media.

III.iv. Information campaigns

The implementation of the EPBD in Malta is part of a greater picture where energy efficiency is promoted at all levels and across all sectors of energy use. The authorities acknowledge that informing the public about energy efficiency facilitates the implementation of the EPBD by promoting public awareness leading to a demand for energy efficient buildings. The BRO, in some cases in conjunction with other government authorities, has organised and participated in several events in relation to the implementation of the EPBD including:

> prominent roadside advertisements (Figure 9) encouraging persons to advertise a sale of property by providing the EPC to estate agents;
> articles in local printed media to promote energy efficiency and outlining requirements of the EPBD (Figure 10);

Figure 9: Roadside advertisements were installed throughout Malta as part of promotion campaigns.

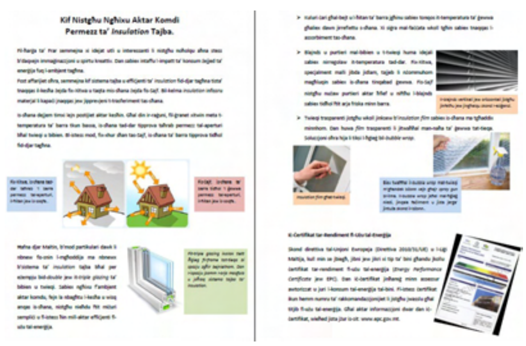

Kif Nistgħu Ngħixu Aktar Komdi
Permezz ta' Insulation Tajba.

Figure 10: Article in local magazine showing principles of energy efficiency and simple energy efficiency techniques, and informing the public on how these relate to EPCs.

> participation in radio and television broadcasts by members of the BRO with live phone-ins from the public to promote various aspects of the EPBD, e.g., the contribution of EPCs to energy efficiency;

> advertisements in local printed national newspapers encouraging persons to advertise a sale of property by providing the EPC to estate agents;

> delivering a series of in-service courses for teachers regarding climate change and energy efficiency, where teachers may then impart knowledge to students later in science lessons, creating a multiplier effect;

> delivering lectures regarding the EPBD and energy efficiency to the public at local level in events organised by the local councils;

> promoting energy efficiency themes via brochures and videos during various events, through a supporting campaign called the Switch campaign;

> distributing brochures informing about the requirements for EPCs when selling and advertising a property (Figure 11);

> updating the BRO's website to provide the latest information about various aspects of the EPBD and energy efficiency.

III.v. Coverage of the national building stock

For the 152,000 households in Malta, about 9,400 EPCs have been issued till the end of November 2015, translated into around 6% of all households. With approximately 500 EPCs issued each month, this is expected to increase at a rate of around 1% per year. The system for the non-residential sector was initiated later, and the coverage at the end of 2013 was less than 1%.

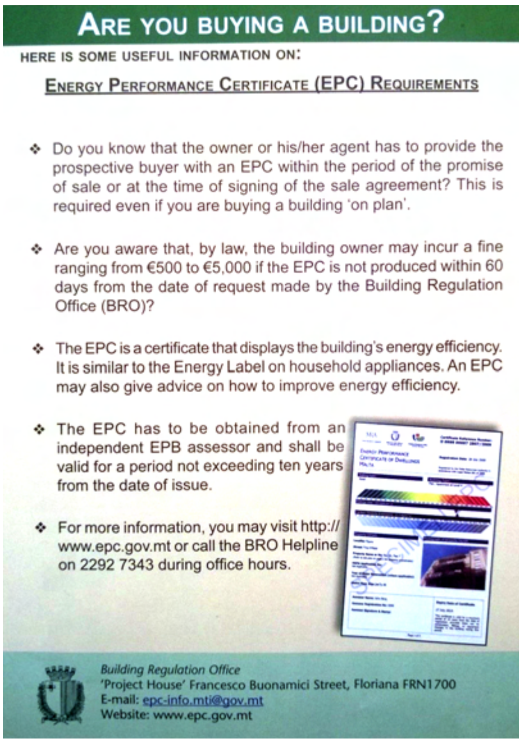


Figure 11: Advert distributed to prospective property buyers and all persons entering promise of sale.

III.vi. Other relevant plans

The government has taken an active approach, where implementation is facilitated by a number of incentives. One of such incentives was the provision of a number of energy efficient lamps to every family in Malta. This increased the take-up of energy efficient lamps, and latest data shows 95% of households are powered by energy efficient lighting.

Financial incentives include rebates on an array of measures and systems including:

> solar water heaters;

> roof or wall insulation;

> double glazing;

> energy efficient appliances (A rated);

> AC with minimum energy efficiency class A and an output equal to or less than 12 kW.

The installation of photovoltaic panels and micro wind turbines are promoted by a generous feed-in tariff together with a grant of 50% of the initial cost of the system.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Requirements for mandatory inspections were first established in Malta by Legal Notice 238 of 2006, followed by Legal Notice 261 of 2008. These requirements were superseded by Legal Notice 376 of 2012, issued after Directive 2010/31/EU came into effect, where mandatory inspections have been adopted again. The BRO has been entrusted with establishing and maintaining a system for the registration of EPCs. The BRB has approved the guidance documents outlining methodologies proposed by the BRO and established the respective inspection frequencies.

IV.i. Progress and current status on heating systems

Inspections of heating systems are carried out on the accessible parts of systems used for space heating of buildings with boilers of an effective rated output of 20 kW or greater (Figure 12). Inspections follow the methodology issued by the BRO, which has been based on MSA EN 15378:2007, and adopted to meet the requirements of Directive 2010/31/EU. The inspection frequencies for boilers exceeding 100 kW are set according to the type of fuel used. For boilers with an effective rated output of 20 - 100 kW, the maximum inspection interval is set at 4 years (Table 3). Inspection frequencies remain unchanged in the case where an electronic monitoring and control system is in place.

The essential aspects of an inspection include a documentation review, a visual inspection of the heating system equipment, including generation, distribution, emission and controls, and a mandatory combustion efficiency analysis. The heating systems inspectors make an assessment of the boiler efficiency and sizing. Inspectors are also required to draw up recommendations for cost-effective improvement of the energy performance of the inspected system(s).

The BRO has established training of inspectors for heating systems in line with the methodology developed. Courses were delivered in collaboration with the Malta Chamber of Engineers. Candidates for the inspector training course are required to possess a degree in mechanical and/or building services engineering, be warranted as engineers, and show experience in design and/or maintenance of heating systems. Candidates who successfully sit for the course assessment may register with the BRO to become registered heating systems inspectors. Such registration is valid for 5 years. To date, there are eleven registered heating systems inspectors. This list is kept updated and published on the BRO website.

The inspection reports must be submitted to the BRO for registration and quality control checks. Monitoring and QA of inspection reports received are delegated to the Malta Competition and Consumer Affairs Authority which is an independent authority, and can ensure that an adequate level of quality is maintained.

Figure 12:
Process adopted for determining
if inspection for heating system is warranted.

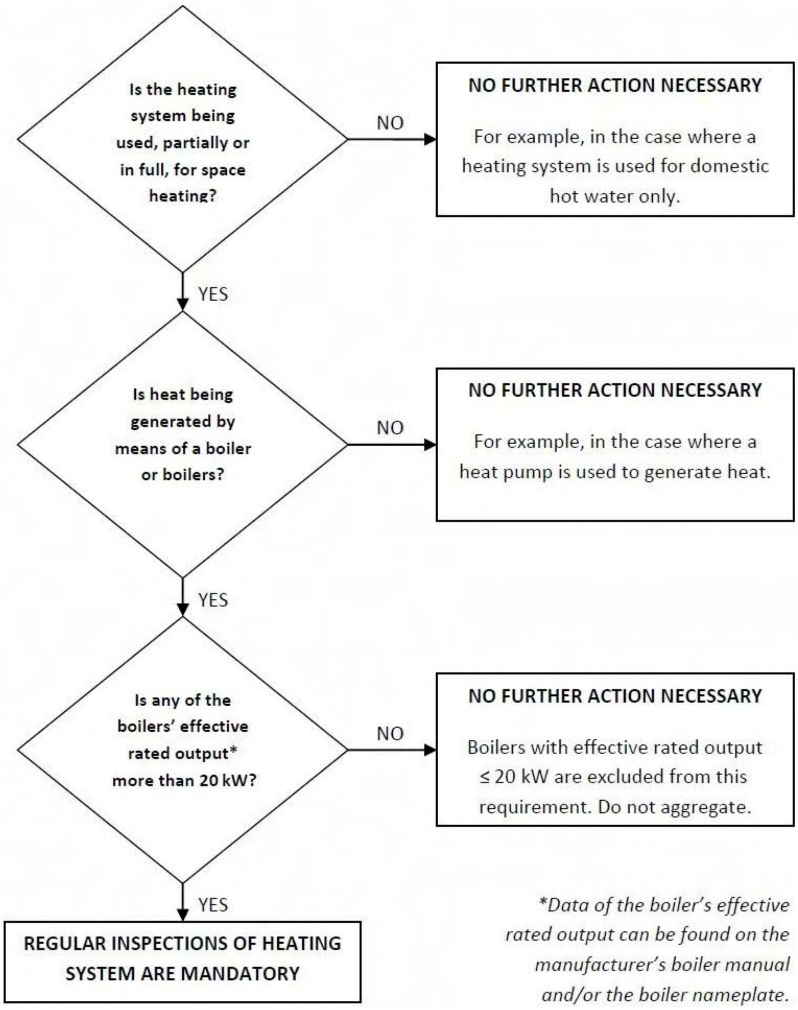


Table 3:
Required frequency of inspections for heating systems.

Effective rated output of boiler	Type of boiler fuel	Inspection frequency of heating system
> 100 kW	All types except gas	2 years
> 100 kW	Gas	4 years
> 20 kW up to 100 kW	All types	4 years

IV.ii. Progress and current status on AC systems

Inspections of AC systems are carried out on the accessible parts of AC systems with an effective rated output of more than 12 KW. Inspections follow the methodology issued by the BRO which has been based on "TM 44: Inspection of Air-conditioning systems", 2012, issued by the Chartered Institute of Building Services Engineers, UK (CIBSE).

Inspection frequencies remain unchanged in the case where an electronic monitoring and control system is in place. The frequency of inspections for AC systems having an effective rated output of more than 12 kW have been approved by the BRB, and are shown in Table 4.

Table 4:
Required frequency of inspections for AC systems.

Effective rated output of AC system	Inspection frequency
12 kW - 100 kW	10 years
More than 100 kW	5 years

The inspections of AC systems address collection of data and compiling of all necessary system documentation, appropriate maintenance of the systems, energy efficient operation of the system, recommendations for the cost-effective improvements to the system. Inspections also include an assessment of the AC efficiency and sizing, compared to the cooling requirements of the building.

The BRO has been organising training courses for AC inspectors. Entry requirements for the AC inspectors course are a degree in mechanical and/or building service engineering, a warrant to practice as engineers, and experience in design and/or maintenance of AC systems. Training courses were entrusted to the Chamber of Engineers, and were delivered in collaboration with the Chartered Institute of Building Services Engineers, UK (CIBSE).

Candidates who are successful in the final assessment, may then proceed to register with the BRO as AC system inspectors for a period of 5 years. A list of registered AC system inspectors is kept updated and published on the BRO website.

The BRO receives the submitted AC inspection reports which are then registered and validated. The Malta Competition and Consumer Affairs Authority has been entrusted with the setting up of an independent quality control system for monitoring and QA of the AC inspection reports.

3. A success story in EPBD implementation

The EPBD was introduced in Malta within a context where energy performance regulation was scarce and resources, human or otherwise, were very limited. The authorities responsible for the implementation of most of the aspects of the directive initially encountered various problems including lack of awareness, resistance from the industry to new systems, lack of resources to ensure that private industry was adhering to requirements of the EPBD. Eventually, a process was initiated were various authorities started to collaborate in such a way that information and some resources could be shared. This improved the level of implementation considerably.

4. Conclusions, future plans

The introduction of the EPBD in Malta was implemented together with a general shift towards energy efficiency. The impact of the implementation of the EPBD has yet to be quantified, and when this is done it is very difficult to qualify which increased efficiencies are due to the EPBD. For new buildings, the improvement due to the introduction of minimum requirements according to the EPBD has been estimated at somewhere between 15 and 25%. However, with a very large existing building stock compared to new buildings being built, the improvement may be small overall.

An analysis of a sample of EPCs for houses shows that the energy performance of new houses has shown a slight improvement over the last few years. Across all sectors of energy use, a reduction of CO_2 emissions was attained where, according to Eurostat, 2013 values were 6.8% lower than in the previous year.

Statistics show that houses were built over various periods, with only just about 1% of the current stock being added every year. The energy use for residential buildings has been shown to be low overall, and therefore the reduction in CO_2 emissions from this sector is expected to be low.

On the other hand, offices and commercial buildings are being constructed at a higher rate, due to the development in the services industry. These buildings have been shown to use energy much more intensively in Malta. The requirements of the EPBD for this sector were implemented at a later stage, and as a result its effects cannot be quantified as yet. This sector is expected to contribute to a greater effect towards energy efficiency.

Large energy savings are expected to accrue from renovation of existing buildings, since a large fraction of the existing houses have been built during a period when energy efficiency was not considered important and relied heavily on fossil fuels to obtain comfort levels.

Following the completion of cost-optimality studies, it is expected that the minimum requirements will be revised in the near future. If an overall energy demand is included in the revised minimum requirements as planned, this will improve correlation between minimum requirements and EPCs, making the latter much more useful.

The NZEB plan has been approved and has defined NZEBs in Malta to act as a catalyst for the improvement of the building stock in the mid-term future. The NZEB plan is expected to provide a clearer picture of the way forward from the present date to 2020 and beyond.

Implementation of the EPBD in the Netherlands

STATUS IN NOVEMBER **2015**

1. Introduction

In The Netherlands, the implementation of the Energy Performance of Buildings Directive (EPBD) falls under the joint responsibility of:

- *the Ministry of the Interior and Kingdom Relations;*
- *the Netherlands Enterprise Agency (RVO.nl), which implements the national EPBD legislation in The Netherlands and is also in charge of managing the certification schemes, the training and accreditation of experts and compliance checking, as well as a central register to stock all certificates;*
- *the National Governmental Inspection Authority IL&T ("Inspectie Leefomgeving & Transport"), in charge of control and enforcement, and along with others, of policing the quality of accredited experts and checking the presence of valid Energy Performance Certificates (EPC) for sale and rental, as well as of obtaining the permits of use for new residences;*
- *certification institutions, in charge of policing the quality of independent experts active in the labelling of non-residential buildings.*

The EPC system has been in place since 2008 and more than 2.3 million EPCs have been registered under this legislation. In December 2012, the government decided to implement a new, much more consumer friendly system for owners of residences. This new system was developed in 2013 and 2014 and has been operational since January 2015. Legislation for the new certification system became effective on 1 January 2015. Changes in the accreditation system for experts for the new EPC for residential buildings were also implemented in January 2015.

This report presents an overview of the current status on the implementation and the plans for the evolution of the EPBD implementation in The Netherlands. It addresses certification and inspection systems, including quality control mechanisms, training of Qualified Experts (QE) and information campaigns and other issues.

In September 2013, a national Energy Agreement ("Energie Akkoord") was signed by more than 40 market participants and other stakeholders. The targets for energy efficiency and use of renewable energy in buildings in this agreement are in line with the requirements of the EPBD. Until 2020, the EPC of 300,000 existing residences will be improved by two energy grades in the energy performance scale. The stock of the social housing sector will be renovated to the level of energy class B on average. In the private rental sector, 80% of the existing houses will be improved to a minimum of energy class C. After 2020, newly built residences have to reach the Nearly Zero-Energy Building (NZEB) standard. The signatures of many key organisations endorsing these objectives is clear evidence that there is broad support for the market uptake of an energy-efficient and energy-neutral building environment in the future of The Netherlands.

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NATIONAL WEBSITES
www.rvo.nl, www.energielabelvoorwoningen.nl
www.zoekuwenergielabel.nl, www.energielabel.nl
www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/energielabel-installatiekeuringen/storing-en-onderhoud
www.rvo.nl/initiatieven/overzicht/27008
www.rvo.nl/onderwerpen/duurzaam-ondernemen/gebouwen/energieneutraal-bouwen/publicaties
www.rijksoverheid.nl/onderwerpen/energielabel-woningen-en-gebouwen

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Energy performance requirements have been in place for new buildings in The Netherlands since 1995. They are updated on a regular basis, moving towards NZEB targets for 2020 (Figure 1).

The change towards more demanding requirements took place as a result of so-called 'tightening studies'. These studies included an analysis of the market penetration of energy efficiency measures, renewable energy applications and energy-efficient heating and cooling generators. They also took into account the cost-effectiveness of these measures and their impact on indoor climate and occupant satisfaction. The tightening studies were carried out by consulting companies and supervised by the RVO on behalf of the Ministry of the Interior. During the studies, all stakeholders were informed about the results and could comment on them, to ensure that practical experiences with energy saving measures are taken into account.

The so-called Energy Performance Standard (EPN), established in 1995, was replaced in July 2012 by a new standard, the Energy Performance Standard for Buildings (EPG) that replaced both the existing residential and non-residential standards.

In 2011 and 2012, a study was performed by a consulting company supervised by the RVO on behalf of the Ministry of the Interior, to establish cost-optimal minimum requirements for existing buildings. These requirements came into effect in 2013-2014. The main requirement for the energy performance of new buildings is the energy performance coefficient.

The energy performance coefficient calculation is part of the building permit application. A project developer has to demonstrate full compliance with the energy performance requirements to receive a building permit for a new building or a major renovation. Permits are checked and issued by local municipalities before construction.

Monitoring and enforcement is carried out by the regional environmental services.

Municipalities are also responsible for compliance checking during construction. In case of non-compliance, they issue a 'cease-work' order that remains valid until the requirements are met. As such, there are no financial penalties. Buildings that do not comply do not get built and if builders deviate, construction is ceased until it is in line with the permit.

Every year, a sample is drawn by the RVO to check if all permits are in line with the legal requirements.

If the permits are not in line with the legal requirements, the RVO will report this to the municipalities who will take legal action.

The minimal energy performance (MEP) for new buildings is defined as the energy performance coefficient (in Dutch 'The *energieprestatiecoefficient*'). This indicator is based on the estimated total

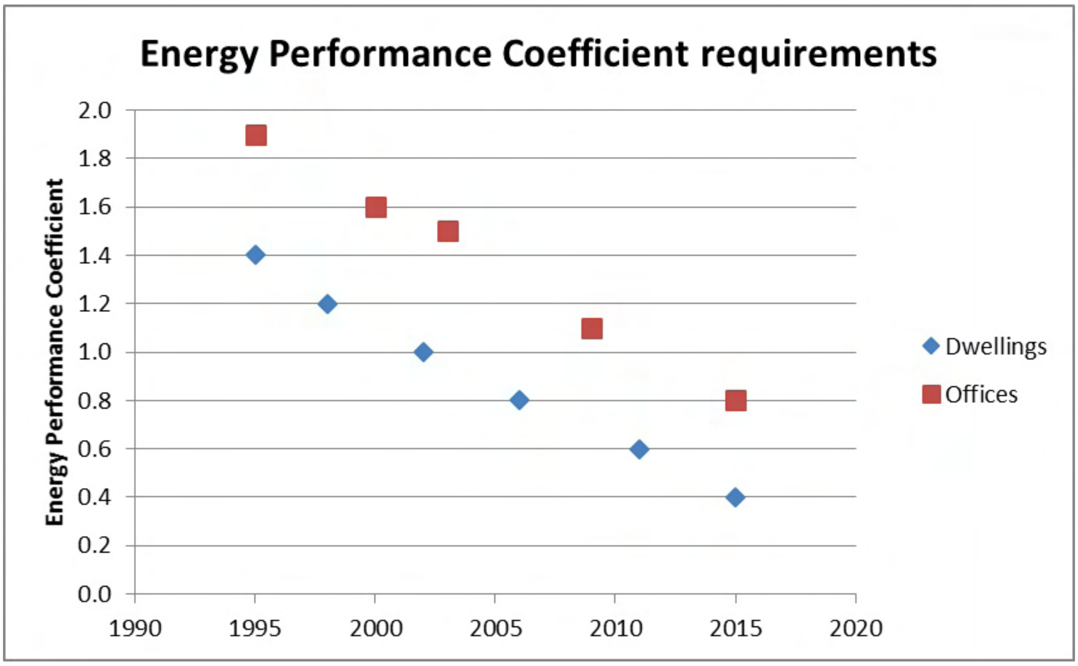


Figure 1: Change over time of the energy performance coefficient in new buildings (future plans are not included because the energy performance coefficient will no longer be used as an indicator for Nearly Zero-Energy Buildings).

primary energy consumption of a building based on a series of indicators, e.g., heating, ventilation and lighting, adjusted to the useful floor area and the renewable energy produced by the building. This indicates the building energy performance in MJ/m². The quotient of the building's calculated annual primary energy needs and the allowed primary energy performance (Table 1) provides the energy performance coefficient. The calculation of the energy performance coefficient is mandatory for all new buildings and for large renovations in houses and offices.

New buildings and major renovations that are required to have a building permit also have to meet minimum requirements for building components, e.g., the R-value of walls, roof and floor, and the U-value of windows and doors. A major renovation is any building in which more than 25% of the envelope will be renovated.

For minor renovations, there are only minimum requirements for the R-value of walls, roof and floor, and U-value of windows and doors. In such cases, no energy performance calculation or building permit is required.

I.ii. Format of national transposition and implementation of existing regulations

Since the oil crisis in the 1970s, The Netherlands applied minimum requirements for the thermal quality of the building envelope. The requirement of the energy performance coefficient was introduced in 1995 (see Table 1 for 2015 values). The minimum requirements for individual building components are listed in Table 2.

The energy calculation method for new and existing buildings is defined in Standard BS 7120 that is in line with the CEN standards. This calculation of the primary energy consumption of a building is based on monthly climate data that is adjusted for physical processes with a shorter timeframe, e.g., solar gains and heat accumulation. The calculation of the thermal quality of the building envelope includes thermal bridges, ventilation and air infiltration, hot water use, efficiency of heat and cold generators, renewable energy used both in and near the building, and the contribution of passive energy,

Building Typology	**Required maximum values for the energy performance coefficient (new buildings)**
Day-care centres	1.1
Prisons	1.0
Healthcare buildings with bed area (hospitals)	1.8
Healthcare buildings (other than with bed area)	0.8
Office buildings	0.8
Accommodation in lodging structure (hotels)	1.0
Accommodation not in lodging structure (conference facilities)	1.4
Educational buildings	0.7
Sports buildings	0.9
Retail buildings	1.7
Residential buildings	0.4
Mobile homes	1.3

Table 1: Required maximum energy performance coefficients for new buildings since 1 January 2015 and, after cost-optimal studies, for non-residential buildings since 1 July 2015. For residential buildings, an energy performance coefficient of 0.4 means approximately 50 – 65 kWh/m².year.

Part 1 - New buildings and major renovations	
Minimum requirements for the thermal quality of the building envelope by 1 January 2015 for new buildings and major renovation (> 25% envelope).	
Roofs	R ≥ 6 m².K/W
Floors	R ≥ 3.5 m².K/W
Façades	R ≥ 4.5 m².K/W
Transparent façade sections	U-value > 1.65 W/m².K
Individual structure	U-value > 2.2 W/m².K
Part 2 - Minor renovations (< 25% envelope)	
Roofs	R ≥ 2 m².K/W
Floors	R ≥ 2.5 m².K/W
Façades	R ≥ 1.3 m².K/W
Transparent façade sections	U-value > 2.2 W/m².K

Table 2: Minimum requirements for building components.

lighting and daylighting. Shading caused by the building itself is included. Shading by other buildings is not taken into account.

I.iii. Cost-optimal procedure for setting energy performance requirements

Cost-optimal calculations for determining the energy performance coefficient for new residential and commercial buildings have been performed in The Netherlands since 1995 (Table 3). In 2015, the minimum requirements in The Netherlands (Table 1) comply with the cost-optimal requirements for new residences as well as for all types of commercial buildings.

The minimum requirements for existing buildings applying to major renovations, alterations of technical building systems and measures for the envelope have been in place since 1 July 2013.

I.iv. Action plan for progression towards Nearly ZeroEnergy Buildings (NZEBs)

The energy performance coefficient has been tightened on 1 January 2015, as an intermediate step to reach the NZEB level. The next step will be to place demands on primary energy consumption and the share of renewable energy up to the NZEB level. In March 2015, a first proposal for these requirements for new buildings was shared with stakeholders (Table 4) and sent to the parliament in July 2015.

The study on the cost optimality in accordance with Article 5 of the EPBD is planned for 2018.

The Dutch government supports a programme from intermediary organisations, aimed at preparing the market players for increased demands to reach the NZEB level for new buildings with 300 K€/year.

In 2016, the organisations will start a new programme under the name 'ZEN' (i.e., 'very energy efficient new buildings') to prepare the market players for tightening NZEB requirements in 2020. This will also be supported by the Dutch government. The RVO will maintain a database with energy efficient examples[1].

Furthermore, the Dutch government supports the "*Energiesprong*" and the "*Stroomversnelling*". The "*Energiesprong*" (energy jump) is an initiative that aims to reach very energy efficient renovations in both the private and social housing sector. They are supported with 45 M€. From the yearly report "*Energiesprong*" 2014, nearly 130 zero-energy-bill houses have been realised. The "*Stroomversnelling*" (white water) aims to renovate 111,000 social

Table 3: Cost-optimal ranges in The Netherlands.

Building typology	Required max. value for energy performance coefficient (new buildings) 2012	Cost-optimal point* (range)	Needed max. values for energy performance coefficient for cost-optimal	Required max. value for energy performance coefficient (new buildings) 2015	Does required max. value for energy performance coefficient 2015 fit into cost-optimal range or better?
Residential buildings	0.6	1.00	0.6	0.4	Yes
Accommodation function not in lodging structure (conference facilities)	2.0	0.90 - 1.00	1.80 – 2.00	1.1	Yes
Prisons	1.8	0.8 - 1.0	1.44 – 1.80	1.0	Yes
Healthcare (other than with bed area)	1.0	0.70 – 0.90	0.70 – 0.90	0.8	Yes
Healthcare with bed area (hospitals)	2.6	0.70 – 0.90	1.82 – 2.34	1.8	Yes
Office buildings	1.1	0.70 – 0.90	0.77 – 0.99	0.8	Yes
Accommodation function in lodging structure (hotels)	1.8	0.85 – 1.00	1.53 – 1.80	1.0	Yes
Educational buildings	1.3	0.70 – 1.00	0.91 – 1.30	0.7	Yes
Sports buildings	1.8	0.80 – 1.00	1.44 – 1.80	0.9	Yes
Retail buildings	2.6	0.80 – 0.90	2.08 – 2.34	1.7	Yes

* A cost-optimal point of 1.0 means that the maximum energy performance coefficient of 2012 is cost-optimal. For example, a cost-optimal point of 0.8 means that the cost-optimal point is 20% lower (i.e., better) than the required maximum energy performance coefficient of 2012.

[1] www.rvo.nl/initiatieven/overzicht/27008

housing buildings and 50,000 privately-owned houses to the level of the net zero-energy bill.

Laws and legislation are adapted to enable owners to get a refund (“*Energiepresetatievergoeding*”) in case of renters for this reduced energy bill. This solves the problem of the split incentive, in which the costs of energy efficiency measures are the responsibility of the building investor or owner, whereas the benefits of a lower energy bill go exclusively to the tenants. Unless these costs are recouped from the tenants, the owner should not be liable for investing in energy efficiency measures.

Figures and statistics on existing NZEBs

In 2014, the RVO carried out studies of the top 30 energy-efficient homes and the top 15 energy-efficient schools and offices. Some of them already meet the requirements for the proposed definition of NZEB. A complete overview of the number of existing NZEBs in The Netherlands is not yet available. Monitoring will start in 2016. The number of NZEBs will gradually increase to 100% after the implementation of the legislation regarding these buildings as per 1 January 2021.

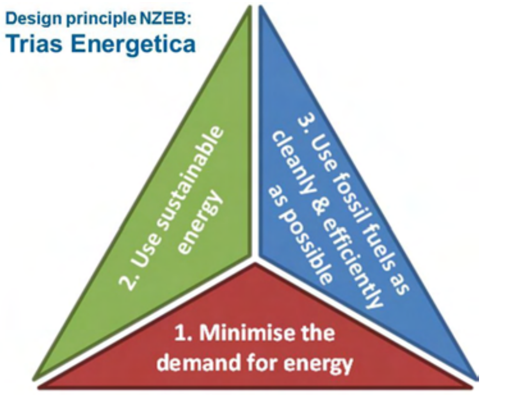


Figure 2: The ‘Trias Energetica’ design principle for NZEBs.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

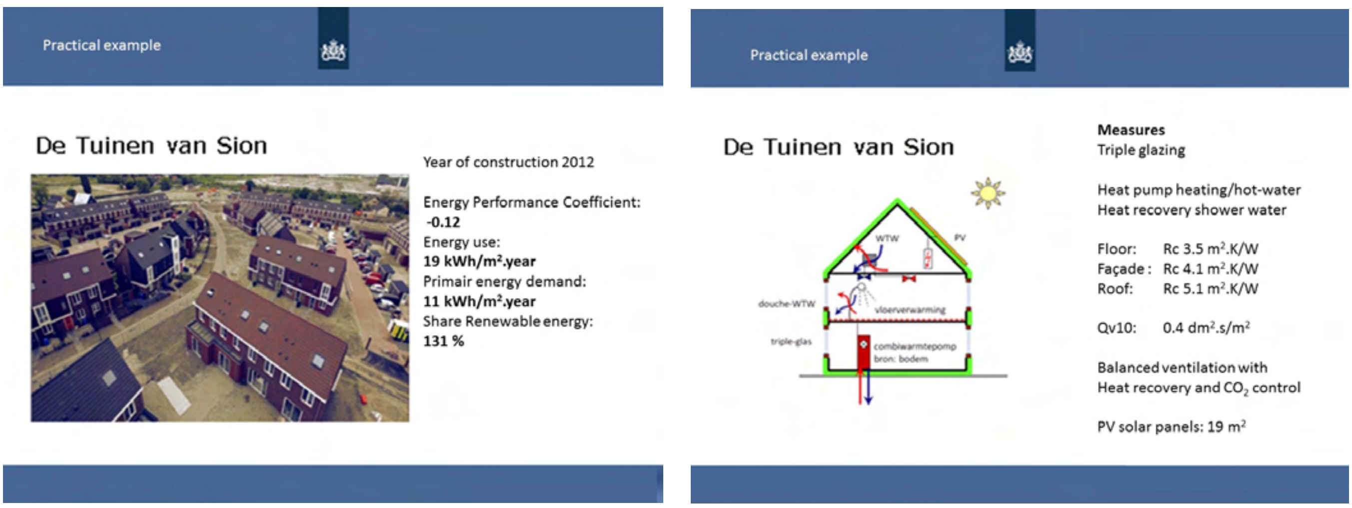
The targets for energy efficiency and use of renewable energy in buildings in the Energy Agreement are in line with Article 4 of the Energy Efficiency Directive (EED). Until 2020, the energy label of 300,000 existing residences will be improved by 2 classes. The stock of the social housing sector will be renovated to energy label class B on average. In the private rental sector, 80% of the existing houses will be improved to a minimum energy label class C. After 2020, newly built residences have to reach NZEB standards.

Table 4: Proposed requirement for NZEB.

Building Typology	Energy-need [kWh/m².year]	Primary energy-use** [kWh/m².year]	Share of renewable energy** [%].
Residential	25*	25	50
Office / healthcare with no bed area / assembly / sport / retail / prisons / lodges	50***	25	50
Healthcare with bed area	65	120	50
Schools	50	60	50

* Studios with less than 50 m² dependent on further research
** Buildings with more than 5 floors dependent on further research
*** Buildings with less than 50 m² dependent on further research

Figure 3: Example of NZEB: The gardens of Sion.



For Article 5 of the EED, the Dutch government has chosen the 'default' approach to ensure that 3% of the total floor area of heated and/or cooled buildings owned and occupied by its central government is renovated each year, and 2% of energy savings per year is reached.

This will be realised through sustainable procurement, optimising and tuning of energy installations and deep renovation once every 20 years. The total savings during the period of 2014 – 2020 will be 700 TJ (100 TJ/year) for the buildings owned by the Government Buildings Agency. In the period of 2009 – 2019 an additional savings of 600 TJ (60 TJ/year) will be reached for the real estate owned by the Department of Defence. The total savings are estimated at 160 TJ/year.

The Netherlands makes no exceptions for historical buildings and buildings owned by the armed forces. Concerning Article 5.7, 'Encouraging other bodies to follow central government's exemplary role in building renovations', The Netherlands has placed this responsibility within the umbrella organisation of municipalities, as confirmed in the national Energy Agreement.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

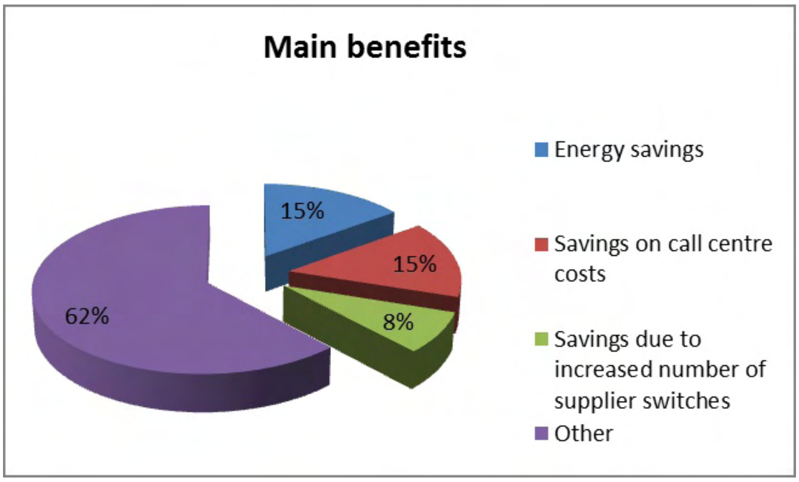
In The Netherlands, there are no requirements for separate energy efficiency measures for Technical Building Systems (TBS). Instead, the total building has to reach a level of efficiency, indicated in the energy performance coefficient. This way, builders and developers are given the freedom to choose the most cost-efficient solution as regards the envelope and the TBS of that particular building. This approach gives freedom in the design and stimulates technical innovation. Products that are not yet integrated into the official calculation method are tested to establish the performance that leads to inclusion in the method. An independent commission of experts has to approve the results of the test before official publication.

This concerns the performance of systems and products in the area of heating, hot water, Air-Conditioning (AC), and large ventilation systems.

II.i. Encouragement of intelligent metering

Following a positively evaluated national cost-benefit analysis and small-scale experience phase, the Dutch parliament agreed in 2014 to introduce a smart gas and electricity meter to all homes and small businesses by 2020. The distribution systems operator is responsible for offering smart meters, grants access for the metering data to the energy supplier, and is the responsible party for collecting and validating the metering data for other third parties upon customer request. The highest benefits associated with the smart meter rollout appear to go to the customer, as the advantages of energy savings and efficiency improvements in the market largely benefit the customer (see Figure 4 for electricity). Therefore, part of the rollout strategy is to encourage the consumer to opt for a smart meter with detailed meter readings and to use it as efficiently as possible. Furthermore, the smart meters are considered a significant contributor to a future smart grid system.

Figure 4: Share of main benefits associated with electricity smart metering rollout.



III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The EPC was introduced in the Netherlands in 2008. The system worked well between 2008 and 2013, when more than 2.3 million EPCs were registered. The Energy Agreement of 2013 states that a simple and affordable EPC plays an important role in meeting the energy savings targets in the built environment. In June 2014, the House of Parliament agreed on a new EPC system that gives individual residence owners direct feedback on the energy achievements of their home. It was thus more cost-effective: an EPC for a house should cost the Dutch citizen no more than approximately 25 €. Sanctioning is part of the new system that is operational since 1 January 2015 and carried out by the IL&T, the National Governmental Inspection Authority.

After this decision, the RVO developed the new EPC for residential buildings in cooperation with stakeholders. It consists of a user-friendly web-based tool where private residence owners can apply for an EPC for their house. Since 1 January 2015, all residential building owners (in total 4.5 million) received a temporary EPC (calculated on the basis of the national cadastral data) by mail. This certificate gives an indication of the energy performance of the residence. The owner can digitally add or change information to the intake data of the Dutch cadastre on which the preliminary EPC is based. This data is trustworthy, so the owner only has to add limited modifications. Both existing and new data are checked by a QE ("*energiedeskundige*") who is in charge of producing the definitive EPC registered in the RVO database.

The Dutch energy performance certification process for residential building owners comprises the following 4 steps:

> *Step 1*. Owners receive a temporary EPC, which indicates the energy performance of the residence based on cadastral data (area, date of construction, building type, quality of insulation of floors, roof and walls, and systems for heating, hot-water and renewable energy).
> *Step 2*. The owner can change or add extra information on energy measures and select a QE who has to approve the changes on the website. The owners have also to provide evidence of the measures taken, such as invoices and photos.
> *Step 3*. The QE checks the uploaded changes and documents, before approving the definite EPC.
> *Step 4*. Finally, based on this approval, the new EPC is registered at RVO.nl.

The final EPC is based on a national calculation method that takes into account the measures taken by the owner for the residence. The EPC is valid for 10 years and is mandatory if a residence is sold or newly rented.

The EPC is mandatory when renting or selling:

> residences and apartments;
> mobile homes as permanent residences;
> recreational residences that are used for more than 4 months per year, or with an expected energy use of more than 25% of the energy use when in permanent use;
> buildings with living spaces combined with non-residential use (calculated as one building).

The IL&T checks the availability of the EPC when owners sell or rent out the property. If there is no final EPC, the owner receives a fine of a maximum of 405 €. Owners receive a warning in advance, giving them the opportunity to obtain an EPC before receiving the fine. In the period of January to March 2015, more than 9,000 owners received a notification that they have to obtain an EPC within 3 months. To date, no fines have been issued.

The system is transparent for both buyer and seller because a certain amount of

Figure 5: Infographic describing the 4 steps of the Dutch labelling process for residential building owners: 1) login, 2) uploaded proof, 3) validation by a recognised expert and 4) registration.

Figure 6: Infographic presenting an overview of the energy characteristics of a house which must be checked by the property owner and where the evidence has to be uploaded.

residence characteristics is checked. A buyer can therefore easily verify the declared energy characteristics. The buyer, when identifying mistakes, can take legal action against the seller. A residence owner in The Netherlands is obliged to provide the correct data about the residence when selling. The buyer or the buying brokers have a research duty, and the seller or the selling broker a notification duty (as stated in the Dutch Civil Code).

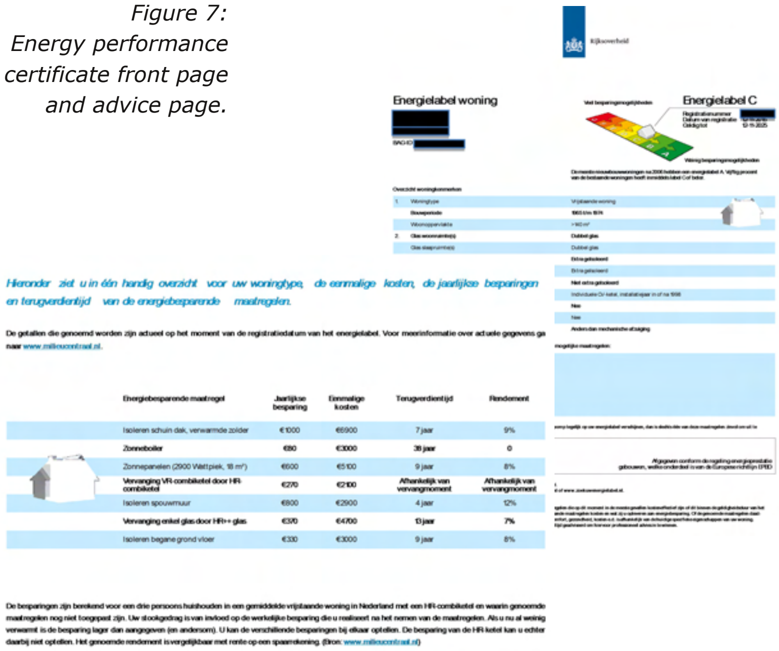


Figure 7: Energy performance certificate front page and advice page.

Figure 8: Number of registered EPCs over the period of 2007 – 2015.

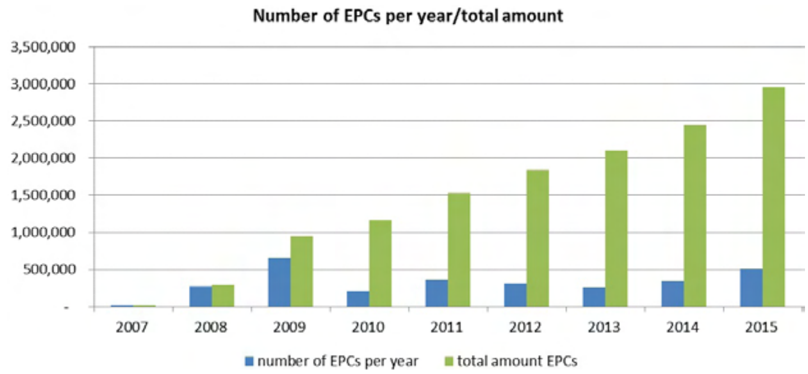
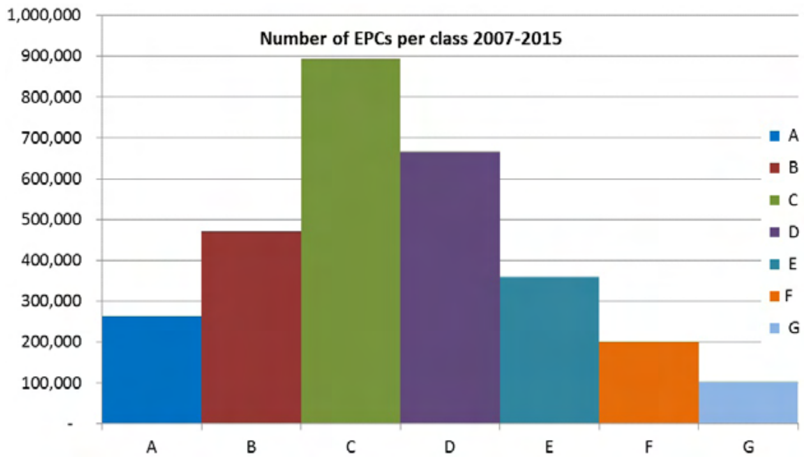


Figure 9: EPCs produced via the web tool, per class.



How flats are certified in apartment buildings

Apartment blocks cannot be certified as one single building. For individual apartments, it is possible to use a reference, provided that the apartments have similar characteristics.

Format and content of the EPC

The EPC is based on an elaborate calculation method, which is determined by the Dutch Normalisation Institute NEN. It is supported by market partners. There is much information available about the Dutch residential stock (land registry of the RVO) at the cadastre.

In the former system, more than 150 building characteristics had to be inserted in the calculation method. Only experts were able to provide this data. In the new system, there are only 20 building characteristics which the owners can provide themselves. The web tool includes how-to explanations, texts and instruction films and was tested extensively before its launch.

EPC activity levels

The EPC system has been in place since 2008 and more than 2.3 million EPCs have been registered under this legislation. Under the new scheme, 425,463 EPCs were registered in the period of 1 January 2015 to 1 November 2015. This gives a total of approximately 2.7 million EPCs.

The Netherlands had an average of 300,000 registered EPCs/year in the period until 1 January 2015. With the new system, this number is expected to reach an average of 460,000/year. Furthermore, there are more than 600,000 unique visitors to the web tool. This indicates that there will likely be an increase in this figure in the near future.

Typical EPC costs

With the introduction of the new EPC system, where QEs can upload the evidence, the costs for the EPC significantly decreased. The costs for the residence owners amount 10-40 €, whereas the costs with the former certification system were around 250 € for residential buildings and approximately 1,000 € for a non-residential building.

Assessor corps

After the owner has changed the data and uploaded the evidence, they select a QE. There are around 200 certified companies in The Netherlands, with around 844 accredited QEs for residential buildings, and 150 for non-residential buildings. In the former system, exams were organised by CITO, the Dutch evaluation Centre[2]. This is still the case for non-residential buildings.

Since 1 January 2015, experts for residential buildings (“*Erkend Deskundige Energielabel Woningbouw*”) must meet the requirements of the former system or pass a new simplified exam. The exam is organised by SVMNIVO[3], the exam centre for housing. In addition, experts must follow a training course from RVO.nl to learn how to operate the web tool. The number of accredited QEs will increase in the near future, as 2,100 persons have applied for accreditation.

Compliance levels by sector

According to data collected by the Land Registry and Mapping Agency at the beginning of 2015, 68% of sold houses and non-residential buildings had an EPC at the moment of sale. A 2015 study carried out among housing corporations revealed slightly higher compliance rates for rented buildings than for sold ones.

Quality Assurance (QA) of EPCs

In The Netherlands, the quality assurance (QA) system for residential buildings was changed on 1 January 2015. Until that date, a system with certified energy label companies was operational. Since 2015, the IL&T is in charge of policing the quality of the accredited experts. In the new system for residential buildings, the IL&T conducts random checks on experts and gives fines. The IL&T has access to the RVO database that comprises the updated entries, evidence and expert assessments. The QEs have to underpin their conclusions with concrete arguments. This data is also included in the RVO database. The RVO also checks whether QEs comply with the requirements of being visible in the web application. Among other things, they must have clear pricing and mention that they are members of the guarantee fund.

If the experts do not comply with the conditions given by the RVO, they receive a formal request to adapt within 3 weeks. If they fail to do so, they will be blocked by the web tool and can no longer issue EPCs until the required adaptations are made.

In 2015, a total of 365 experts have received a notification from the RVO. More than 300 of them now live up to the RVO standard.

In 2014, a total of 1,429 EPCs were checked by 4 certification institutes. Of these, 6% of residential buildings did not comply with the quality criteria. For non-residential buildings the non-compliance rate was 11.1%.

The experts involved have received a notification from these certification institutes and they will be checked next year. The experts will be responsible for the costs of these extra controls. If this situation repeats itself, the experts will lose their licence. In 2013, 3 experts have lost their licence as a result of this and they are excluded from the activities related to EPCs. Reports for 2014 are not yet available.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The Human Environment and Transport Inspectorate of the Ministry for Infrastructure and the Environment has checked the compliance rate with the requirement for visibility of the EPC in public buildings (municipality, province and government buildings) in 2014.

The IL&T can give owners of such buildings a financial penalty in case of non-compliance. To date several owners of public buildings have received a warning of non-compliance with the requirement for public display of the EPC. They are given a 6 months period to become compliant and will be checked again after this period.

Format and content of the EPC

The display of the EPC is similar to the front page of the EPC used for sale and rent, which comprises of the energy label class, address and an overview of measures to enhance the energy performance of the building (Figures 10 and 11).

EPCs are updated every 10 years or after renovation of the building.

Figure 10: Example of an EPC on display in a public building.

[2] *www.cito.nl*

[3] *www.svmnivo.nl*

Activity levels

The obligation to display the EPC has been mandatory since 2008. In 2015, 1,183 public buildings have been identified and 584 of them have been checked. Of those, 245 buildings had not yet made an EPC visible. Another 380 public buildings will be inspected in 2016.

Costs

The costs for calculating the EPC for non-residential buildings vary between 150 € and 1,000 € according to the size of the building (approximately 0.5 €/m²). Costs for display are excluded.

Assessor corps

There are approximately 200 certified companies with about 150 QEs for issuing EPCs for non-residential/public buildings. The register can be found online at www.qbisnl.nl (Figure 12).

QEs have to apply within the dispositions of the National Standard BRL 9500. Certification Institutes assess the competence of the candidates and the internal quality assurance of the organisation before accreditation is granted (Figures 13, 14, 15).

Quality Assurance (QA) of EPCs

In the non-residential sector, the certification institutes perform random checks and take follow-up action. This has led to the removal of a small number of QEs.

Evaluations show that QEs make mistakes because of the complex methodology used to calculate the energy rate. The consultants' organisation FEDEC agreed to organise extra information workshops and other actions to improve the quality of the QEs.

III.iii. Implementation of mandatory advertising requirement

If a building is sold, the energy label must be included in the advertisement. The presence of the EPC is checked by the IL&T.

Of all houses sold in The Netherlands, 80% are advertised on the site of the real estate chain, Funda. The remaining 20% are sold through agencies or ways other than Funda, in most cases without an advertisement. On the Funda website (Figure 16), the preliminary EPC is presently shown in 100% of the cases, along with the characteristics of the property. Only 18% of the advertisements show the final EPC. The obligation to publish the final EPC is only mandatory if an EPC already exists. In many cases, house owners have not registered their final EPC when the advertisement is

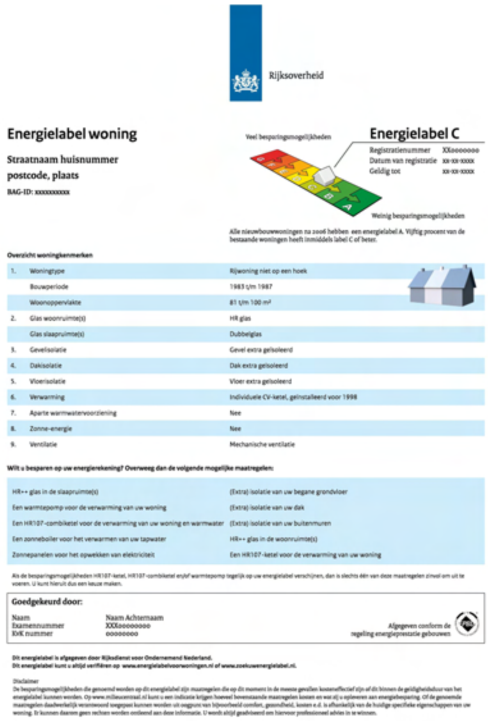


Figure 11: Front page to be displayed.

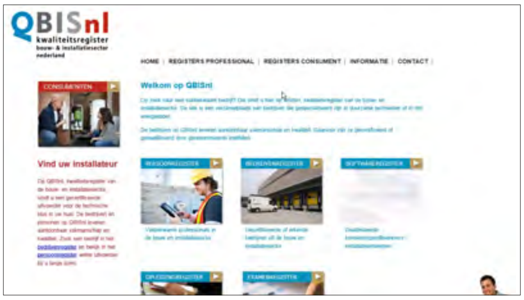


Figure 12: Web tool for qualified experts.

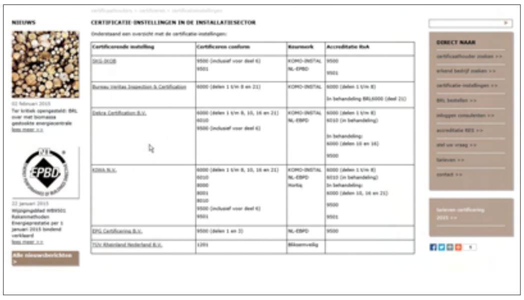


Figure 13: Overview of Dutch certification institutes.

Figure 14: Inspection guidelines for qualified experts.

Figure 15: Information on how to follow the training and exam requirements.

published. This explains the relatively low number of final labels in advertisements.

Furthermore, citizens can also find label information of specific buildings at www.zoekuwenergielabel.nl (Figure 17).

III.iv. Information campaigns

Before 2015, several activities to promote the EPC were undertaken via a specific website, television and/or media campaigns.

In the period between January and March 2015, 4.5 million residence owners that did not have an EPC received a letter with a temporary energy label for their residences. The intention of this initiative was to make them aware of the energy performance of their property and the opportunities to improve it, as well as of their obligation to have a definitive EPC when selling or renting their house. The obligation related to the labels was also communicated through social media and other national and regional public channels. A call centre was set up with a staff of over 40 employees to answer questions. Municipalities developed additional awareness campaigns and organised local information desks.

III.v. Coverage of the national building stock

There are 7,587,028 residential buildings in The Netherlands. At the end of 2014, 33% of these residential buildings had an EPC (2,499,336 units).

For the public sector, as defined in the EPBD, it is not possible to estimate the coverage yet since there are no central data or statistics available regarding the number of public buildings.

Since the introduction of the new energy labelling system (January - November 2015), more than 435,000 new EPCs were registered. More than 600,000 homeowners have visited the web tool in 2015 and are in the process of registering their EPC.

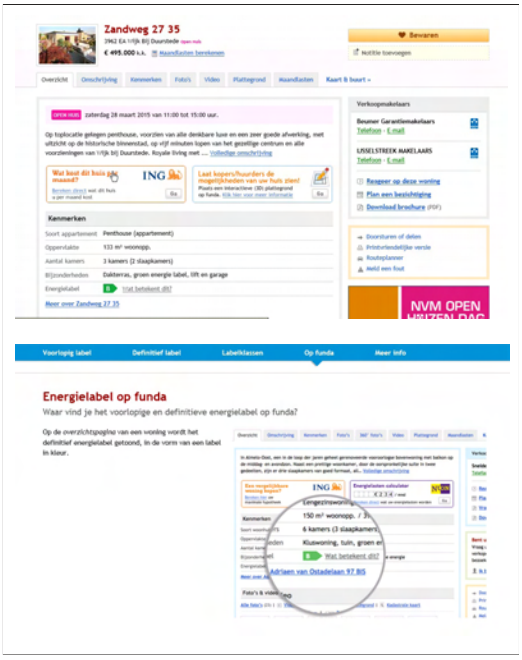


Figure 16: Funda website.

Figure 17: Public information website.

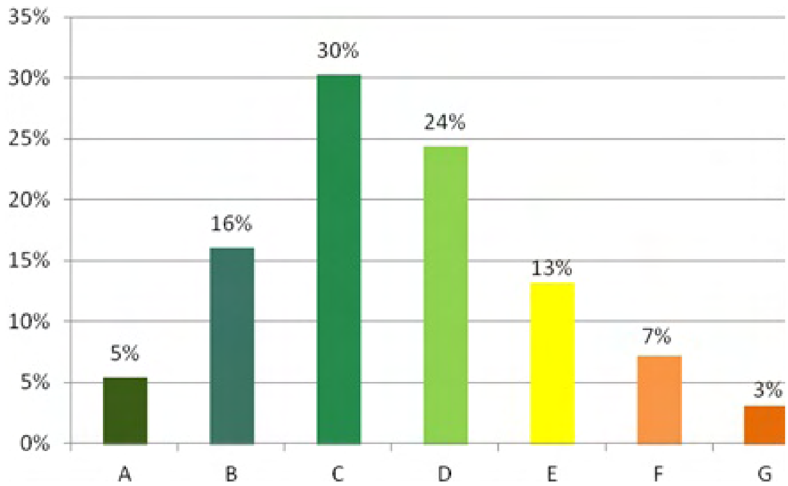


Figure 18: EPCs for residential units in 2014.

	A(+)	B	C	D	E	F	G	Total
Apartment	3,745	7,644	8,968	5,601	3,315	1,819	899	31,991
'Gallery residence'	56,838	132,993	177,916	154,026	81,057	34,495	10,556	647,881
Maisonette	3,109	8,412	15,822	9,749	4,631	3,095	1,497	46,315
'Veranda residence'	24,030	91,990	174,491	141,573	85,129	53,703	24,736	595,652
Family house	29,827	97,914	226,865	189,468	87,398	41,842	13,122	686,436
Corner house	19,713	58,488	146,393	103,100	61,437	40,558	19,262	448,951
Villa	2,900	6,602	9,440	7,882	5,191	3,876	3,015	38,906
Building (care)	327	529	835	662	503	154	191	3,201
	140,489	404,572	760,730	612,061	328,661	179,542	73,278	**2,499,336**

Table 5. EPCs for residential units by type in 2014.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

In The Netherlands, mandatory inspections for gas-fired heating systems with more than 100 kW and for non-gas-fired heating systems with more than 20 kW are in place. This obligation is regulated in the Activities Decree and Activities Regulations. For gas-fired heating systems between 20 kW and 100 kW, The Netherlands has opted for the alternative approach.

There has been a mandatory inspections regime for AC systems in place since 1 December 2013. This comprises a mandatory inspection for systems larger than 12 kW. Private homes are excluded from this regime because there are very few such systems in houses.

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

Compliance with the inspections of heating systems is carried out by the municipalities. The actual inspection is carried by companies with a SCIOS certificate. SCIOS stands for Foundation of Certification Inspection, Maintenance, and Combustion (Activities Regulations, Article 3.7m, paragraph 4). The certificate shows the abilities of the company and the employees. An online list of approved inspection companies is available on the SCIOS website[4]. The inspection frequency is indicated in Table 6.

For small systems (< 100 kW), inspection activity only starts in 2016.

Gas-fired systems of 20-100 kW are used for heating in more than 5 million homes (over 90% of the existing housing stock). The Netherlands has opted for a system of voluntary inspection and maintenance, combined with energy-saving advice for these systems, described later in this report.

Arrangements for assurance, registration and promotion of competent persons

The 'Activities Decree' (part of the Dutch Environmental Protection Act) includes regulations for inspection and maintenance of gas-fired heating systems above 100 kW and non-gas-fired heating systems above 20 kW (Activities Decree, Article 3.7, paragraph 4, 3.10p and Activities Regulations, Article 3.7m). The periodic inspection ensures safe operation as well as optimum combustion and energy efficient functioning. The risks of air pollution (CO, NOx, SO_2, particulates and C_xH_y), explosion and energy waste are addressed. An inspection includes the system for the supply of fuel and combustion air, the exhaustion of combustion gases and the adjustment for combustion efficiency (Activities Regulations, Article 3.7, paragraph 3). The holder of the combustion plant shall keep the final report available for the authority.

The SCIOS inspectors record their findings in the inspection report. The supervisor of the competent authority (usually municipalities) checks if inspections have taken place and if reports are available. The municipalities can access the SCIOS database where all inspections are recorded via a secure web application.

Enforcement and penalties

The inspection for gas-fired heating systems larger than 100 kW and for non-gas-fired systems larger than 20 kW is carried out under the SCIOS certification scheme. If inspections fail to meet the SCIOS standards, they lose their licence. Inspection reports, including the advice on energy saving, are registered in a central database and randomly checked by SCIOS and OK-CV. Data of the number of inspections and their results is not available for large systems (> 100 kW).

Alternative measures for gas-fired heating systems between 20 kW and 100 kW

The proportion of systems with regular maintenance is already high at approximately 90% in 2011, but it has decreased in recent years, partly as a result of the economic crisis. Moreover, the quality of the performed maintenance and inspections varies. For these reasons, in collaboration with the branches, a new quality label developed in 2015 was put on the market, called OK-CV (www.ok-cv.nl). Regular maintenance under OK-CV is combined with an inspection and savings advice.

A communication and marketing campaign among contractors was conducted in 2014. From 2015, licenses are issued to contractors. The government supports the development and communication of OK-CV.

Table 6: Inspection frequency for heating systems.

Fuel	Nominal Capacity	Periodical Inspection
Gas	≤ 100 kW	-
	> 100 kW	At least once every 4 years
Solid/liquid	< 20 kW	-
	20 - 100 kW	At least once every 4 years
	> 100 kW	At least once every 2 years

[4] www.scios.nl

The quality of the assessment is carried out by the OK-CV organisation that has developed a database with all results of inspections. If inspectors fail to meet the OK-CV standards, they lose their licence.

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

Since 1 December 2013, the mandatory five-yearly inspection of AC systems with an output of more than 12 kW was officially published in the official journal '*Staatscourant*' (Publication Staatscourant 2013 -32499).

Building owners are responsible for the inspection. The inspection is carried out by inspectors who have obtained an EPBD A or B certificate that describes the quality and required skills of the craftsmen who carry out the inspection.

Inspectors with an EPBD A or B certificate are accredited to inspect AC systems with a cooling capacity of, respectively, < 45 kW or > 45 kW. Courses and exams for these certificates are available. The inspector has to hand over the inspection report to the owner or tenant of the building. This report includes the results of the inspection and recommendations for cost-effective improvement of the energy performance.

At least 1,500 professionals have obtained a certificate for the inspection of AC systems until 2015. This number is still growing.

Accredited inspectors who passed the exam are registered in the RVO database, which complies with the Data Protection Act. The list of accredited inspectors is published on the RVO website.

The IL&T carries out random checks to verify that the mandatory inspection has been performed. Owners who did not have an inspection performed currently get 6 months to do so. If they fail to meet the requirement, they can get a fine of up to 20,250 €.

The IL&T also carries out random checks to determine if the inspections reports meet the requirements. If a report does not live up to quality standards, the owner will get a formal notification from the IL&T stating that they have 6 weeks to acquire a new, improved inspection report. If owners do not comply, they will be placed in default and they will be fined as if they had not had an inspection performed in the first place, at a maximum of 20,250 €.

Accredited inspectors have to take a new exam every 5 years. If they fail, they will be removed from the RVO database. Inspection figures for 2014-2015 are not available.

Promotional activities

A protocol for AC inspections was developed in 2014 and tested in 2015 as a pilot programme in the city of The Hague. The outcome of this pilot was communicated throughout The Netherlands and directed to non-residential building owners. There are about 4,000 buildings in this city which are likely to have an AC system. This is 10% of the total building stock with AC systems > 12 kW. Homes are excluded because AC systems are not commonly used in Dutch houses. In The Netherlands, the percentage of homes with AC systems is between 10 and 15%.

Figure 19: Information campaign for OK-CV.

Figure 20: Presentation of the first OK-CV certificate by Minister Blok.

The RVO has launched a special website with information on the inspection procedures. A communication plan was developed to inform building owners of the obligations. Articles and news items were published in several professional media outlets. The remaining activities in the communication plan will be carried out from the end of 2015 onwards.

3. A success story in EPBD implementation

The introduction of the new EPC in The Netherlands has changed the landscape of the Dutch built environment. While the previous EPC was merely technical and expensive and suffered resistance among the Dutch population, the new simplified EPC has empowered citizens to directly influence their energy use. The practical advice has given building owners concrete steps for improvement. The new EPC has become a marketing tool instead of a technical process. It is motivating for owners to improve the energy level of their houses and get a new EPC. A good level is perceived as an indicator for good quality and an added value. This is also recognised by banks and other financial institutions and has influenced mortgaging. Banks are investigating if they can offer lower interest rates for better EPCs from 2016 onwards. The EPC has supported builders and installers in their pursuit of energy efficiency as a new or renewed market. New market offers have sprung up from different companies that offer integral solutions for homeowners and buildings to upgrade their EPC. The long-term experience of Dutch professionals with integral solutions contributes to an increased demand. The voluntary agreement of the partners in the 'Energy Accord' gives a central place to improvements of the EPC as a vehicle to reach the 2020 objectives. This broad support has contributed to higher investments in energy efficiency and renewable energy.

The results of the simplified web-based approach since its introduction in January 2015 until December 2015 are:

> 4.5 million houses got a letter with information about the EPC and a personal pre-setting in the EPC web tool;
> 2,150 trained QEs, of which 851 working with the web tool;
> costs are kept low because of competition, with an average of 25 € per EPC;
> over 630,000 individual log-ins;
> over 510,000 registered EPCs.

4. Conclusions, future plans

In general, The Netherlands has implemented the Energy Performance of Buildings Directive.

For the near future, a number of measures are foreseen to stimulate energy efficiency in the building environment. The focus is on the application of alternative high efficiency systems during major renovations. Extra attention will be given to enlarge the economic value of the Energy Performance Certificate (EPC) during the selling and buying process of houses and buildings. Also, the market for energy efficiency will be further developed.

Measures currently running at the end of 2015 are:

a) 'SDE+': subsidy scheme for investments in renewable energy systems such as geothermal systems and bio-based installations;
b) 'EIA': tax reduction for investments in innovative sustainable energy systems based on an EPC indicator;
c) possibilities for an extra mortgage for private investment in extreme energy efficiency measures (zero energy bills) up to a maximum of 25,000 €;
d) *'National Energy saving Fund'* (NEF): cheap loans for energy saving measures for private owners (300 M€);
e) *'STEP'*: subsidy for social housing corporations for investment in energy efficiency (400 M€) based on EPC improvements;
f) *'Funds for the Energy Saving Rental Sector'* (FEH): cheap loans for extreme energy efficient renovations (75 M€);
g) *'Energie Prestatie Vergoeding'*: social housing corporations that rent houses or apartments with a 'zero energy bill' can oblige the occupants to pay a contribution to the energy investments. This overcomes the barrier of the split incentive.

Implementation of the EPBD in Norway

STATUS IN NOVEMBER **2015**

1. Introduction

Directive 2002/91/EC, the first version of the Energy Performance of Buildings Directive (EPBD), has been fully implemented in Norway since 2010. By the end of 2015, approximately 570,000 Energy Performance Certificates (EPCs), had been issued. The majority of these concern houses and apartments, while 22,000 concern non-residential buildings.

Directive 2010/31/EU has not been formally included in the Agreement on the European Economic Area (EEA), and is thus not implemented in Norway. The content of this directive is, however, actively pursued in the planning of future regulations.

In 2013, a dedicated control scheme was established where samples are controlled for the existence of certificates and inspection reports. In the future, the content and quality will also be subject to control.

This report presents an overview of the current status of implementation, as well as of further plans for improvement in EPBD schemes in Norway. It addresses certification and inspection systems, including the status of quality control mechanisms, the status of Qualified Experts (QEs) in the market, information campaigns, and incentives and subsidies.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

In 2012, a broad agreement in the Parliament stated that all new buildings should be at "Passive House" level in 2015, and Near Zero-Energy Buildings (NZEB) by 2020.

The two Norwegian standards for passive houses and low-energy buildings are already in place. These are the NS 3700 for residential buildings, and the NS 3701 for non-residential buildings. However, the definition of the "Passive House" level was to be implemented in the building regulations in 2015. In November 2015, the new requirements were published and will be effective from January 2016, with 2016 as a transition period. This means that in 2016 the new requirements are voluntary, whereas from January 2017 they will be mandatory. The requirements do not fully meet the "Passive House" standards.

The requirements for 2020 are intended to comply with NZEB, but they have yet to be decided.

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NATIONAL WEBSITES www.energimerking.no, www.dibk.no

I.ii. Format of national transposition and implementation of existing regulations

The Norwegian building regulation, mandatory from 2017, has two options for how to fulfil the requirements. For non-residential buildings only the first option is allowed:

- The first option contains specific energy limits for different building types. The requirements are set in kWh/m² useful energy demand per year within the building envelope, considering heat recovery from ventilation systems but not considering system losses and energy export. If this option is chosen, a set of absolute minimum requirements must also be fulfilled.
- The other option, for residential buildings only, addresses different components of the building envelope, as well as technical installations and solutions. The requirements will be considered fulfilled if it is shown that 9 specific energy measures are applied. In addition to requirements concerning insulation and envelope airtightness, there are specific requirements for the heat recovery of ventilation air in the ventilation apparatus (yearly mean heat recovery rate), and the Specific Fan Power (SFP) factor.

To ensure flexibility in heating systems, and systems being based on renewable energy, all buildings larger than 1,000 m² shall have flexible heating systems, normally waterborne, and be prepared for low-temperature heating distribution. Detached dwellings need to have a chimney, unless flexible heat distribution is installed. Installation of heating systems prepared for fossil fuels is not allowed. As Norwegian electricity production is almost exclusively based on renewable energy and fossil fuels are to be phased out from buildings, primary energy factors are not used in the regulations. To stimulate local renewable production, when electricity is produced on the property (more than 20 kWh/m².year), the specific energy limit can be exceeded by 10 kWh/m².year.

The Norwegian energy requirements are set for 13 different building categories. Indicatively, Table 1 shows the progress over time of certain aspects necessary to fulfil the Norwegian minimum energy requirements, for commercial buildings, single-family houses and apartment buildings.

Table 2 shows the absolute minimum requirements that must be fulfilled if using the option of net energy demand limit.

Table 1: Minimum energy requirements for buildings in Norway.

Requirement	1997	2007	2010 (after EPBD Directive 2002/91/EC)	2015
Net energy demand kWh/m².year	-	Single-family house:125 + 1,600/m² heated floor area Apartment: 120 Commercial building: 165	Single-family house:120 + 1,600/m² heated floor area Apartment: 115 Commercial building: 150	Single-family house:100 + 1,600/m² heated floor area Apartment: 95 Commercial building: 115
Maximum area of glass plus doors	20% of heated floor area	20% of heated floor area	20% of heated floor area	25% of heated floor area
Max U-value: exterior wall W/m².K	0.22	0.18	0.18	0.18
Max U-value: roof W/m².K	0.15	0.13	0.13	0.13
Max U-value: exposed floors W/m².K	0.15	0.15	0.15	0.1
Max U-value: glass/doors W/m².K	1.6	1.2	1.2	0.8
Thermal bridges (normalised U-value) W/m².K	-	Single-family house: 0.03 Other buildings: 0.06	Single-family house: 0.03 Other buildings: 0.06	Single-family house: 0.05 Other buildings: not defined
Minimum efficiency of heat recovery in ventilation air	60%	70%	Dwellings: 70% Commercial building: 80%	80%
Minimum airtightness (Max air changes/hour at 50 Pa pressure difference)	Single-family house: 4.0 Other buildings (with more than two floors):	Single-family house: 2.5 Other buildings (with more than two floors): 1.5	Single-family house: 2.5 Other buildings (with more than two floors): 1.5	1.5
Max SFP factor kW/(m³/s)	-	Dwellings: 2.5 Commercial building: 2.0	Dwellings: 2.5 Commercial building: 2.0	Dwellings: 1.5
Max screening factor for glass/window (gt)	-	-	0.15 (all buildings)	

Table 2: Minimum requirements under the "specific energy limits" option.

U-value exterior wall W/m².K	U-value roof W/m².K	U-value exposed floors W/m².K	U-value glass/doors W/m².K	Airtightness (air changes/hour at 50 Pa pressure difference)
≤ 0.22	≤ 0.18	≤ 0.18	≤ 1.2	≤ 1.5

Since 1 January 2013, all new buildings are required to be controlled by an independent expert at the end of the construction process. For larger residential buildings and for non-residential buildings, the control will be more extensive than for single-family houses. Air leakage testing is mandatory for all building types and must be documented according to the current standard.

The Norwegian standard for the calculation of the energy performance of buildings is called NS 3031. This standard is built on the EN 15603. The regulation of 2015 is based on the 2014 version of NS 3031.

I.iii. Cost-optimal procedure for setting energy performance requirements

The requirements in place from 2016 are considered to be cost-effective. Since Norway has not implemented the Directive 2010/31/EU, the requirements have not been evaluated according to the procedure decided by the EU.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The 2012 agreement on climate issues in the Norwegian Parliament stated that the building requirements in 2020 will correspond to NZEB level. This has again been stated by the Government in 2015, when 2016 requirements were presented. However, the concept of NZEB in a Norwegian context has not yet been fully defined.

Figures and statistics on existing NZEBs

The statistics available do not include a separate category for NZEB, as Norway has no NZEB definition. Somewhat better statistics can be found regarding buildings meeting the Norwegian Passive House standards. The support scheme has worked well and now more than 10% of new buildings (ca 1,000 buildings) meet these criteria. The Norwegian support scheme for new buildings meeting the Passive House criteria of the *"Passive House"* standards has therefore been discontinued, and a new programme for even more ambitious projects has replaced the passive house support programme. Support is given in particular to innovative solutions to improve technical systems and heating systems.

Two examples of Norwegian NZEBs are shown in Figures 1 and 2.

[1] http://ngbc.no/breeam-nor/

Figure 1:
Norway´s first NZEB, a single-family house, was completed in 2012 and has been in operation ever since. The table shows the specified calculated energy needs. After the first full calendar year in use, the actual used energy for the operation of the house (excluding outdoor pool and other consumption not related to the building operation) was about 6,500 kWh, and the produced electricity from the solar panels was 7,126 kWh.

Heating	12.9 kWh/m².year
Hot water	29.8 kWh/m².year
Ventilation fans	4.4 kWh/m².year
Cooling	0.0 kWh/m².year
Technical equipment	17.5 kWh/m².year
Pumps	0.8 kWh/m².year
Lighting	11.4 kWh/m².year
Others	0.8 kWh/m².year
Total	76.8 kWh/m².year

Figure 2:
'Powerhouse Kjørbo' with the specified calculated energy needs during operation. This rehabilitated office building demonstrates the possibility of transforming a typical 1980s office building into a plus-energy office building, generating more energy during its lifetime than what was used during production of materials, construction, operation and demolition. The project was completed in 2014 and was awarded the BREEAM-NOR "Outstanding" classification, the highest classification in BREEAM-NOR[1]. The project also fulfils all requirements in the Norwegian passive house standard for non-residential buildings, NS 3701. The building produces energy using tilted solar panels on the flat roofs.

Heating	5.9 kWh/m².year
Hot water	1.4 kWh/m².year
Ventilation	2.3 kWh/m².year
Cooling	1.3 kWh/m².year
Lighting	7.7 kWh/m².year
Others	0.8 kWh/m².year
Total	19.4 kWh/m².year

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

It has not yet been decided whether the Energy Efficiency Directive (EED) is a part of the EEA agreement. The EED is thus not yet implemented in Norway.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

All the technical building systems are included in the energy limits given in the minimum requirements defined in section I.ii. When using the option of specific energy limits, the builders have an incentive to document good performance of the systems, otherwise they need to use standard values in the calculation of energy performance.

The current and future regulations have a special requirement for energy supply to stimulate energy flexibility. Installation of fossil fuel boilers will not be allowed according to mandatory requirements from January 2017. Only electricity (mostly renewable in Norway) or other renewable sources, or district heating, are allowed.

According to the regulation, which is to be mandatory from 2017, a building with more than 1,000 m^2 floor area shall be designed and constructed with a flexible heating system, prepared for low temperature heat.

Wherever provisions in municipal plans stipulate an obligation to connect to a district heating system, buildings shall be equipped with a heating system allowing for the use of district heating for heating rooms, ventilation heating and hot water.

II.ii. Regulation of system performance, distinct from product or whole building performance

The Norwegian performance based regulations set some general requirements regarding heating and cooling installations. In the regulation mandatory from 2017, it is required that pipes and other elements of the heating system be insulated according to cost efficiency and Norwegian standards.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

Technical systems must comply with the given minimum requirements and specific energy limits of energy performance for all new buildings and main renovations.

There are no requirements specifically for installation, dimensioning, adjustment, and controls. The main incentive is for the developers to use and install equipment that can contribute to better energy performance and bring the actual building below the given limits.

II.iv. Encouragement of intelligent metering

At the moment there is no encouragement of intelligent metering. A pilot project regarding smart metering is currently being developed.

New metering equipment for electricity will be installed in all buildings by 2019.

II.v. Encouragement of active energy-saving control (automation, control and monitoring)

To be able to benefit from economic support for the installation of heat pumps, a specific energy and heat monitoring system must be installed. To be able to apply for economic support to upgrade existing commercial buildings, an energy monitoring system must be in place before the upgrade.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The scheme for the certification of buildings is the responsibility of the Ministry of Petroleum and Energy. The Norwegian Water Resources and Energy Directorate (NVE) is the managing body for certification and inspection schemes. The Government has decided that Enova, a public enterprise that is owned by the Ministry of Petroleum and Energy[2], will take over the management of the certification and inspection schemes as of 1 July 2016. NVE will remain responsible for control activities. The legislation is in place since 1 January 2010 under the Energy Act, but following a political discussion, the regulation was revised as of 1 July 2010[3].

[2] *www.enova.no*

[3] *Regulation for energy certification of buildings and inspection of boilers, heating systems, ventilation and AC systems: www.lovdata.no/cgi-wift/ldles?doc=/sf/sf/sf-20091218-1665.html*

The Directive's requirements for public buildings in Norway relate to all non-residential buildings. Thus, the regulation does not distinguish between public and private buildings. The EPC for both residential and non-residential buildings is valid for 10 years, or until major changes are implemented in the building.

EPCs are issued by the NVE after on-line registration of building data. The registered data are stored in the database at NVE premises. The EPCs are publicly available, whereas more detailed data are used for analyses, research and development. The regulation requires that the EPC be shown to potential buyers and renters as a part of the marketing. However, parts of the certificate, for instance the energy label, can be used in a short version.

The regulation requires that every residence has an EPC. This applies to both apartments and single-family houses. The political background for this was the wish to stimulate the households' own interest and activity related to energy quality and energy performance of the building.

Format and content of the EPC

The EPC is the legal document produced during the energy certification.

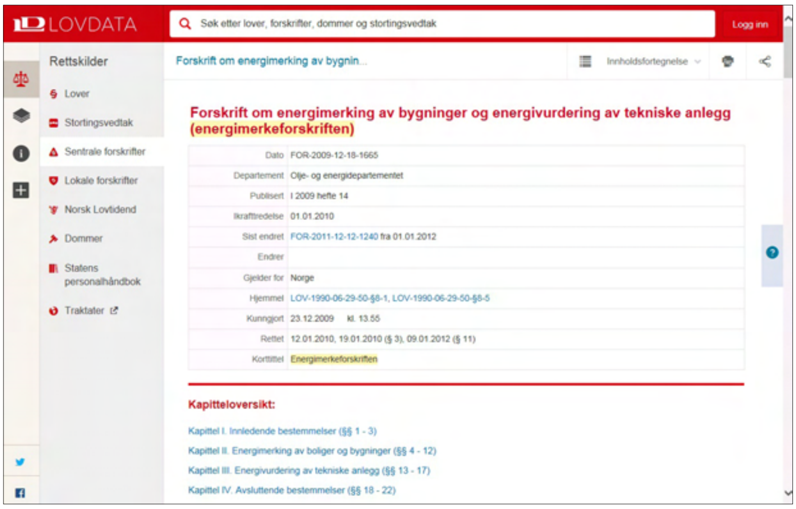
The EPC (*Energiattesten*) includes the following content:

> **Identity data.** The top of the front page includes the address and necessary data for the identification of the building or the apartment, the name of the person or organisation responsible for the certification (normally the owner), as well as the name of the person who has registered the data.

> **The energy label.** This matrix presents the result of the calculations in two dimensions. First, on the vertical axis, the energy grade (grades A to G) represents the calculated delivered energy needs. New buildings will normally achieve energy grade C, although this depends on the efficiency of the heating system in place. Installation of a heat pump or solar collectors could improve the grade. Grades A and B are normally reserved for buildings with an energy performance above the minimum requirements. Second, on the horizontal axis, the heating grade represents the extent to which the heating of space and water can be accomplished with Renewable Energy Sources (RES) other than electricity. The character represents the energy grade and the colour represents the heating grade, where green is predominantly based on renewables and red means heating is based on fossil fuels or electricity. An explanation is given on the front page of the certificate.

> **Measured energy consumption.** For existing buildings, an average of the measured energy use per energy carrier for the last three years is shown at the bottom of the front page.

Figure 3: The regulation for energy certification and inspections https://lovdata.no/dokument/SF/forskrift/2009-12-18-1665?q=energimerkeforskriften



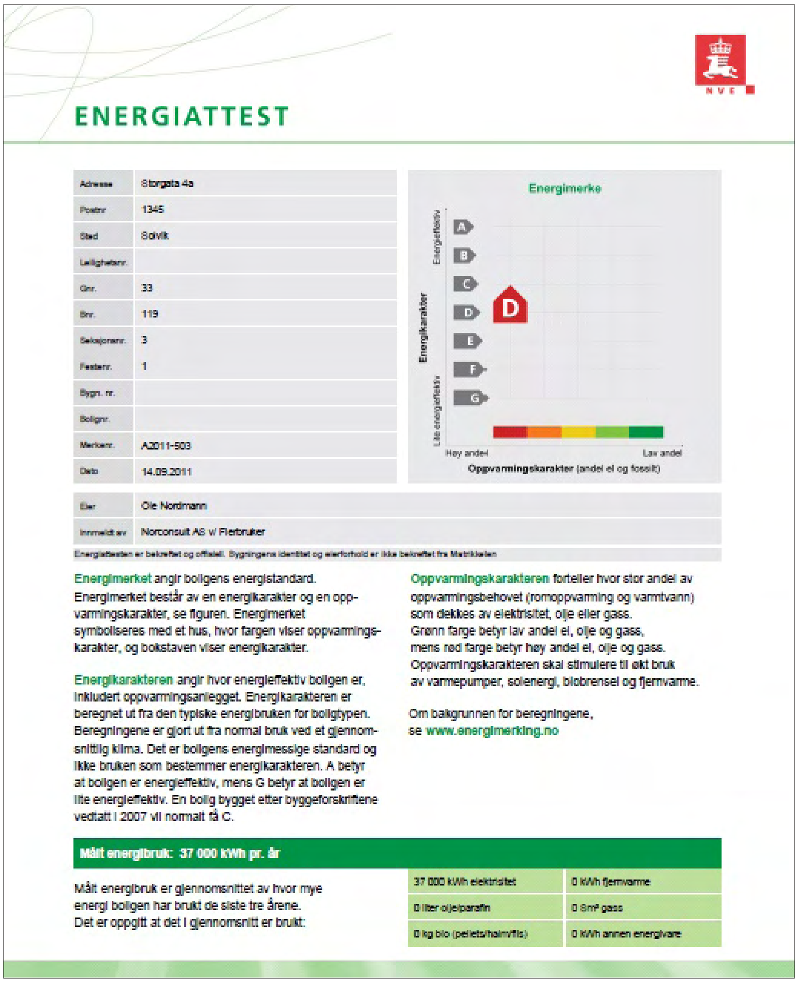


Figure 4: The first page of the EPC. The label is shown in its two dimensions, energy and heating.

Figure 5: The logo of the Norwegian scheme for energy certification.

For non-residential buildings, this is obligatory, but for residential buildings it is only encouraged. For new buildings this section is left blank.

- **User influence.** On page 2, a paragraph is devoted to general advice on how to save energy, even if it does not affect the calculation of energy performance.
- **Recommendations.** A summary of the recommendations is listed, whereas a more extensive description is given in the appendix. Where an expert is responsible for the certification, he is also responsible for the list of recommendations. For existing dwellings without an expert certificate, the recommendations are made by the IT system based on the buildings' registered data.
- **Central input data.** On page 3, most of the key input data given by the owner are presented, in order to allow the reader to check obvious data, e.g., building type, year of construction, etc.
- **Information and help desk.** The last page is devoted to general information on the energy certification, as well as to contact data for the help desk established by the Norwegian authorities.

A short version of the energy label is the profile of a building with the same combination of letters and colours as in the energy label matrix (see Figure 4).

There are small differences between certificates for residential and non-residential buildings. The differences mostly concern the language and the relevance of content.

Figure 6: Number of Energy Performance Certificates issued as of November 2015 (distribution by grades).

All buildings

Energiy Grade	Heating Grade					Sum
A	160	782	1,876	1,238	190	4,246
B	4,513	7,073	3,530	9,306	660	25,082
C	18,519	16,756	4,674	15,417	1,517	56,883
D	48,017	42,095	7,689	16,565	2,203	116,569
E	37,858	44,710	8,946	6,884	1,196	99,594
F	48,423	62,860	8,886	10,170	1,481	131,820
G	41,648	60,223	8,247	9,516	1,731	121,365
Sum	199,138	234,499	43,848	69,096	8,978	555,559

EPC activity levels

More than 570,000 EPCs have been issued over a period of 5 years (since January 2010). It is estimated that this implies that more than 400,000 unique buildings/ apartments have been certified. Some buildings have been certified again and a number of non-residential buildings require more than one EPC, one for each building category represented. Figure 6 shows the number of issued EPCs as of November 2015.

More than 90% of the EPCs are issued for residences. It is assumed that sale is the main trigger for the certification process – more so than rental. In December 2011 and in June 2012, a control was held for 5 advertised sales in each county, 95 properties in total. In December 2011, only 52% of these had been certified. This modest first result led to an improved dialogue with the estate agents, who then established better routines. Six months later, the result was considerably better: by then, more than 75% were certified.

The rate of certification appears to be slower for non-residential buildings. In the autumn of 2012, a corresponding control was held, which showed that only 37% of the buildings in question were certified. In 2013/2014, a more detailed control was held with 92 large non-residential buildings. Buildings were controlled upon the availability of the EPC, whether it was made visible for the users and whether inspection of technical systems was carried out. More than 50% had one or more defects. This has been followed by formal warnings, and in the end resulted in compulsory fines for the owners of 13 buildings who had not yet fulfilled their obligations. The fines accumulate until the obligation is fulfilled. The result of the control is also presented to the media.

Typical EPC costs

In the Norwegian scheme, the certificate for existing residences can be obtained free of charge by anyone registering data him/herself on the internet. If someone hires an expert, the cost will be according to the hourly cost of the expert, seldom less than 200 €.

For non-residential buildings, the owner is obliged to use an expert. The cost of certification will thus normally span from 1-10 work days, with a total cost between 1,000 € and 10,000 €. All new buildings require expert certification. This is normally done by the same expert and with the same data as for control of minimum requirements in the building regulation. The extra cost is thus minimal.

Assessor corps

For residences, most owners do the registration themselves through the specifically developed registration system. Very few experts are thus involved, except for new buildings.

For non-residential buildings a large number of experts are involved, including various technical professionals related to buildings, and very few are dedicated to certification only. It is estimated that 1,000-2,000 experts are actively involved in certification.

The competence requirements to be an expert are defined in the regulation. It requires a bachelor's degree in engineering and some experience, according to the complexity of the building. The expert shall not seek approval by the Government, but must be able to document his competence to the building owner, and to the Government in case of control. The Government offers guidance for experts in print and on-line, but there is no dedicated training program to become an EPC expert.

Compliance levels by sector

For residential property, a considerable number of properties for sale have a certificate. Approximately 20% of all residences in Norway have an EPC by 2015. The total number of residences is 2.4 million, and with an additional 450,000 leisure homes used only a few months every year. For non-residential buildings, there are no reliable figures but the share of buildings with an EPC is much lower than in the residential sector. Non-residential buildings add up to 750,000 buildings, whereas only a small part of them require an EPC. Agricultural buildings and some other types of buildings (old churches, industrial buildings with low needs of heating) are exempted.

Enforcement with building owners and real estate actors

Real estate actors have not taken an active role in the certification process. However, their duty to use the EPC during marketing gives them a vital role in securing the certificate's existence. A few controls have been performed and used as background for dialogue with the real estate agents' organisation. The legal control of their activity lies outside the NVE and has not yet been implemented. Mandatory inclusion of the energy label in the advertisements has not yet been implemented, as Directive 2010/31/EU has not been transposed in Norway.

The responsibility to create the EPC lies with the owner. In practice, the use of penalties is difficult when it comes to residential properties. Therefore, the buyer/renter of a house or apartment has been given the right to order an expert certificate at the seller's cost if an EPC is not shown according to the regulation. This gives the buyer a strong position if he demands an EPC. The strategy of enforcement for residences is thus to give the buyer/renter a strong position followed by controls and information on the performance of trade agents, etc.

For non-residential buildings, sanctions are possible, and were used for the first time in 2015. Eight (8) compulsory fines were imposed on owners of non-residential buildings.

Quality Assurance (QA) of EPCs

The energy certification system contains data validity checks and there are strong restrictions on what data are eligible. The most important Quality Assurance (QA) is, however, the control performed by the buyer who reads the EPC and demands that data be correct. The EPC is designed to enable the reader to understand the main input data used.

Controls have so far concentrated on the existence of the EPC and if relevant, whether the EPC is available to the users of the building.

The scheme for energy certification of buildings is considered a success in combining a simple registration by building owners for existing residences with a requirement for expert registration for new buildings and non-residential. The compliance rate is below what was expected and needs a revised strategy for both information and control.

III.ii. Information campaigns

In the first years from 2010-2011, a campaign was led to reach both the general public and the property and buildings sector. During 2013 and 2014, most of the relatively small resources

Figure 7: Advertisement for buyers/tenants in the housing market.

Figure 8: Advertisement on energy label calculator for residences. The calculator enables owners to see how improvements affect the energy label.

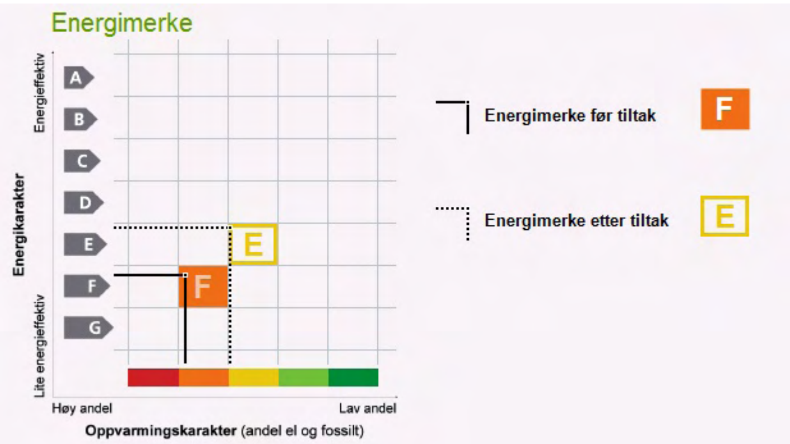


Figure 9 Energy label calculator: display of the result where a number of recommendations are simulated for an existing residence. The label has improved from "orange F" to "yellow E".

were used for advertisements and to some extent editorial content for different media. In the public information campaigns over the first two years (2010-2011), the main emphasis was on energy certification and less on inspection of technical systems. Figures 8 and 9 show examples of advertisements.

The slowing down in the rate of certification over the last two years (2014 and 2015), in particular for non-residential buildings, created a clear challenge to implement a new information strategy capable of overturning this trend.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Articles 8 and 9 of Directive 2002/91/EC are implemented in the same regulation as the energy certification, and the requirements for inspections are in force since 1 January 2010. It must, however, be noted that the practical implementation is slow. Up to 1 July 2010, the regulation had a transition period, giving the owner a time limit to fulfil the obligations. The transition period was later withdrawn, meaning that the obligation was a surprise to the building owners.

Norway has adopted a regular inspection of boilers to meet the EPBD. The inspections must cover heating, Air Conditioning (AC) and ventilation systems. The regulation has been set in accordance with the limits specified in the EPBD. But, rather than adopting the EPBD's minimum size defined in effective rated output for AC systems, the regulation sets the threshold in the area (m^2) served by the systems. This is considered more practical for the building owners. In addition, the regulation:

- includes split units, to discourage the use of several small and less effective systems;
- enables the inspection of pure ventilation systems without cooling devices, as this is a fairly common method of heating and cooling in Norway.

The inspection requirements, thus, are the following:

- boilers fuelled by fossil fuels with an effective rated output above 20 kW are to be inspected every 4 years (every 2 years for boilers with an output above 100 kW);
- heating systems fuelled by fossil fuels with an effective rated output above 20 kW, and older than 15 years are to be subject to a one time inspection;
- AC systems with an effective rated output above 12 kW or serving an area above 500 m^2 are to be inspected every 4 years.

The building owner has the responsibility to have an inspection made by a competent inspector. The report from the inspection shall be uploaded to the energy certification system at the NVE. It shall also be available on the premises. The content of the report is outlined in the regulation:

- identification of building and system;
- description of system;
- summary of evaluation, with any deviations from normal, and including dimensioning of the system;
- registered data;
- recommendations;
- signature of the expert;
- general information on the inspection report, including dates, sources of information, etc.

The NVE has presented a template form for each type of inspection (Figure 10). These forms can be downloaded in excel format and used directly by the expert. Other formats and technical systems are allowed as long as the data and evaluations are given at a level comparable with the template produced by the NVE. The minimum levels of competence are stated in the regulation according to each type of inspection. The requirements include formal competence and practical experience. By performing the inspection, the expert declares that he/she meets the requirements and is ready to document this on request.

The template given by the NVE defines a large number of check-points and data to be registered. These are considered necessary to fulfil the objectives of the inspection and to give a reasonable return of the cost. For building owners who have good documentation of the systems and carry out regular maintenance works, the inspection will not cause high extra cost, because it is permissible to use an expert who is already involved in the maintenance, as long as he/she meets the requirements of competence. For building owners who neglect the continual need for maintenance, the cost of inspection can be very high. The first objective of the Government is to give an incentive to all owners of technical systems to establish good regular routines for service and maintenance.

The responsibility for inspection is not connected to the responsibility for energy certification. However, there are obvious benefits in coordinating the tasks. Any inspection report will be for the benefit of the certification expert. It will be useful for the expert who inspects a heating system to use the calculations for the energy performance of the building in question. And, for the owner, the whole process can be more effective if done by a limited number of experts working in cooperation.

The first control on inspections took place in 2013 and 2014 covering both certification and inspections in 92 large non-residential buildings. Any building owner failing to document a relevant inspection report received a warning. Following continuous neglect of the obligation, a compulsory fine was decided for 8 building owners.

The NVE has used both advertisements (see Figure 11) and editorials in the relevant press to motivate experts and system owners.

The number of boiler systems and heating systems inspected as of 2015 is less than 1,000 in total. This is clearly not a success, although the scheme has the potential of being the prime motor for oil-fuelled boiler maintenance and improvements. The reasons for the low rate of compliance can be outlined as follows:

> The Government's information campaign has been inadequate.
> Oil-fuelled boilers are clearly in decline, awaiting a probable full phase-out decision.
> The public scheme has been perceived as a competitor to a private and voluntary scheme for inspection and maintenance.

The scheme for inspection of AC systems, including ventilation systems, has been far more successful. As of December 2015, approximately 19,000 systems have been inspected. It is estimated that the total number of systems is between 50,000 and 100,000. Also here there is a large potential for improved compliance.

Figure 10: First page of the template form for inspection of boilers and heating systems.

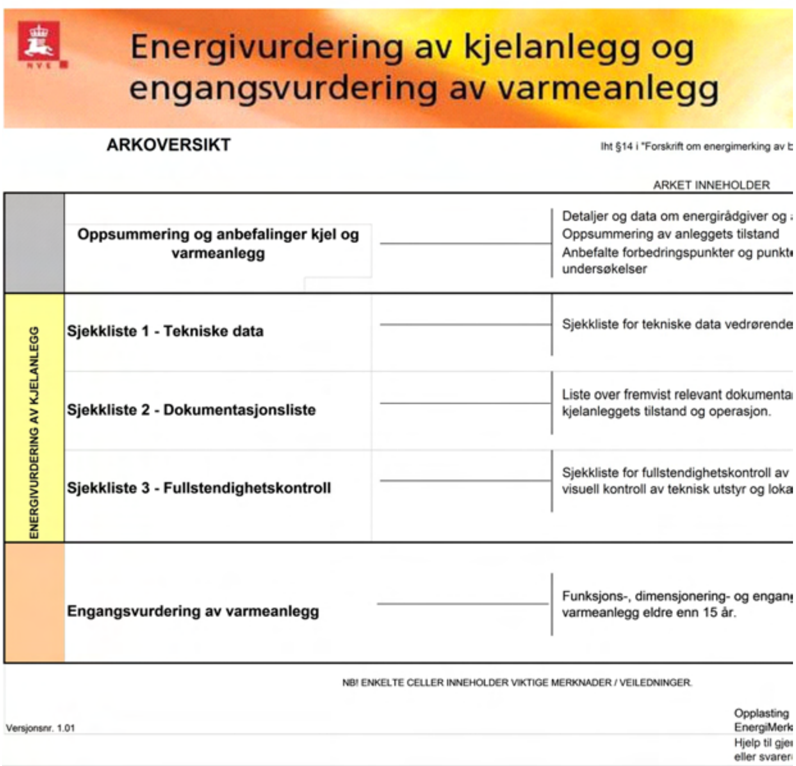


Figure 11: Advertisement on inspection of boilers and AC systems.

The reasons for considerable better compliance when it comes to AC systems compared to heating systems are:

> The relevant industry organisation has promoted the scheme.
> There is no obvious competition from existing measures.

The schemes for inspection of technical systems have a long way to go to attract the necessary interest among building owners and relevant experts. The challenge is both to have a more active information strategy for the market, and to expand the control activity. In case of inspections of oil-based boilers and heating systems, it is necessary to define a new strategy when the plan for phasing-out oil-based heating systems is decided.

3. A success story in EPBD implementation

The Norwegian energy performance requirements set in 2007, mandatory after 2 years, have had various effects on the Norwegian construction market. The requirements were perceived as especially harsh on the Norwegian window producers, who now had to find a solution to the requirement for U-value set to 1.2 on average. At the time, there were no producers in Norway able to deliver windows meeting this requirement. Within the end of the transition period, most if not all producers had started developing new technology and were able to meet the new requirements. Continuing to develop new technology, producers were soon able to deliver windows good enough to help buildings fulfill the requirements set in the Norwegian passive house standard for residential buildings, NS 3700. This standard was published in 2011, followed by a standard for non-residential buildings published in 2012. Both standards were followed by public support schemes. Passive houses are now being built all over the country by a large variety of builders as opposed to being considered a rare special niche market only a few years back. The Government announced in 2013 that new requirements, to be decided in 2015, would be close to the now-established Passive House level. The new requirements were decided in November 2015, although less ambitious than the level defined by the Passive House standards.

Norwegian window producers continue to develop cutting edge technology, and are now developing windows to meet the NZEB requirements, which are set to be announced before 2020. This includes windows with integrated solar collectors.

In 2013, more than 1 million m^2 of passive houses and 400,000 m^2 of low energy buildings were built with support from the national programme for passive and low energy buildings. This makes up for more than 10% of the new building stock and the program was therefore discontinued and replaced by another program for even more ambitious projects, such as NZEBs.

4. Conclusions, future plans

New minimum requirements were decided upon in November 2015, effective as of January 2017. The new requirements will be a step towards the 2020 requirements.

The certification scheme awaits a decision on the implementation of the Directive 2010/31/EC. In any case, new requirements and new standards will probably lead to a revised scale of energy and heating grades. At the same time, the layout of the EPC needs revision.

The inspection of AC systems has begun well, whereas inspection of boilers will need revitalisation. In 2015 the Government announced that the responsibility of EPC schemes and inspections will be moved from the NVE to Enova as of July 2016, to allow for better coordination with information activities and financial support programmes. All this constitutes a need to evaluate experiences since 2010, and to consider which changes are needed to make sure that the objectives are met.

The schemes for certification and inspection need a renewed information strategy. At the same time, the controls have shown to be an effective measure, and will be developed further.

Implementation of the EPBD in Poland

STATUS IN MARCH **2015**

1. Introduction

In Poland, the transposition of Directive 2002/91/EC on the Energy Performance of Buildings (EPBD) into national law took place in the period 2007-2009. Technical building requirements have been obligatory since the beginning of 2009 with amendments to the national Construction Act and to the relevant Regulation of the Minister of Infrastructure, and include the energy assessment and energy certification of buildings, the inspection of boilers and cooling systems, as well as new tightened energy performance requirements for buildings. The main criterion for the building energy performance assessment became the index of non-renewable primary energy needs (energy performance) related to the heated or air-conditioned (cooled) area.

The implementation of Directive 2010/31/EU started in 2011. Revised energy performance requirements for buildings came into force in the beginning of 2014 and the revised methodology for the energy assessment of buildings and building parts, as well as new templates for energy certificates became obligatory on 3 October 2014.

The new Act on the Energy Performance of Buildings, which has been drafted for more than three years, is now adopted by the Polish Parliament and is in force from 9 March 2015. This act addresses the implementation of all issues arising from the EPBD, i.e., principles for issuing an Energy Performance Certificate (EPC, for buildings and building parts), principles for inspection of heating and Air-Conditioning (AC) systems, rules for maintaining the obligatory central register of EPCs and also guidelines for drawing up a national plan for increasing the number of Nearly Zero-Energy Buildings (NZEBs). Its aim is, among others, to contribute to the promotion of energy-efficient buildings and increasing public awareness regarding the opportunities for energy savings in buildings.

The transposition and implementation of the EPBD into national law is supervised by the Polish Ministry of Infrastructure and Development (former Ministry of Transport, Construction and Maritime Economy).

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2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Energy performance requirements for new buildings were already mandatory in Poland before the implementation of the EPBD. For multi-family residential buildings and collective buildings, these requirements were related to the building net energy demand and the thermal insulation of the transparent building envelope elements. For single-family residential buildings, the requirements were related to either the building net energy demand, or the thermal insulation of the building envelope (one or the other, optional). For other types of buildings, the requirements were only related to the thermal insulation of the building envelope.

As a result of the implementation of Directive 2002/91/EC requirements were modified and became obligatory since the beginning of 2009. These requirements allowed two alternative ways of fulfilment:

the first consisted of satisfying requirements concerning the thermal insulation of the building envelope and some detailed requirements related to the building systems; the second, having a performance character, is based on the EP_{max} index, which represents the demand of non-renewable primary energy related to the heated area, expressed in kWh/m^2.year. Both methods applied to new and refurbished buildings, but in the second case, the threshold values that were specified in the requirements could be exceeded by 15% relative to new buildings. In accordance to Article 4 of Directive 2010/31/EC, by the end of 2011 Poland initiated studies on setting energy requirements following cost-optimality calculations. Proposals for the upgrade of the requirements were submitted to the responsible ministry in May 2012. After a public consultation was completed in the beginning of 2013, the Building Regulations were updated. The ministerial ordinance was published on 13 August 2013 and became obligatory from 1 January 2014 in order to provide building designers and construction product manufacturers the necessary time to adopt to the changing requirements.

Table 1: Maximum permissible values of EP_{H+W} for heating and water heating (kWh/m^2.year).

Building category	**$EP_{H+W\ max}$**		
	Obligatory from 1 January 2014	Obligatory from 1 January 2017	Obligatory from 1 January 2021* (NZEB level)
Residential buildings:			
- single-family houses	120	95	70
- multi-family houses	105	85	65
Hotels and dormitories	95	85	75
Non-residential buildings:			
- health care buildings	390	290	190
- other	65	60	45
Industrial, heated storage and livestock buildings	110	90	70

* In case of buildings occupied and owned by public authorities, obligatory from 1 January 2019

Table 2: Maximum permissible values of ΔEP_C for cooling (kWh/m^2.year).

Building category	**$\Delta EP_{C\ max}$**		
	Obligatory from 1 January 2014	Obligatory from 1 January 2017	Obligatory from 1 January 2021* (NZEB level)
Residential buildings: - single-family houses - multi-family houses	$\Delta EP_C = 10\ A_{f,c}/A_f$	$\Delta EP_C = 10\ A_{f,c}/A_f$	$\Delta EP_C = 5\ A_{f,c}/A_f$
Hotels and dormitories Non-residential buildings: - health care buildings - other Industrial, heated storage and livestock buildings	$\Delta EP_C = 25\ A_{f,c}/A_f$	$\Delta EP_C = 25\ A_{f,c}/A_f$	$\Delta EP_C = 25\ A_{f,c}/A_f$

Where: A_f – area of heated rooms in a building [m^2],
$A_{f,c}$ - area of cooled rooms in a building [m^2].
* In case of buildings occupied and owned by public authorities, obligatory from 1 January 2019

Table 3: Maximum permissible values of ΔEP_L for lighting (kWh/m^2.year).

Building category	**$\Delta EP_{L\ max}$**		
	Obligatory from 1 January 2014	Obligatory from 1 January 2017	Obligatory from 1 January 2021* (NZEB level)
Residential buildings: - single-family houses - multi-family houses	$\Delta EP_L = 0$	$\Delta EP_L = 0$	$\Delta EP_L = 0$
Hotels and dormitories Non-residential buildings: - health care buildings - other Industrial, heated storage and livestock buildings	for $t_0 < 2{,}500$ $\Delta EP_C = 50$ for $t_0 \geq 2{,}500$ $\Delta EP_C = 100$	for $t_0 < 2{,}500$ $\Delta EP_C = 50$ for $t_0 \geq 2{,}500$ $\Delta EP_C = 100$	for $t_0 < 2{,}500$ $\Delta EP_C = 25$ for $t_0 \geq 2{,}500$ $\Delta EP_C = 50$

Where: t_0 – operating time of built-in lighting installation [hours/year].
* In case of buildings occupied and owned by public authorities, obligatory from 1 January 2019

I.ii. Format of national transposition and implementation of existing regulations

The current requirements for new buildings contain two types of requirements. The first type is based on the EP_{max} index, which defines the limits for non-renewable primary energy demand for heating, ventilation, AC and Domestic Hot Water (DHW) systems, and in the case of non-residential buildings, also lighting systems. The EP_{max} index is related to the conditioned floor area. The second type includes minimum levels of thermal insulation for the building envelope components, expressed by U-values in W/m^2.K. For renovated buildings there is only one requirement, i.e., to ensure permissible U-values for the retrofitted building components.

The calculated EP index for a building cannot exceed the value calculated as follows:

$$EP = EP_{H+W} + \Delta EP_C + \Delta EP_L\ [\text{kWh/m}^2\text{.year}]$$

where:

> EP_{H+W} is the partial value of the non-renewable primary energy demand index for heating, ventilating and water heating;

> ΔEP_C is the partial value of the non-renewable primary energy demand index for cooling;

> ΔEP_L is the partial value of the non-renewable primary energy demand index for lighting, only considered in the case of non-residential buildings.

The maximum values for EP_{H+W}, ΔEP_C and ΔEP_L applicable at the start of 2014, 2017 and 2021 are defined in the regulations, paving the way towards the national application of NZEBs. For new buildings owned and occupied by public authorities, the requirements set for 2021 will take effect from the beginning of 2019. The maximum values of EP_{H+W}, ΔEP_C and ΔEP_L are given in Tables 1, 2 and 3.

The maximum permissible U-values for opaque and transparent building components calculated according to the EN ISO 6946 apply to all types of buildings and are given in Tables 4 and 5.

The regulations set a limit to the total area of the glazings installed in a building. For residential buildings, buildings providing accommodation (dormitories, hotels) and public buildings, the maximum area of glazings A_{Omax} with a thermal transmittance U ≥ 0.9 W/m².K is given by the following equation:

$$A_{Omax} = 0.15\ A_Z + 0.03\ A_W$$

where:

> A_Z is the floor area adjacent to the exterior walls to a distance of 5 m from those walls, on all floors above ground level;

> A_W is the remaining part of the floor area above ground level.

In public buildings, the total area of all transparent elements installed in the building envelope can exceed A_{Omax} due to requirements concerning daylighting needs.

For industrial buildings, as well as for buildings used for heated storage and livestock, the maximum total area of all the glazed elements in the building envelope, regardless of their thermal insulation, cannot exceed 15% of the area of the external walls for single-storey buildings, and 30% in case of multi-storey buildings.

EP index values are calculated according to the national methodology, which is based on the EN ISO 13790 and partly on other EPBD standards related to thermal comfort and indoor air quality for heated and air-conditioned spaces. In occupied rooms, the maximum allowed internal temperature is 20 ºC, except for bathrooms, special hospital rooms and swimming pools where a higher temperature may be used.

Requirements concerning protection against overheating of rooms have been set for all building categories. This is defined as a maximum solar energy transmittance coefficient of 0.35. The impact of shading devices and other sun protection devices on the total energy transmittance is included in the Polish building regulations. The impact of overhangs and fins is calculated according to EN ISO 13790.

In order to protect rooms against internal condensation and mould growth, the level of thermal insulation of external partitions and their connections must result in the required value of temperature factor at the internal surface (EN ISO 10211) f_{Rsi} calculated according to the EN ISO 13788. In the absence of detailed calculations, $f_{Rsi\ min}$ is assumed to be equal to 0.72.

Table 4: Permissible values of thermal insulation for opaque building elements.

Fabric element and internal temperature in the room	Maximum U-value (W/m².K)		
	Obligatory from 1 January 2014	Obligatory from 1 January 2017	Obligatory from 1 January 2021* (NZEB level)
External walls:			
a) ti ≥ 16 °C	0.25	0.23	0.20
b) 8 °C ≤ ti < 16 °C	0.45	0.45	0.45
c) ti < 8 °C	0.90	0.90	0.90
Internal walls:			
a) in case of Δti ≥ 8 °C and separating heating rooms from corridors and staircases	1.00		
b) in case of Δti < 8 °C	no requirements		
c) separating heated and unheated rooms	0.30		
Walls adjacent to expansion joints with width:			
a) up to 5 cm	1.00		
b) more than 5 cm	0.70		
Walls of unheated underground rooms	no requirements		
Roofs, flat roofs and floors in contact with outdoor air:			
a) ti ≥ 16 °C	0.20	0.18	0.15
b) 8 °C ≤ ti < 16 °C	0.30	0.30	0.30
c) ti < 8 °C	0.70	0.70	0.70
Roofs on the ground:			
a) ti ≥ 16 °C	0.30		
b) 8 °C ≤ ti < 16 °C	1.20		
c) ti < 8 °C	1.50		
Floors over unheated and closed spaces:			
a) ti ≥ 16 °C	0.25		
b) 8 °C ≤ ti < 16 °C	0.30		
c) ti < 8 °C	1.00		
Floors over heated rooms:			
a) in case of Δti ≥ 8 °C	1.00		
b) in case of Δti < 8 °C	no requirements		
c) separating heated rooms from unheated	0.25		

* In case of buildings occupied and owned by public authorities, obligatory from 1 January 2019

Table 5: Permissible values of thermal insulation for transparent building elements.

Type of window or door	Maximum U-value (W/m².K)		
	Obligatory from 1 January 2014	Obligatory from 1 January 2017	Obligatory from 1 January 2021* (NZEB level)
Vertical windows, balcony doors and transparent walls:			
a) t_i ≥ 16 °C	1.3	1.1	0.9
b) t_i < 16 °C	1.8	1.6	1.4
Roof windows:			
a) t_i ≥ 16 °C	1.5	1.3	1.1
b) t_i < 16 °C	1.8	1.6	1.4
Windows in internal walls:			
c) in case of Δti ≥ 8 °C	1.5	1.3	1.1
d) in case of Δti < 8 °C	no requirements	no requirements	no requirements
a) separating heated from unheated rooms	1.5	1.3	1.1
Door in external walls and in walls separating heated from unheated rooms	1.7	1.5	1.3
Windows and doors in external walls of unheated rooms	no requirements		

* In case of buildings occupied and owned by public authorities, obligatory from 1 January 2019

The envelope of all building types should ensure high airtightness. For buildings having a height up to 55 m, the air leakage of windows and balcony doors, under a pressure difference of 100 Pa, should not exceed 2.25 $m^3/m.h$ (if related to the length of joint) and 9 $m^3/m^2.h$ (if related to their area). For higher buildings, these threshold values become 0.75 $m^3/m.h$ and 3 $m^3/m^2.h$ respectively[1].

For compliance with the building regulations, the U-values for opaque building components must be calculated according to EN ISO 6946, whereas those for windows and doors must be calculated according to EN ISO 10077.

Figure 1: Energy prices of energy carriers in Poland in 2012 (1 PLN = 0.24 €).

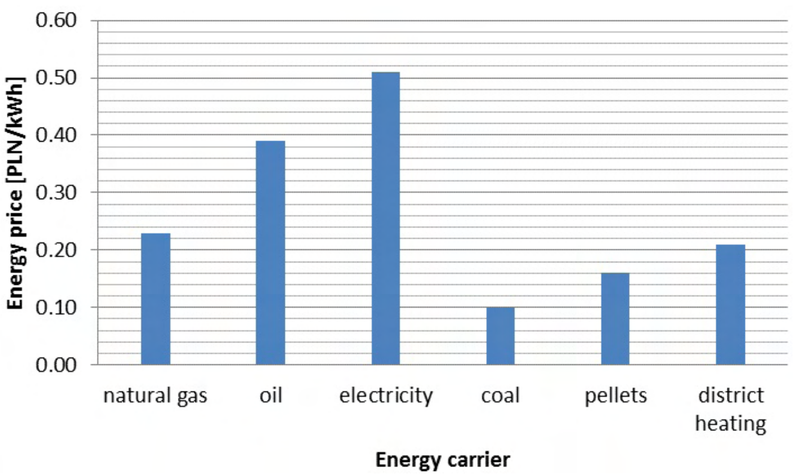


Figure 2: Establishment of the cost-optimal level of energy requirements for apartments blocks (1 PLN = 0.24 €).

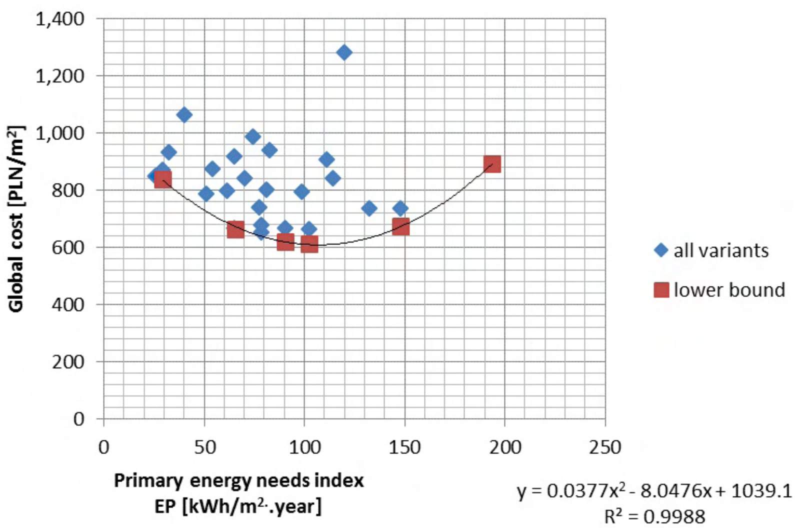


Table 6: Expected increase in energy prices above the rate of inflation.

Energy carrier	Annual growth rates above inflation (%)
Electricity	3.8
Natural gas	4.8
Coal and pellets	3.6
District heating	1.7
Oil	2.7

The ventilation level in the EP index calculations is set at 30 m^3/h.person for all categories of buildings. Infiltration is always included in the energy performance calculations in the form of an additional external air flux. The recommended (but not required) airtightness level n_{50} is < 3.0 h^{-1} for buildings equipped with natural or hybrid ventilation and <1.5 h^{-1} for buildings equipped with mechanical ventilation or AC systems. In cases where an airtightness test has been performed, this flux is calculated according to the results of the test. If there are no test results available, the default values are used instead.

In the calculation of heat losses, thermal bridges are taken into account. The decision on which method to apply — detailed calculation or default values — will be made by the building designer or by the energy expert responsible for the elaboration of the EPC.

I.iii. Cost-optimal procedure for setting energy performance requirements

A study to determine the cost-optimal levels of thermal insulation of buildings and building components was performed in 2012 and analysed the following six categories of buildings:

> single-family buildings;
> multi-family residential buildings;
> hotels;
> offices;
> schools;
> hospitals.

Calculations were performed on the basis of prices of building materials, equipment and appliances in effect at the beginning of 2012. There is a big discrepancy in prices for energy obtained from different energy sources (e.g., electricity, district heating, natural gas, etc. - Figure 1), and the predicted increase in energy prices was calculated based on the expected inflation rate for the years 2000 - 2010 (Table 6).

For each building type, several variants were applied, to compare diverse technical solutions for the building envelope and the technical systems. The cost-optimal requirements were determined as the lower limits of the curves connecting the global costs of every variant. The NZEB definition does not include a renewable component. The results of the calculations performed for new multi-family residential buildings are shown in Figure 2. A cost-optimal level

[1] *These requirements apply to building products, e.g., windows and balcony doors, and they are tested in the frame of ITT.*

EP_{min} = 102.3 kWh/m^2.year has been achieved in the case of a typical residential building (compactness ratio = 0.37) with condensing gas boiler providing heat for space heating and DHW. These calculations provided the basis for setting the building energy requirements currently in force (until 2021).

NZEB requirements have also been set at all levels (U-values, infiltration, ventilation, etc.), following the same cost-optimal calculations.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The first draft of the national plan for increasing the number of NZEBs respecting national conditions was subject to public consultation in September 2014. This document confirmed the previously accepted plans for tightening the energy performance requirements for buildings, as given in the amended building regulations in force from the beginning of 2014. The proposed definition of NZEB is based on an EP_{max} index and U_{max} values for building envelope elements and does not define the share of renewable energy. NZEBs will become the norm in 2021 (indicative figures are provided in Tables 1 – 5). Particular attention is paid to buildings owned and occupied by public authorities, for which NZEB standards will become obligatory at the start of 2019. Until the end of 2014, the definition of NZEB given in the draft national action plan has not yet been approved by the authorities. For this reason, there are no financial programmes directly supporting this kind of buildings. However, there are a number of ongoing financing programmes to support the construction of energy efficient buildings and to promote the use of renewable energy in the building sector. These programmes, which are already indicated in the draft national plan, will also provide the resources for financing the construction of NZEBs in Poland in the future (Figure 3). The main sources of national financial support, as indicated in the draft national plan, are:

> Subsidised loans for the construction of energy-efficient buildings in the years 2013 - 2022; buildings eligible under this scheme should fulfil the requirements concerning net heat demand for heating $Q_{H,nd}$ calculated according to EN ISO 13790. If $Q_{H,nd} \leq 40$ kWh/m^2.year, the subsidy for a single-family house is 7,100 € and for an apartment in a multi-family house 1,500 €.
If $Q_{H,nd} \leq 15$ kWh/m^2.year, the subsidies are respectively 12,000 € and 2,200 €. The total amount available for subsidy is 71 M€ and the predicted number of subsidised buildings and/or apartments is expected to be ca.12,000. The corresponding predicted energy savings are approximately 93,500 MWh/year, with a CO_2 emissions reduction accounting for 32,300 ton/year.

> The LEMUR[2] programme, supporting energy-efficient public buildings in the years 2013 - 2020; this programme supports building projects if the EP index, as indicated in the EPC of the building, is 5 to 15% lower than the EP_{max} defined in building regulations. The subsidies range from 30 to 70%.

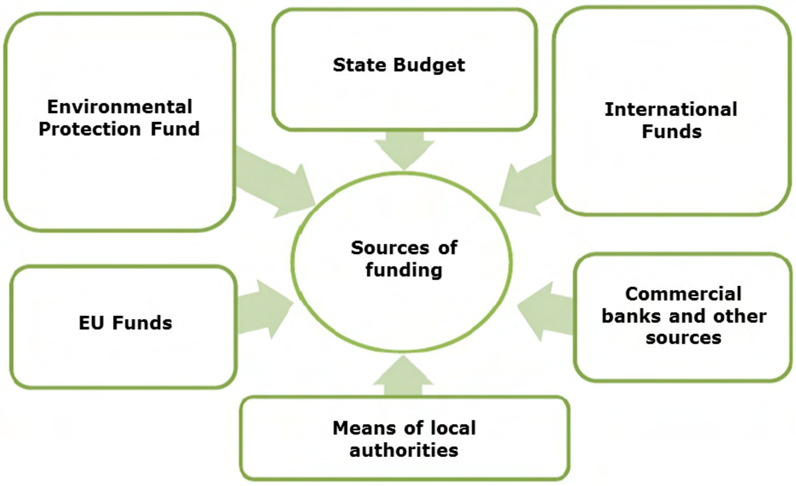
Construction of NZEBs in Poland will also be financially supported through international funds which aim to increase energy efficiency, limit CO_2 emissions and increase the production of energy from Renewable Energy Sources (RES), e.g., the Swiss-Polish Cooperation Programme, the European Economic Area (EEA) Grants and Norway Grants.

There are currently no available statistics or estimations concerning the number of existing NZEBs in Poland.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The Polish Ministry of Infrastructure and Development created a strategy for the

Figure 3: Sources of financial support for Nearly Zero-Energy Buildings in Poland.



[2] eieepoland.pl/en/lemur-energy-efficient-public-buildings/

promotion of investments in the modernisation of buildings. The strategy has been incorporated as an annex to the Polish National Action Plan for Energy Efficiency for 2014. The strategy includes, among others, a description of the planned measures to improve energy efficiency in the building sector, as well as policies and measures to stimulate their thorough cost-effective renovations. It also identifies future prospects for investment decision-making, as well as it estimates the potential value of energy savings and other benefits arising from the renovation of buildings.

Poland decided to choose alternative measures to ensure the implementation of Article 5 of the EED (exemplary role of public buildings) which are as follows:

> fulfilling minimum energy performance requirements as contained in the regulation of the Minister of Infrastructure and Development of 12 April 2002 on the technical conditions to be met by buildings;
> establishing the priority “Promoting energy efficiency and use of RES in the public and housing sectors” as part of the draft Operational Programme for Infrastructure and Environment in the period 2014 - 2020;
> supporting programmes implemented by the National Fund for Environmental Protection and Water Management;
> using RES in public buildings;
> developing guidance concerning the application of measures to improve the energy efficiency in residential single- and multi-family houses and public buildings.

It is estimated that, as a result of the above alternative approaches, the target of annual energy savings, amounting to 2,122.15 MWh/year, will be achieved.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The technical requirements on building systems, covering heating, DHW, AC, ventilation (including large systems) and lighting installations (for large non-residential building) are specified in the Ministerial Ordinance on the technical criteria to be met by buildings.

The latest amendment of this ordinance (originally published in 2002) took place in 2013 and is in force since 1 January 2014.

II.ii. Regulation of system performance, distinct from product or whole building performance

The ordinance sets general requirements concerning technical building systems and their performance. They are formulated both as basic descriptive targets that have to be fulfilled by the systems and their elements, and as performance requirements concerning devices or whole installations.

According to the ordinance, building heating, ventilation and AC systems shall be designed and executed in order to satisfy maximum requirements on energy performance (EP index) for the whole building. However, no minimum energy performance levels for particular technical building systems are defined.

As regards certain elements of heating, DHW and cooling systems, one of the key areas covered by the regulation is the limitation of heat loss from pipes that has to be kept on the rational minimum level. Specific requirements on thermal insulation of pipes and components are given in Table 7.

Table 7: Requirements on thermal insulation of pipes and components in heating, hot water and cooling systems.

No	Pipe or component	Minimum thickness of thermal insulation (material λ = 0.035 W/m.K) [mm]
1	d_i < 22 mm	20
2	22 ≤ d_i < 35 mm	30
3	35 ≤ d_i < 100 mm	equal to the diameter d_i
4	100 ≤ d_i	100
5	Pipes passing through walls or ceilings	50% of the thickness given in rows 1 ÷ 4
6	Pipes in heating systems in the walls separating different uses	50% of the thickness given in rows 1 ÷ 4
7	Pipes according to row 6 embedded in the floor	6
8	Ducts for air heating (interior of heated area of the building)	40
9	Ducts for air heating (exterior of heated area of the building)	80
10	Pipes of chilled water cooling (building interior)	50% of the thickness given in rows 1 ÷ 4
11	Pipes of chilled water cooling (building exterior)	As given in rows 1 ÷ 4

The ordinance provides also performance requirements on the maximum level of Specific Fan Power (SFP) of fans used in AC and mechanical ventilation systems, as shown in Table 8. The SFP may be increased when certain elements are used in the system (Table 9).

Generally, heating, DHW, lighting, ventilation and AC equipment used in the systems shall also fulfil requirements set at separate national regulations which are implementing other European directives, e.g., boiler efficiency, ecodesign, etc.

The provisions of the ordinance are applicable to related technical building systems in the case of design of new buildings and renovation of existing buildings.

II.iii. Provisions for installation, dimensioning, adjustment and control

Generally, according to the ordinance, DHW, heating, ventilation and AC systems shall be designed (dimensioned) and executed (installed) in a way that ensures the energy demand requirements (total energy demand) are fulfilled. Specific provisions on certain technical aspects are given in the ordinance, as well as in other Polish and European standards and voluntary technical guidances.

II.iv. Encouragement of intelligent metering

By 2014, there is no direct encouragement of intelligent metering. However, implementation of Information and Communication Technology (ICT) solutions supporting the energy efficiency of buildings is mentioned as one of the priorities of the Strategy for Innovation and Economic Efficiency "Dynamic Poland 2020" (2013).

II.v. Encouragement of active energy-saving control (automation, control and monitoring)

There are no specific provisions requiring the use of active energy-saving control devices for all technical building systems. However, the ordinance requires heating installations connected to district heating systems to be controlled automatically according to the external conditions. The same ordinance requires AC systems to be equipped with monitoring devices (control of energy use and operational conditions).

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The energy performance certification system is governed and administrated by the Ministry of Infrastructure and Development (as of October 2014), former Ministry of Transport, Construction and Maritime Economy. The legal framework for implementing acts was introduced by the amendment of the Construction Act (Journal of Laws of 2007 No 191, item 1373, as amended) defining delegations for the secondary legislation:

> Ordinance of the Ministry of Infrastructure and Development of 3 June 2014, on the methodology of energy performance calculations for whole buildings, separate apartments, or building parts constituting separate technical - functional areas, along with the scope of energy performance certificates (Journal of Laws item 888), that replaced the previous ordinance published in 2008;

> Ordinance of the Ministry of Infrastructure of 21 January 2008, on the training and examination of experts requesting authority to issue energy performance certificates (Journal of Laws No 17, item 104, as amended);

No	Type and application of fan	Specific Fan Power SFP [kW/(m³/s)]
1	Supply fan:	
	a) air-conditioning system or supply and exhaust ventilation with heat recovery	1.60
	b) supply and exhaust ventilation without heat recovery and supply ventilation	1.25
2	Exhaust fan:	
	a) air-conditioning system or supply and exhaust ventilation with heat recovery	1.00
	b) supply and exhaust ventilation without heat recovery and supply ventilation	1.00
	c) exhaust system	0.80

Table 8: Performance requirements on the maximum level of Specific Fan Power (SFP) of fans used in air-conditioning and mechanical ventilation systems.

No	Additional element of ventilation or air-conditioning system	Additional SFP [kW/(m³/s)]
1	Additional filtration level	0.3
2	Additional filtration level with filter class H10 or higher	0.6
3	Gaseous contaminants filters	0.3
4	High efficiency heat recovery device (temperature effectiveness higher than 90%)	0.3

Table 9: Elements of the systems that allow to increase the SPF.

> Ordinance of the Ministry of Finance of 28 December 2009, on the obligatory civil liability insurance of persons issuing energy performance certificates (Journal of Laws No 224, item 1802).

As a result, the Energy Performance Certificate (EPC) became an obligatory document for new buildings, buildings subject to major renovations and buildings and apartments being sold or rented, since 1 January 2009.

Under the provisions of these regulations, EPCs are produced by certified experts. As of the end of 2014 there is no central database of EPCs. However, the new Act on Energy Performance of Buildings, coming into force in March 2015, imposes an obligation to maintain a central register for the energy performance of buildings at the ministry in charge of construction. This central register will contain a database of EPCs.

The validity of the EPCs is 10 years, unless its energy performance changes as a result of a major renovation, in which case the EPC must be renewed.

Figure 4: Template of Energy Performance Certificate (EPC) for apartments.

ŚWIADECTWO CHARAKTERYSTYKI ENERGETYCZNEJ LOKALU MIESZKALNEGO		
Numer świadectwa		

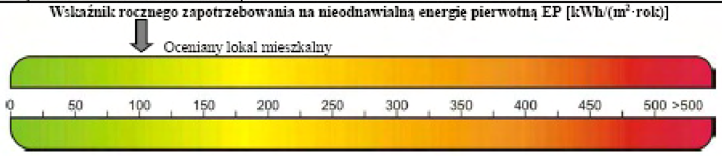
Oceniany lokal mieszkalny		
Rodzaj budynku [1)]		Zdjęcie budynku
Przeznaczenie budynku [2)]		
Adres budynku		
Rok oddania do użytkowania budynku [3)]		
Metoda obliczania charakterystyki energetycznej [4)]		
Powierzchnia pomieszczeń o regulowanej temperaturze powietrza (powierzchnia ogrzewana lub chłodzona) A_f [m^2] [5)]		
Powierzchnia użytkowa lokalu [m^2]		

Ważne do (rrrr-mm-dd)	

Stacja meteorologiczna, według której danych obliczana jest charakterystyka energetyczna [6)]	

Ocena charakterystyki energetycznej lokalu mieszkalnego [7)]	
Wskaźniki charakterystyki energetycznej	**Oceniany lokal mieszkalny**
Wskaźnik rocznego zapotrzebowania na energię użytkową	EU = … kWh/(m^2·rok)
Wskaźnik rocznego zapotrzebowania na energię końcową [8)]	EK = … kWh/(m^2·rok)
Wskaźnik rocznego zapotrzebowania na nieodnawialną energię pierwotną [8)]	EP = … kWh/(m^2·rok)
Jednostkowa wielkość emisji CO_2	E_{CO2} = … t CO_2/(m^2·rok)
Udział odnawialnych źródeł energii w rocznym zapotrzebowaniu na energię końcową	U_{oze} = … %

Wskaźnik rocznego zapotrzebowania na nieodnawialną energię pierwotną EP [kWh/(m^2·rok)]



Obliczeniowa roczna ilość zużywanego nośnika energii lub energii przez lokal mieszkalny [9)]			
System techniczny	**Rodzaj nośnika energii lub energii**	**Ilość nośnika energii lub energii**	**Jednostka/(m^2·rok)**
Ogrzewczy	1)		
	n)		
Przygotowania ciepłej wody użytkowej	1)		
	n)		
Chłodzenia	1)		
	n)		

Sporządzający świadectwo:	
Imię i nazwisko: Nr uprawnień budowlanych albo nr wpisu do rejestru [10)]: Data wystawienia:	Podpis i pieczątka

How flats are certified in apartment buildings

Flats in apartment buildings must be certified individually. They are certified on the basis of the same methodology as whole buildings, introduced by the ordinance of the Ministry of Infrastructure and Development of 3 June 2014. Flats can be certified either on the basis of climatic data for the specific region, or using data about actual (measured) energy consumption.

In addition, the construction act contains several provisions referring to the certification of apartments aimed at facilitating that process, namely:

> for buildings connected to a district heating network, or buildings using a central heating installation, the EPC of an apartment can be prepared on the basis of a whole building's EPC;

> the EPC of an apartment belonging to a group of apartments with identical design and material solutions can be prepared on the basis of an energy performance analysis of any of them.

As of 9 March 2015, when the Act on the Energy Performance of Buildings came into force, in the case of a group of apartments with identical design and material solutions, and identical utility area, which are specifically located within the building, it will be possible to prepare only one EPC that applies to all the apartments.

Format and content of the EPC

The Ordinance of 3 June 2014 specifies the basic requirements, the calculation methodology and the format of the EPC.

There are 3 types of EPCs, i.e., for:

> whole buildings;

> apartments;

> building parts constituting separate technical – functional areas (in non-residential buildings).

However, all types are very similar and differences are minor (e.g., etiquettes, table fields, etc.). The EPC format (Figure 4) provides a pre-defined template consisting of:

> the front page, containing essential information on the building, including basic data, a photograph, the calculated energy performance illustrated on a linear scale and compared with the regulatory requirements for new buildings, the annual amount of consumed fuel, the share of RES in final energy, the CO_2 emissions, as well as basic information on the expert issuing the EPC;

> a page containing technical - functional characteristics of the assessed building and its technical systems, such as U-values compared with requirements concerning thermal insulation of the building envelope components;
> a page containing energy demand indicators and categories of cost-effective recommendations on potential reduction of final energy consumption (notes on building envelope, installations and energy sources, DHW installations, building use). There is no standardised list of improvements in use;
> a page with additional information about the content of the EPC.

EPC activity levels

There is yet no central register of EPCs in Poland and therefore the exact number of issued EPCs is not known. EPCs must be issued for all new buildings at both the planning stage (when the conformity with regulatory energy performance requirements is checked) and at the start of the operation (at use-permit stage). An EPC is also mandatory for buildings undergoing major renovations. Since about 100,000 buildings in Poland obtain use-permits every year, it can be assumed that the number of EPCs issued in the period of 2009 - 2014 exceeds 600,000.

Typical EPC costs

The price of the EPC is fully market driven. The lowest prices offered in the publicly available transaction service are below 10 €, whereas the highest offer for public buildings exceeds 1,000 €. The typical price for an EPC for an apartment and a single-family building is about 50 € - 100 €. For an apartment building, the typical price ranges between 200 € and 400 €.

Assessor corps

According to the construction act, an EPC may be issued by a Qualified Expert (QE) having full civil rights, that:

> has an engineering degree in architecture, civil engineering, environmental engineering, energetic or equivalent, or a M.Sc. degree in any discipline, whatsoever;
> and
  - completed a training course and passed the state exam at the responsible ministry, or
  - completed (at least) one year of post-graduate study in the field of architecture, civil engineering, environmental engineering, energy auditing for thermo-modernisation or energy certification purposes, or
  - is a licensed architect or construction engineer within the meaning of the Polish law;
> and is on the list of experts entitled to issuing EPCs, governed by the ministry.

According to the Ordinance on the training and examination of experts, the training course or postgraduate study mentioned above shall include 50 hours of lessons (both theoretical and practical), concerning regulatory basics, national provisions and regulations, assessment of the thermal protection of buildings, assessment of heating systems and DHW systems, ventilation and AC systems, lighting systems, calculation methods and certification methodology.

Licenses for architects and construction engineers are issued on the basis of separate laws. The requirements for a practice period and the examination conducted by the Chamber of Engineers are specified in the construction act and are not directly connected with the EPC. The Polish Chamber of Civil Engineers has its own central register of members[3] (approx. 115,000).

A list of experts entitled to issuing EPCs may be found on the website of the Ministry of Infrastructure and Development. By the end of 2014, the central registry of experts who have passed the state exam or completed post-graduate studies, contained 10,593 experts.

In terms of penalties, the only possible sanction is expulsion. According to the construction act, the state authorisation of a QE may be withdrawn when an expert has been sentenced for a crime, has lost civil rights, is in case of total or partial disability, or when there is a failure to comply with the requirements, or a violation of the rules (e.g., false information, lack of obligatory insurance). By the end of 2014, two experts have been withdrawn from the database and one engineer lost his authorisation.

New regulations referring to assessors' qualifications came into force on 9 March 2015. According to these:

> experts with an engineering or M.Sc. engineering degree will no longer have to complete courses with exams or complete post-graduate studies;
> experts with an M.Sc. degree (but no engineering degree) will have to complete appropriate post-graduate studies (the possibility of taking a short course with an exam will be withdrawn).

[3] *http://piib.org.pl/index.php/lista-czsonkopmenu-45*

Compliance levels by sector

Until October 2014, there was no central register of EPCs and hence, there is currently no information on compliance levels. However, since the presence of an EPC and the compliance with the energy performance levels is checked on the stage of obtaining a building permit, it can be assumed that all new and renovated buildings comply with the minimum levels enforced by the Polish law.

Enforcement with building owners and real estate actor

According to the construction act, the energy assessment (check if legal performance requirements are satisfied) must be carried out for new buildings and buildings undergoing major renovations, once at the planning stage, when the conformity with regulatory energy performance requirements is verified, and again at the start of the operation (at use-permit stage), when the EPC is required by the building control authorities. If there is no EPC, or the building does not comply with the minimum energy performance levels, the building permit is not granted.

For existing buildings, an EPC is required in every case when the property is subject to change of ownership, is being sold or rented. In the case of sale or rent, there is no control system and no penalties are foreseen in the legislation.

Quality Assurance (QA) of EPCs

In October 2014, there was no direct mechanism of Quality Assurance (QA) of EPCs in Poland. Therefore, the number of EPCs controlled in 2013 and 2014 is zero. According to the Construction Act, the civil Law of 23 April 1964 applies and any EPC containing false data on energy use is considered as a product having a physical failure. Potential conflicts between the Qualified Expert (QE) and the client in this matter will be settled in court. The responsible ministry can carry out an investigation whether an expert violated rules specified in the Construction Act. This investigation can be performed ex-officio or per request. If it is proven that an expert violated those rules, the expert loses the authorisation for issuing EPCs. There are no other penalties foreseen for minor faults.

An ordinance requires the QE to have a civil liability insurance with a minimum of 25,000 €.

New regulations referring to QA of experts come into force in March 2015 when the central registry of EPCs becomes operational.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The certification process for public buildings or large buildings visited by the public falls under the same regulations as other buildings (previously described). According to the Construction Act, the EPC shall be visible to the public in the case of large buildings (> 1,000 m^2 till March 2015) used by public authorities, or for public services buildings, e.g., railway stations, airports, museums, exhibition halls and others.

New regulations on the QA of EPCs came into force in March 2015. Based on these:

> the owner or manager of a building used by judicial authorities, public prosecutor or public authorities, with an area exceeding 250 m^2, will have to ensure that the EPC of the building is visible to the visitors;

> the owner or manager of a building with an area greater than 500 m^2, in which services are provided to the public, and for which an EPC is already issued, will have to ensure that the EPC of the building is visible to the visitors.

The template of the EPC for public and large buildings visited by the public is the same as the one used for other non-residential buildings. EPCs for public and large buildings visited by the public are issued by the same group of experts as EPCs for other buildings. Provisions on QA are also the same as described earlier.

The frequency for updating EPCs is determined by their validity of 10 years. The EPC also loses its validity when the energy performance of the building has changed, e.g., as a result of a major renovation.

Due to the lack of a central EPCs register or relevant research data, the total number of buildings having a certificate on display cannot be estimated.

The price of the certificate is fully market driven. There has been no official research conducted about the typical cost of an EPC for public and large buildings visited by the public. Depending on the type and size of the building, a typical cost may vary from 300 € to 1,000 €.

III.iii. Implementation of mandatory advertising requirement

At the end of 2014, a mandatory advertising requirement has not yet been implemented by Polish law. Therefore, there are no requirements enforcing the use of the energy performance indicator of the building's EPC in commercial media. There is also no common voluntary scheme developed. However, some market players voluntarily use the energy performance indicator and a graphic energy label, similar to the one included in the EPC template in advertisement (Figure 5). This is more frequent for the sale of new single-family houses.

New regulations including a mandatory advertising requirement came into force in March 2015. According to these regulations, the energy performance indicator from the EPC will have to be included in both sale and rental advertisements. Details on the implementation of this provision are not yet known.

III.iv. Information campaigns

The responsible ministry published a brochure in 2010 that was targeted to those intending to buy, rent or sell an apartment or house, containing basic information on the EPC, as well as information on relevant regulations and procedures, including the certification of QEs.

Information on the energy performance of buildings is available on the ministry's webpage, including the following topics:

> central register of QEs;
> QE's examination procedures;
> database with climatic data for Poland.

In 2013 and on behalf of the Ministry of Economy, the "Guidance on Energy Efficiency in Public Buildings", that was developed by the European Public Private Partnership (PPP) Expertise Centre (EPEC[4]), was translated into Polish.

The Ministry of Environment developed a website in 2014 called "The house that saves for me"[5], containing the following information:

> basic information on energy efficiency of buildings;
> software application for designing energy efficient houses;
> simplified calculator of savings resulting from various design and material solutions;
> promotional movies.

Since 2009, the "Thermo-modernisation and Renovation Fund" operating in Poland, allows building owners to apply for the 20% refund of eligible thermo-modernisation investments. As the programme was developed before the implementation of the EPBD, EPCs are not taken into consideration.

Examples of information material are given in Figures 6, 7, 8 and 9.

Figure 5: Examples of voluntary energy assessment in advertisements.

Figure 6: EPBD related topics on the Ministry of Infrastructure and Development website.

Figure 7: Cover page of the official brochure for Energy Performance Certificates (EPC).

[4] *www.eib.org/epec/about/*
[5] *oszczedzam-energie.mos.gov.pl/*

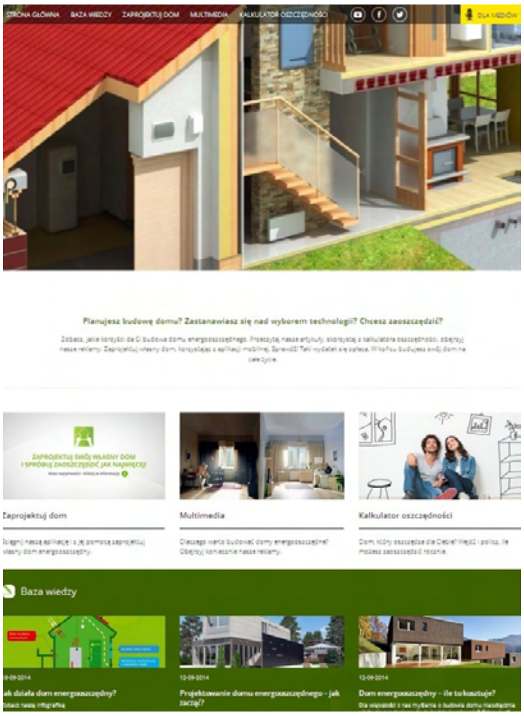
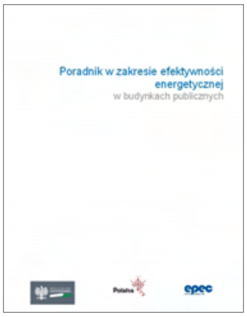


Figure 8: "The house that saves for me" website.

Figure 9: Cover of the Polish Guide "Poradnik w zakresie efektywności energetycznej w budynkach publicznych" ("Guidance on Energy Efficiency in Public Buildings").



III.v. Coverage of the national building stock

Due to the lack of a central EPCs register or other relevant research data, the total number of buildings already certified is unknown. According to the Ministry of Infrastructure and Development, the number of buildings in Poland in 2011 exceeded 5.5 million.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Poland adopted regular inspection of heating and AC systems. Regulations and requirements are mentioned in the Construction Act and in the new Energy Performance of Buildings Act and state that building owners or building managers are obliged to carry out a periodic inspection of the technical conditions of the building's heating and AC systems, as well as their power adjustment concerning heating or cooling needs.

According to the drafted regulations, reports issued after 9 March 2015 are registered in a central register for the energy performance of buildings and will be randomly chosen for verification.

IV.i. Progress and current status on heating and AC systems

Overview, technical method and administration system

By virtue of the Construction Law and since 12 November 2010, periodical inspections must be performed as follows:

> at least every 2 years for boilers of an effective rated output over 100 kW using non-renewable liquids or solid fuels;

> at least every 4 years for gas boilers;

> at least every 4 years for boilers of an effective rated output between 20 kW and 100 kW using non-renewable liquids or solid fuels.

After 9 March 2015, when the new Law on the energy performance of buildings came into force, periodical inspections must be performed not less than:

> at least every 2 years for boilers of an effective rated output over 100 kW using liquids or solid fuels;

> at least every 4 years for boilers of an effective rated output over 100 kW using gas;

> at least every 5 years for boilers of an effective rated output between 20 kW and 100 kW.

According to the Construction Act and the upcoming Law on the energy performance of buildings, AC systems with a rated output over 12 kW should be inspected periodically and at least once every five years, in relation to assessing the energy efficiency of the refrigeration equipment used, as well as their size in relation to the needs.

Arrangements for assurance, registration and promotion of competent persons

In accordance with the construction law, periodical inspections can be made by engineers with building qualifications in the relevant field of expertise, or by a person who is qualified to supervise the manufacturing, processing, transmission or consumption of heat and other power equipment.

There is a central register of the members of the Polish chamber of civil engineers[6].

According to the drafted regulations, from 9 March 2015, persons entitled to perform periodical inspections must be included in the central register[7].

The price for an inspection is not fixed and costs depend on the area of building, typically 1 PLN/m^2 (0.24 €).

Enforcement and penalties

The lack of an inspection report may result in fine to the owner or manager of the building. There is currently no data concerning the penalties issued. Judgement on the infractions shall be

[6] *piib.org.pl/index.php/lista-czsonkopmenu-45*
[7] *rejestr.cheb.mir.gov.pl/wykaz-osob-uprawnionych-do-kontroli-systemu-ogrzewania-lub-systemu-klimatyzacji*

made on the basis of the provisions of the Code of Conduct in Misdemeanour Cases. The fine may be up to 500 PLN (around 120 €) and is imposed by the authorities in change of supervising construction activities.

According to the drafted regulations, from 9 March 2015 and in accordance with the Law on the Energy Performance of Buildings, failing to perform an inspection process, as well as performing the inspection without the required qualifications, results in an obligatory fine to the owner, the manager of the building, or the expert, respectively. The verification of the inspection outcomes is made ex-officio, or by request of the building owner/manager.

Quality control of inspection reports

In accordance with the Construction Act, the protocol of the inspection of the heating and AC systems should be included in the construction site book for both existing and new buildings. There is currently no database available including the number of heating or AC system inspections. As a result, there is also no publicly available data on the number of heating or AC inspections controlled in 2013.

According to the drafted regulations, from 9 March 2015, the inspection reports will be registered in the central register for the energy performance of buildings and they will be randomly chosen for verification. At the start of October 2014, the draft Ordinance for the inspection of heating and AC systems containing examples of an inspection protocol has been released for public consultation.

3. A success story in EPBD implementation

A success story in the Polish EPBD implementation by the end of 2014 is the establishment of the regulatory framework which will enable future complementary works and development. The currently existing package of policy instruments includes the following:

> The ordinance of the Ministry of Infrastructure and Development on the methodology for energy performance calculations of whole buildings, separate apartments or building parts, constituting separate technical - functional areas, along with the scope of the energy performance certificates, set up on 3 June 2014. The ordinance specifies a methodology for calculating the energy performance, the methodology for preparing an EPC and the various types of EPCs - for building residential premises, or building parts constituting separate technical - functional areas.

> The Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings, sets minimum energy performance requirements for new buildings, as well as for those undergoing renovation. Requirements for the EP index, as well as those defined by the provisions of Annex 2 to the regulation, including those relating to the permissible value of heat transfer coefficient U and other requirements related to energy savings, have been established in accordance with the guidelines of the EPBD and the Commission Delegated Regulation (EU) No 244/2012 of 16 January 2012, so as to be cost-optimal.

In accordance with the current version of the *"National Plan for increasing the number of Nearly Zero-Energy Buildings"*, and the rules set in the regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings, requirements were set out by Article 9 of Directive 2010/31/EC. The content of this national plan includes an analysis of financial incentives, as well as market barriers for action to improve the energy performance of buildings.

The Construction Law and the Energy Performance of Buildings Law (which repeals the existing provisions about the energy performance of buildings set in the construction law) specify, among others, the principles for the preparation and transfer of EPCs, as well as principles for controlling the heating and AC systems in buildings, for drawing up the relevant documentation of control, as well as requirements for persons qualified to issue EPCs and to control heating and AC systems.

4. Conclusions, future plans

The new Act on the Energy Performance of Buildings was published on 8 September 2014 and came into force on 9 March 2015. This act transposes part of the provisions of the Directive 2010/31/EU, into Polish law.

The new act introduces the following changes:

> withdrawal of the obligation to acquire an EPC for all buildings that are put into

use. An EPC will be obligatory only for buildings:
- being sold;
- being rented;
- used by public authorities, judicial authorities or public prosecutors, with an area over 250 m^2;

> widening the scope of qualifications that entitle experts to produce energy performance certificates;

> introduction of the possibility of issuing EPCs either using calculation, or based on actual energy consumption (estimated on the basis of documents confirming the actual amount of final energy delivered to the building for the purpose of its technical systems);

> extension of the period of execution of mandatory inspections of heating systems with boilers with a nominal capacity of 20 kW to 100 kW from 4 years (obligation existed from 1 January 2009) to 5 years;

> withdrawal of the obligation to control heating systems with boilers of an effective rated output greater than 20 kW, being in use for at least 15 years from the date appearing on the identification plate of the boiler. After the entry into force of the act, these devices must be inspected periodically, similar to any other devices of heating systems;

> introduction of the requirement for providing information in advertisements on the energy performance of buildings or building parts being sold or rented;

> a mechanism for checking the quality of the EPCs and of inspection reports by an independent body;

> delegation to develop a national plan aimed at increasing the number of buildings with low energy consumption, for the ministry responsible for housing and spatial planning;

> introduction of a requirement for the preparation and display of the EPC of buildings occupied by public institutions with area greater than 250 m^2;

> introduction of a requirement for the display of the EPC of buildings with an area greater than 500 m^2, in which services are provided to the public, and for which an EPC is already available.

Most of the provisions of the act came into force 6 months after the publication date.

Moreover, four laws implementing the act are being prepared:

> the regulation on the format of inspections of heating and AC systems protocols;

> the regulation on the scope and methodology of verification of the EPCs and heating and AC systems inspection reports;

> the regulation on the methodology for the energy assessment of buildings and building parts, and new templates of energy certificates;

> the regulation on the obligatory civil liability insurance of persons issuing energy performance certificates.

Implementation of the EPBD in Portugal

STATUS IN DECEMBER **2014**

1. Introduction

The national implementation of the Energy Performance of Buildings Directive (Directive 2010/31/EU - EPBD) started in 2007, based on three decrees published in 2006. The legislation was revised in 2013 to transpose the tighter requirements of the EPBD. The revision process had contributions from nearly 100 different stakeholder institutions, resulting, among others, in the improvement of the methodologies and the certification process based on extensive experience gained over the last years. As of November 2015, the new legislation has been in force for two years, and despite an initial adaptation period, the market seems to have adjusted to the changes. The requirement to have an Energy Performance Certificate (EPC) when advertising a building for sale or rent was a major change that contributed to increasing the number of EPCs issued every month. But the change was not only through legislation. ADENE, the Portuguese Energy Agency, has developed a strategy in order to upgrade the National Building Energy Certification System (known as SCE). These changes included the development of a new online platform to issue EPCs, a new EPC layout, a new website, and the publication of support documentation and guidelines for experts. The main goal was to better adapt the SCE to market needs.

This report presents an overview of the current status of the EPBD implementation and the plans for its evolution in Portugal. It mainly focuses on energy performance requirements and EPCs, including quality control mechanisms, training of Qualified Experts (QEs) and information campaigns.

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2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

This section presents an outline of the transposition and implementation of the EPBD energy performance requirements in Portugal. It also describes the cost-optimal procedure for setting requirements, the action plan towards Nearly Zero-Energy Buildings (NZEBs) and plans for the implementation of the Energy Efficiency Directive (2012/27/EU - EED) Articles 4 and 5.

I.i. Progress and current status

Energy efficiency requirements for residential buildings in Portugal were first introduced in 1991, and for non-residential buildings in 1998. In 2006, the building codes were revised for all buildings due to the transposition of the Directive 2002/91/EC. These codes were again revised to transpose Directive 2010/31/EU. The process started in 2010, the technical committees completed their job by the end of 2012, and the legislation came into force one year later. The following sections describe how the national requirements evolved from 2006 to 2014, addressing the most relevant aspects of the revised building codes.

I.ii. Format of national transposition and implementation of existing regulations

The calculation methodologies are based on using a reference building for comparison, and include the parameters presented in Table 1. The reference building is considered to be of the same type as the building under evaluation, but with reference values for the building components and technical systems —Table 2, without the contribution of renewable energy and energy efficient solutions (heat recovery, etc.).

The energy performance requirements established for residential buildings are set in terms of useful energy demand needs for heating and cooling. The total primary energy for heating, cooling and Domestic Hot Water (DHW) is also limited to a maximum value. There is a minimum renewable energy contribution required for DHW, based on a minimum solar thermal panel area for each building occupant.

Non-residential buildings have an energy performance requirement which limits the maximum primary energy for heating, cooling, DHW, and lighting. Table 3 presents the average values in terms of energy needs and primary energy and the corresponding requirements for buildings built before the EPBD, under Directive 2002/91/EC and after the publication of Directive 2010/31/EU.

Table 1: Requirements included in calculations.

Building	Main legislation requirements	Requirements included in calculations
Residential and non-residential	Thermal behaviour, energy and indoor air quality	Thermal comfort
		Minimum requirements for U-values, including thermal bridges
		Windows – solar factor and shading devices
		Ventilation, indoor air quality, infiltration
		Maximum energy needs and primary energy consumption
	Systems efficiency	Minimum efficiency for heating, ventilation and air-conditioning systems, renewable energy systems, and lighting (only for non-residential)
Non-residential	Ventilation and indoor air quality	Minimum outdoor air supply, indoor air quality, infiltration
	Installation and maintenance	(Not relevant for calculations)

Table 2: Minimum requirements evolution for residential buildings, envelope, ventilation and renewables.

Time interval		1990 - 2006		2006 - 2012		2012 - 2016		After 2016	
		Lisbon	Bragança	Lisbon	Bragança	Lisbon	Bragança	Lisbon	Bragança
U-value [W/(m^2.K)]	External **walls**	1.4	0.95	0.7	0.5	0.5	0.35	0.4	0.3
	External **roof/floor**	1.1	0.75	0.5	0.4	0.4	0.3	0.35	0.25
	External **window**	4.2	4.2	4.2	3.3	2.9	2.4	2.8	2.2
	Flat thermal bridges	None		2 x U-value (closest element)					
Maximum window solar gain factor **g-value**	Light inertia	0.15					0.1	0.15	0.1
	Medium and heavy inertia	0.56							
Ventilation (air changes per hour)		None		≥ 0.6		≥ 0.4			
Renewable energy systems		None		Minimum solar energy contribution for domestic hot water (reference value 0.65 m^2/occupant)					

			Existing				New	
			(before 2006)		2006-2013		after 2013	
			Average	Max.	Average	Max.	Average	Max.
Residential	Heating (kWh/m².year)	Energy demand	94	a)	45	b)	45	c)
	Cooling (kWh/m².year)	Energy demand	15	14	12	13	10	10
	Domestic hot water (kWh/ m².year)	Energy demand	36	-	18	d)	17	d)
	Total (kWh/m².year)	Primary Energy	259	e)	87	f)	103	g)
Hospitals	Total (kWh/m².year)	Primary Energy	217	222	209	281	200	226
Sports facilities	Total (kWh/m².year)	Primary Energy	218	211	144	182	148	191
Hotels	Total (kWh/m².year)	Primary Energy	226	227	237	255	215	250
Educational buildings	Total (kWh/m².year)	Primary Energy	118	109	76	112	117	198
Offices	Total (kWh/m².year)	Primary Energy	157	144	120	161	159	211
Restaurants	Total (kWh/m².year)	Primary Energy	265	256	125	191	183	245
Retail trade	Total (kWh/m².year)	Primary Energy	146	144	123	174	81	136

Note: Comparisons between periods for the purpose of evaluating the evolution and impact of requirements is not recommended due to the differences between methodologies, requirements, cost optimal studies, climate data, etc.

a) Varies between 33 – 56 kWh/m².year (1st and 3rd quartile)

b) Varies between 38 – 66 kWh/m².year (1st and 3rd quartile)

c) Varies between 46 - 75 kWh/m².year (1st and 3rd quartile)

d) Minimum solar energy contribution for domestic hot water

e) Varies between 105 - 182 kWh/m².year (1st and 3rd quartile)

f) Varies between 88 - 177 kWh/m².year (1st and 3rd quartile)

g) Varies between 113 - 220 kWh/m².year (1st and 3rd quartile)

Table 3: Energy performance indicators and corresponding requirements.

I.iii. Cost-optimal procedure for setting energy performance requirements

The revised 2013 requirements presented in Table 3 were a major step towards improving the energy efficiency of buildings. These requirements were established considering the comparative methodology framework for calculating cost-optimal levels published by the EC. The first report presented dealt with new residential buildings (apartments and single-family houses) for different climates in Portugal, and the main goal was to test the methodologies for a range of materials, solutions and technical systems (e.g., insulation thickness, glazing types, heat pumps, etc.). This report concluded that the legislation requirements are close to the cost-optimal levels as presented in Table 4 and that it is not necessary to change them. For non-residential buildings, the study focused only on office buildings, the most representative building typology. The report concluded that the legislation requirements are outside the cost-optimal levels range and that the reference building characteristics should be updated in order to have the legislation requirements within the cost-optimal levels range.

Most of the requirements will be tightened again in 2016 following the planned update of the national legislation.

The building code is structured in a way that allows for a quick and easy update of requirements if necessary.

Thermal comfort is ensured by the envelope requirements and by limiting the energy needs, making it cheaper for occupants to control their environments.

Table 4: Cost-optimal energy performance for residential buildings and office buildings in Lisbon.

		Weighted average for primary energy levels		
		Cost-optimal levels of minimum energy performance requirements (kWh/m².year)	Minimum energy performance requirements in force (kWh/m².year)	Difference (%)
Residential	New	33.24	30.59	7.97
	Existing	52.97	52.94	0.10
Office buildings	New	137.3 a) 140.5 b)	192.0	- 39.5 - 36.7
	Existing	129.6 a) 130.5 b)	164.0	-26.0 -25.7

a) Adopting a variable refrigerant flow (VRF) system for heating and cooling

b) Adopting a chiller for heating and cooling

In residential buildings, it is assumed in the energy calculations that there is a minimum requirement of 0.4 air changes per hour in order to guarantee the indoor air quality. For non-residential buildings, minimum outside airflow rates are set depending on the building use, floor area and number of occupants.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

The national action plan for the progression to NZEBs is supported by the revised legislation. The adopted definition of the NZEB establishes a relation with cost-optimal evaluations. NZEBs are defined as buildings that cumulatively offer:

a) components compatible with the upper level (most efficient) of cost-optimal evaluations; and

b) implementation of renewable energy that covers a very significant fraction of the remaining building needs.

This energy must be produced on site (whenever possible) and/or, alternatively —when local production may be insufficient, e.g., in urban areas— as nearby as possible. This definition still needs to be complemented by additional numerical targets, e.g., with the share of renewables and U-values for the envelope (or primary energy targets).

Given that the NZEB definition is not yet completed, it is still not possible to provide examples and to know how many NZEBs are built in Portugal, although relevant buildings have been designed considering the NZEB principles. The legislation states that the building stock should progressively include NZEBs and that, by 31 December 2020, all new buildings will be NZEBs. New buildings occupied and owned by public authorities will be NZEBs after 31 December 2018. Although NZEBs are not fully defined yet, buildings with the A^+ label should be near NZEB level.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Building renovation has been a long-standing government priority and different actions have been undertaken to promote it. The Portuguese National Renovation Strategy (under EED Article 4) focuses on several aspects related to building renovation, e.g., the current status of the current building stock (up to 452 million m^2 of built area. For residential and non-residential), the evaluation of cost-optimal approaches based on the current legislation, and steps to take until 2020. Certain flexibility to the requirements is allowed to building renovation, so that different cost-optimal solutions can be considered in accordance with the building characteristics and differentiated between new and renovated buildings. Additionally, there is a link between the National Energy Efficiency Action Plan (NEEAP) and the Renovation Strategy, basically on programmes dealing with energy efficiency in buildings, integration of thermal Renewable Energy Sources (RES), e.g., solar thermal and biomass, as well as renewable energy in homes and offices.

Financial incentives are also being considered, mainly in the form of programmes supported by European Union funds that will enhance building renovation through the implementation of energy efficiency measures and renewable energy systems in buildings. For residential buildings, there is a 311 M€ credit line available.

Regarding public buildings, an Energy Efficiency Programme for Public Administration (ECO.AP) was launched. This programme aims to achieve a 30% improvement in energy efficiency in public service and public administration buildings by 2020. ECO.AP is an evolving program that sets energy efficiency measures to be implemented to buildings of public service, agencies and public equipment. It aims to change behaviours and promote the rational management of energy services, notably by hiring Energy Services Companies (ESCOs). The pilot phase includes 300 buildings.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The legislation published in 2013 introduced new requirements for Technical Building Systems (TBS). These requirements focus on the need to transpose the EPBD and promote the building energy efficiency as a whole (rather than at an individual system level). Some of the requirements go beyond the EPBD, e.g., the introduction of energy efficiency requirements for lifts. The requirements are mostly supported by the European standards whenever available.

A set of design requirements is defined for heating and cooling systems and other technical systems, as shown in Table 5. The regulations define minimum efficiency requirements for heat pumps based on the Eurovent energy label scheme. Boilers and gas heaters must also meet a minimum efficiency requirement. Air handling units have to fulfil a minimum Eurovent label based on Standard EN 13053. For ventilation systems there is a requirement set in terms of maximum Specific Fan Power (SFP) according to Standard EN 13779. Heat pumps for heating, cooling and DHW must comply with the European Quality Label for heat pumps. Heat pumps for DHW must have a minimum Coefficient of Performance (COP) of 2.3 based on Standard EN 16147. Electric motors in pumps and fans have to fulfil a minimum energy label according to Standard IEC 60034-30.

The legislation also sets minimum requirements for heating, cooling and DHW that pertain to generation, distribution, emissions and control of technical systems. Large ventilation systems are also addressed, with requirements on fan power and heat recovery.

II.ii. Regulation of system performance, distinct from product or whole building performance

In the previous legislation, the building energy efficiency was mainly imposed through the use of building performance indicators, setting specific maximum energy consumption rates for the whole building and for some specific energy uses, e.g., heating, cooling and DHW. The new legislation keeps most of these requirements and introduces additional requirements for technical systems that directly influence the whole building performance. This situation creates a more demanding scenario for designers, reducing their freedom to adopt less efficient solutions at a system level.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

New buildings and buildings that undergo major renovations have to fulfil requirements, although there are exceptions for existing buildings. Also, systems that are replaced or upgraded need to fulfil specific requirements.

Exceptions are allowed in the case of buildings where the fulfilment of

Building type	Technical system		Requirement evolution			Standard
			Before 2013	2013-2015	After 2016	
Residential and non-residential buildings	Heat pumps	Cooling	None	Eurovent Label C (Example: Chiller COP ≥ 2.8; EER ≥ 2.7)	Eurovent Label B (Example: Chiller COP ≥ 3.0; EER ≥ 2.9)	EN 14511
		Heating				EN 14825
		Domestic hot water (DHW)		COP ≥ 2.3		EN 16147
	Boilers			Minimum nominal efficiency 86%	Minimum nominal efficiency 92%	-
	DHW gas heater	Power ≤ 10 kW		Efficiency ≥ 82%		
		Power > 10 kW		Efficiency ≥ 84%		
Residential	Domestic electric storage water heaters			Maximum stand-by heat loss		EN 60379
Non-residential	Air handling unit			Eurovent Label D Efficiency ≥ 47% Velocity ≤ 2.5 m/s Δp ≥ 125 Pa	Eurovent Label C Efficiency ≥ 57% Velocity ≤ 2.2 m/s Δp ≥ 170 Pa	EN 13053
	Pumps		Minimum EFF2 label	Minimum IE2 or IE3 class		IEC 60034-30
	Fans			Minimum IE2 or IE3 class Minimum SFP 4 or 5 W/(m³/s)		IEC 60034-30 EN 13779
	Lighting		None	Maximum power (W/m²)/100 lux Example: Offices 2.5 (W/m²)/100 lux for 500 lux		EN 12464-1 EN 15193
	Lifts			Minimum C	Minimum B	VDI 4707
	Central building management system		Mandatory if HVAC thermal power > 250 kW			EN 15232

Table 5: Minimum requirements for technical systems.

requirements is not possible due to technical, functional, economic or architectural reasons. However, implementation of alternative measures for technical systems is nevertheless mandatory in such cases, and the alternative measures must not lower the energy performance that the building had before the renovation. All constraints must be identified in the design plans and stated on the EPC when available (an EPC is required for all major renovations).

II.iv. Applicability to new buildings

For new buildings there are no exceptions to the requirements. Given that the building is new, it is possible to properly plan and integrate the systems requirements, as this normally has a limited impact on architecture.

II.v. Provisions for installation, dimensioning, adjustment and control

It is mandatory that Heating, Ventilation and Air-Conditioning systems (HVAC) with a thermal power higher than 25 kW have a detailed HVAC design project made by a qualified engineer. The HVAC distribution pipes, storage tanks and ducts must fulfil a minimum insulation thickness as presented in Table 6. The provisions for building management systems depend on the HVAC systems' thermal power as shown in Table 5. The components of the building technical systems should have the 'CE marking' to guarantee that the product complies with the requirements of the relevant European health, safety and environmental protection legislation and their performance should be characterised based on a national or international energy label scheme, if available.

II.vi. Encouragement of intelligent metering

For new non-residential buildings it is mandatory to have intelligent metering of HVAC equipment with electric power above 25 kW. The same applies for boilers with thermal power above 100 kW. New non-residential buildings with thermal power above 25 kW must appoint an installation and maintenance technician (TIM) who guarantees the proper system installation. Existing non-residential buildings with thermal power above 250 kW must also be supervised by a TIM that guarantees the proper maintenance of all systems. The TIM supervises all relevant activities and manages relevant technical information. Another task of the TIM is to promote the installation of energy metering systems in the buildings.

Intelligent metering is also encouraged through requirements for the installation of building management systems in new buildings and major renovations. Existing buildings do not have any building management system requirements.

II.vii. Encouragement of active energy-saving control (automation, control and monitoring)

New buildings with an HVAC thermal power above 100 kW must have a building management system, whether or not centralised. If the power is above 250 kW, the building management system has to be centralised and must at least comply with label C according to Standard EN 15232.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

ADENE designed, implemented and currently manages the SCE, which is based on a central registry and database with restricted access. QEs are the only persons allowed to issue certificates. They must be recognised architects or engineers with at least five years' experience in building energy efficiency. To become a QE, candidates may attend optional training sessions but they all

Table 6: Thermal insulation thickness requirements for air ducts, pipes and storage tanks.

		Thermal insulation thickness (mm) for a reference thermal conductivity – 0.040 W/m.k							
		Hot fluid inside				**Cold fluid inside**			
Air duct		20				30			
Pipe	Diameter (mm)	Fluid temperature (ºC)				Fluid temperature (ºC)			
		40 < T ≤ 65	65 < T ≤ 100	100 < T ≤ 150	150 < T ≤ 200	-20 < T ≤ -10	-10 < T ≤ 0	0 < T ≤ 10	10 < T
	D ≤ 35	20	20	30	40	40	30	20	20
	35 < D ≤ 60	20	30	40	40	50	40	30	20
	60 < D ≤ 90	30	30	40	50	50	40	30	30
	90 < D ≤ 140	30	40	50	50	60	50	40	30
	140 < D	30	40	50	60	60	50	40	30
Storage tank	Surface area ≤ 2 m^2	50							
	Surface area > 2 m^2	80							

have to pass a required exam offered by ADENE. Most of the QEs attended training sessions as per the new regulations in order to update their knowledge on building codes. Complementary training sessions are often promoted by ADENE to improve qualifications in specific areas, e.g., lighting, HVAC, RES systems and building simulation programmes.

In terms of methodology, there were relevant changes to the legislation implementing Directive 2002/91/EC relative to those implementing Directive 2010/31/EU.

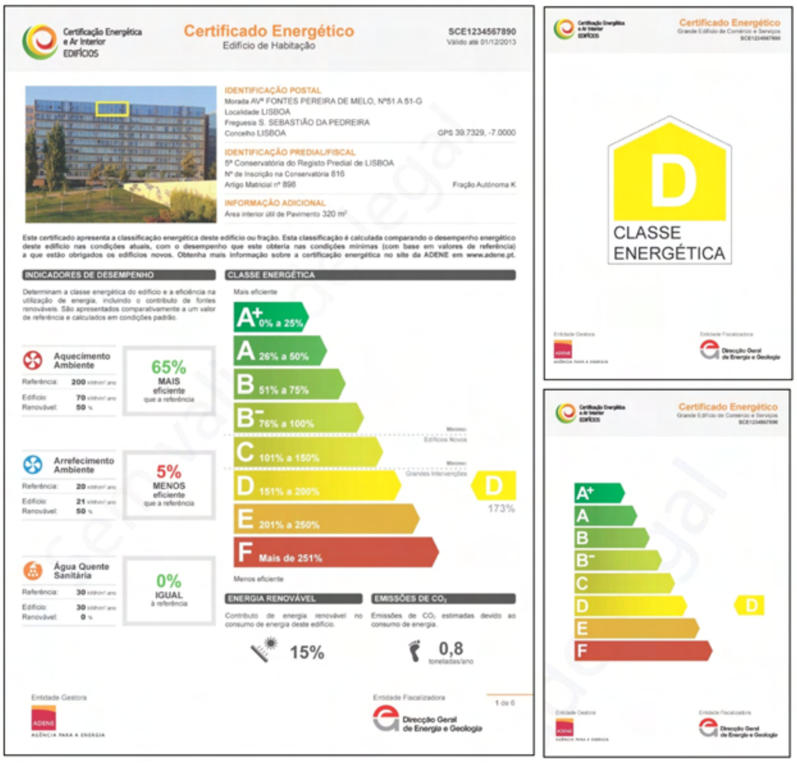
In apartment buildings, each flat is certified individually. In non-residential buildings, only one EPC is issued if the building has a centralised HVAC system.

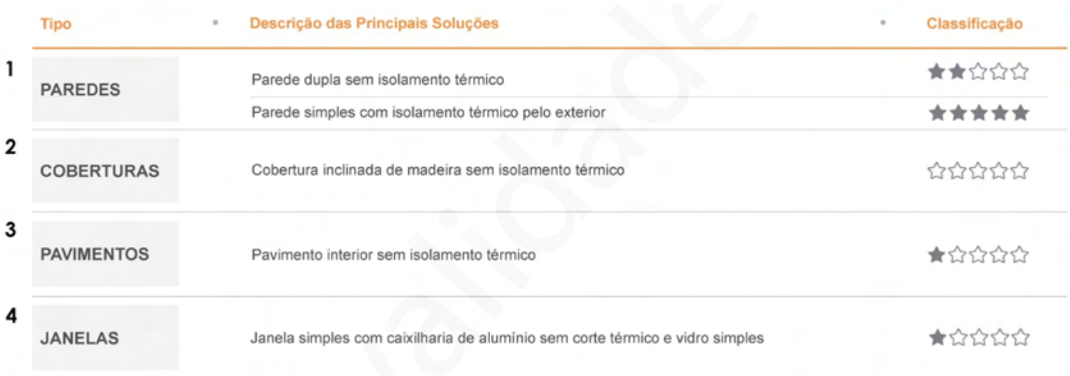
Figure 1 presents, on the left, the first page of the EPC for residential buildings. It also presents two alternative display layouts (A6 and A4 sizes) for non-residential buildings. The main body of the EPC consists of 4 pages, presenting simple core information that is easily understood by the general public. The remaining pages provide detailed technical information regarding all the building characteristics that influence the energy performance.

The energy label includes 3 energy efficiency indicators for heating, cooling and DHW. For non-residential buildings, lighting indicators are also included. Each indicator determines if the building is more or less efficient compared to its reference. The energy label classifies buildings on an efficiency scale ranging from A⁺ (high efficiency) to F (poor efficiency) and is based on calculations in terms of primary energy. Nominal CO_2 emissions and the amount of renewables are also listed on the front page of the certificate in a simple and practical way.

Page 2 of the EPC for residential buildings informs the consumer about the quality of the envelope components based on a star rating. A higher number of stars represents a better component in terms of thermal performance (see example in Figure 2). Additionally, it is also possible to evaluate the building behaviour during the heating and cooling season and to get an idea about the building heat losses and gains, as shown in Figure 3. This data is calculated during the evaluation procedure and is different for every building or apartment certified.

Figure 1: Three ways to display the EPC, in two different sizes.





Tipo	Descrição das Principais Soluções	Classificação
1 PAREDES	Parede dupla sem isolamento térmico	★★☆☆☆
	Parede simples com isolamento térmico pelo exterior	★★★★★
2 COBERTURAS	Cobertura inclinada de madeira sem isolamento térmico	☆☆☆☆☆
3 PAVIMENTOS	Pavimento interior sem isolamento térmico	★☆☆☆☆
4 JANELAS	Janela simples com caixilharia de alumínio sem corte térmico e vidro simples	★☆☆☆☆

1) - Walls; 2) - Roofs; 3) - Floors; 4) - Windows

Pior ☆☆☆☆☆ Melhor ★★★★★

Figure 2: Example of how the EPC displays quality stars for the envelope components, as indicated on the 2nd page of an EPC.

Figure 3: Example of heat losses and gains balance as indicated on the 2nd page of an EPC.

Page 3 is dedicated to improvement measures and recommendations identified by the QE. It is possible to get a clear picture of which areas should be addressed during the decision process. Page 4 includes definitions, notes and statistical information about the distribution of energy labels in each residential EPC, as shown in Figure 4. This provides information to the building owner on how efficient the building is when compared to the market average.

As a replacement of the mandatory inspections required by the EPBD, a first initiative was developed that introduced, within the new EPC layout, a section including advice to the building users. This section focuses on the importance of the heating, cooling and DHW systems according to the total energy consumption of the building. It also recommends regular inspection and maintenance of this equipment. For new equipment, the importance of properly selecting and sizing and the corresponding benefits are also addressed.

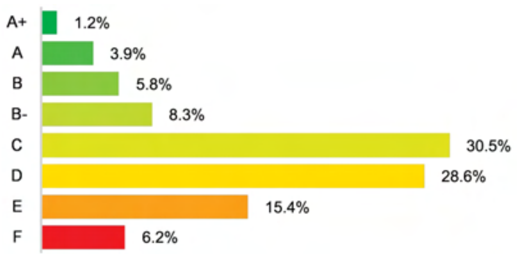


Figure 4: Database energy label distribution.

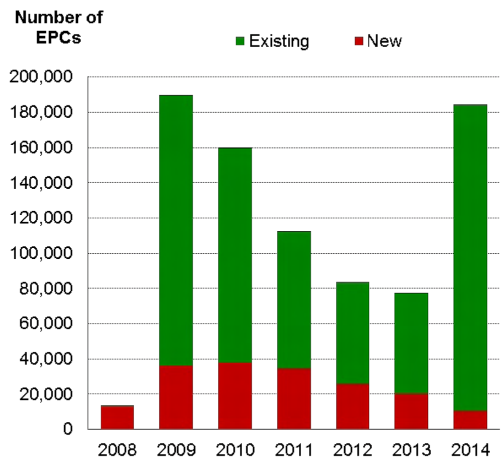


Figure 5: Evolution of the total number of EPCs issued for residential and non-residential buildings.

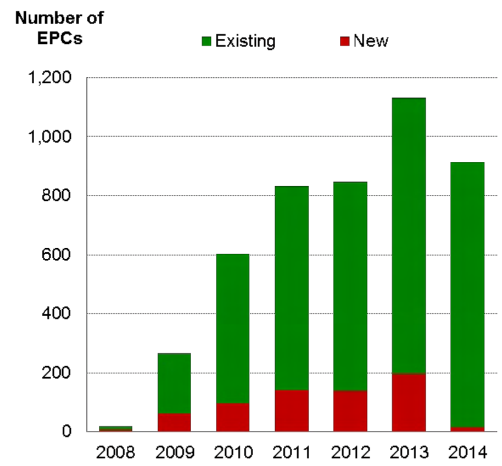


Figure 6: Evolution of the number of EPCs issued for large non-residential buildings.

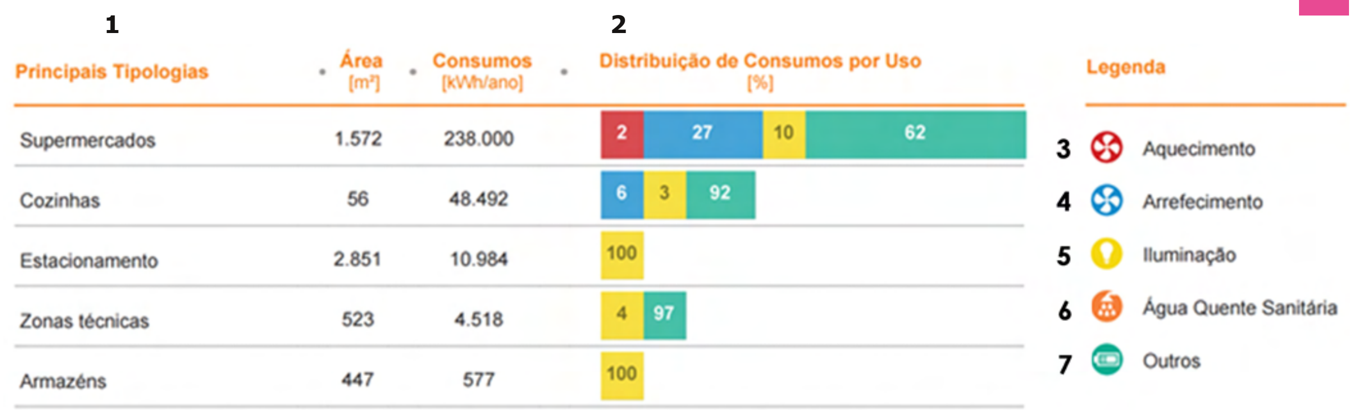
The implementation of the EPC has been very successful for buildings being sold. On the other hand, the rental market was slower in taking up the EPC, and only in the last year has it increased. The latest analysis of the EPC database clearly shows that the number of EPCs issued for rentals is on the rise. The current trend in the market shows a shift from the number of building sales and an increase in rentals. The new regulations therefore contain stronger control mechanisms that promote the increase of EPCs for rentals. One of those mechanisms is the obligatory advertisement of the EPC label before the building is rented or sold and when offered to the market.

Figure 5 presents the evolution of the total number of EPCs issued every year since they were initially implemented in 2008. Currently, around 15,000 EPCs are being issued every month, covering nearly 90% of the licensing and selling processes that take place in the country. Furthermore, a national database of certified buildings is being developed with up-to-date information. This will be used for monitoring the progress of the different aspects of the implementation of the EPBD, from basic statistics, e.g., the number of certified buildings, to impact assessment, including estimated energy savings. It is worth noting the large increase in registrations for 2014, due to the start of the mandatory requirement for including the energy label in advertisements for sale and rent.

Figure 6 presents the evolution of the number of EPCs issued for large non-residential buildings, which shows that this is an ongoing process that has been growing positively.

For non-residential buildings, the EPC layout was developed in order to provide added value information for the energy managers of these buildings. This includes a bar chart that provides the breakdown of the different final energy sources and a bar chart to provide practical information about the energy consumption by energy use for the different parts of the building, as shown in Figure 7. An EPC issued for a non-residential building is valid for 6 years.

In 2013, 8 non-residential EPCs have undergone a Quality Assurance (QA) assessment based on a full check of the input data and results.



1) - Building zones; 2) - Energy consumption; 3) - Heating; 4) - Cooling; 5) - Lighting; 6) - Hot water; 7) Other

Figure 7: EPC displays of energy consumption by energy use and building typology.

Currently, 90% of the EPCs in the database have been issued for residential buildings and 10% for non-residential buildings.

An EPC for residential buildings typically costs from 135 € to 465 €. These figures include the costs for the expert (between 100 € and 400 €) and the registration fee at ADENE´s database, which for residential buildings ranges from 35 € to 65 €. An EPC for non-residential buildings may cost between 2 €/m² and 5 €/m² plus the registration fee. The fees for non-residential buildings range from 150 € for buildings with a floor area up to 250 m², to 950 € for buildings with a floor area above 5,000 m².

The QA assessment starts with an automatic software check of input data during the EPC issuing process, in order to avoid potential mistakes before even issuing it. After the EPC has been issued, there are another two QA stages: a simple QA check and a detailed QA check. The simple QA check is based on a straightforward visual verification of the form and the EPC, checking its accordance with the defined methodologies, without any complex calculations or additional information requests from QEs, and this is performed on a random sample of the EPCs issued daily.

The detailed QA check includes a full data review of calculations and a building audit, in order to check the compliance with the requirements and methodologies. Such an audit involves checking all the supporting documentation prepared and used by the expert (e.g., projects, drawings, reports, photos, etc.) and identification of eventual differences and mistakes that occurred. It has proved to be an important tool in improving the work of the QEs. Until the end of 2014, about 19,000 EPCs have undergone (or are undergoing) a QA assessment. This means that around 2% of the total EPCs issued were audited. In 2013 and 2014, about 1,293 and 2,907 EPCs respectively have undergone some kind of QA assessment. In the worst-case scenario, the QA process can lead to a fine, (so far, fines have been imposed on 7 experts). In general, when the QE does not comply with the regulations, he is required to correct the calculations and issue another EPC (with fees paid by the experts themselves, when applicable). In order to evaluate the work of QEs and consumer satisfaction, a mystery client strategy has also been put in place. This strategy was based on selecting QEs that were contacted by homeowners to issue an EPC. The homeowners were previously informed about the need to evaluate the QE's work and were asked to fill in an evaluation questionnaire assessing the expert's work.

III.ii. Progress and current status on public and large buildings visited by the public

In Portugal, the definition of a public building includes every non-residential building owned by private or government bodies. This definition is much wider than the strict interpretation of the EPBD requirements. Every non-residential building larger than 500 or 1,000 m² (depending on typology) is required to display an EPC at the main entrance, which is valid for 6 years. Currently, there are nearly 6,000 non-residential buildings certified and many more in the process of being certified. This has been the building typology where most difficulties were found in implementing the EPBD requirements in Portugal.

III.iii. Implementation of mandatory advertising requirement

Advertising the energy performance indicator was not a requirement before the EPBD, although some real estate agents have advertised the energy performance of top-class buildings.

Figure 8: Example of an advertisement including the energy label.

Figure 9: Model to be used in advertisements for the energy efficiency label.

Since December 2013, it is a requirement to include the energy performance indicators in all advertisements, and the real estate market has been gradually doing so. The requirement to include the EPC in advertising has been one of the major legislation changes, and seems to be the reason for the increase in the number of EPCs issued in 2014, as presented before in Figure 5.

Besides owners, also real estate agents need to guarantee that the EPC label is displayed in advertisements. In order to facilitate the information exchange between the EPC and the advertisement, ADENE, together with the Portuguese real estate association (APEMIP), opened up access to the EPC database for real estate agents. Through this information exchange, it is possible for users to cross-check information between the databases and to update it. A manual provides guidelines and examples on how to display an energy label in advertisements. An example is presented in Figure 8 and the model for the different energy labels is presented in Figure 9.

In spite of all the efforts, several cases of non-compliance were identified and reported and, in those cases, real estate agents were asked to provide the minimum amount of information to the public (with the EPC label). Non-compliance may lead to infringement procedures, which may in turn result in fines of up to 45,000 €, but no fines have yet been imposed.

III.iv. Information campaigns

To promote and enhance the SCE, ADENE launched an advertising campaign. In the first year (2007) the campaign's slogan, “Let's save energy to save Portugal”, was displayed on television channels, in the press and on the internet. The promotion of EPCs has been based on ADENE´s staff participation at different kinds of events, e.g., fairs, workshops, conferences and seminars all over the country, playing an active role in disseminating the advantages of the EPC and stressing the importance of implementing the improvement measures. In these events, ADENE also displayed an online interactive energy performance simulator for households, "CasA+", at www.casamais.adene.pt.

The impact of the information campaign was assessed in 2010. The results revealed that 76% of the inquired participants had already heard about the EPC, and among those that already had an EPC, 75% would recommend friends and relatives to obtain an EPC. This study also revealed the importance of the EPC recommendations for those who implemented them.

Currently, the focus has been on presenting the new regulations in conferences and seminars all over the country, including municipalities and various stakeholders. In order to inform homeowners about the energy certification process, a leaflet was developed that presents guidelines to support them on the consumer level, namely hiring a QE and providing the needed documents. Figure 10 presents one of the leaflet pages.

Figure 10: Leaflet on energy certification process.

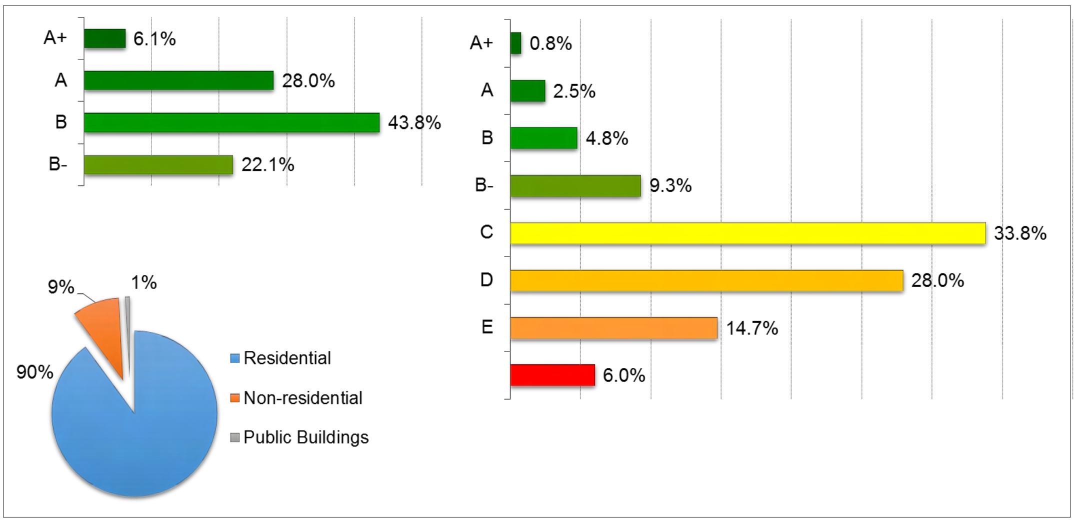


Figure 11: Energy label distribution for new and existing buildings.

III.v. Coverage of the national building stock

As of December 2014, more than 800,000 EPCs were issued since the scheme's launch in July 2007 in response to the requirements of the EPBD. Residential buildings represent 90% of the total EPCs issued. Considering that the number of residential building units in the country is close to 5.9 million, according to the National Statistics Institute (INE), it is possible to conclude that currently a little more than 10% of the residential building stock has an EPC.

Figure 11 presents the distribution of energy labels of the current building stock. For existing buildings the most common label is C, while for new buildings it is B.

In 2014, around 10,655 EPCs for new buildings and 169,452 EPCs for existing buildings were issued.

III.vi. Other relevant plans

The EPC is being progressively required in tendering processes and for obtaining public funding and, e.g., to apply and receive financial incentives from the national Energy Efficiency Fund (FEE) and from the National Strategic Reference Framework (QREN). Additionally, the EPC will play an important role when it comes to implementing EU structural funds, mainly under the “Portugal 2020” initiative, and not only identifying which buildings should be addressed but also validating the implemented improvement measures.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

In 2006, Portugal officially adopted option a) of Article 8 of Directive 2002/91/EC, establishing a regular inspection of boilers. The inspection of boilers as well as of Air-Conditioning (AC) systems was, however, a challenging issue due to the specific climate characteristics of the country. Boilers and AC systems only operate for relatively short periods of time during the year. Thus, the relevant energy consumption is very low. This means regular inspections are not a high priority in terms of cost-effectiveness. Considering these difficulties, the transposition of the EPBD in Portugal no longer imposes regular inspections, and instead allows for alternative measures (e.g., provision of advice).

IV.i. Report on equivalence

Portugal is still working on the equivalence of the alternative measures, given that it was not yet possible to evaluate the impact of the campaigns.

IV.ii. Progress and current status on heating systems

Inspections are not mandatory, although in order to promote the correct installation and maintenance, buildings with a thermal power above 25 kW are required to have systems installed and maintained by a TIM. The TIM is an experienced engineer or a trained technician that supervises these activities and manages all the relevant technical information. Additional tasks include the design and implementation of a maintenance plan, which is mandatory for buildings with a thermal power above 250 kW.

There is a plan to provide targeted advice to users concerning the replacement and maintenance of heating systems with boilers and AC units, other modifications to heating and cooling systems, and alternative solutions to assess the efficiency and appropriate sizing of the boilers or AC units. This plan complements the EPC in delivering information whenever the QE finds a boiler and/or an AC system in the building. Information about this subject will be distributed to relevant stakeholders in the market and technicians dealing with boilers and AC systems, to cover the rest of the existing building stock. Professional associations dealing with these technical systems will also be engaged when necessary.

3. A success story in EPBD implementation

The EPC as a key driver for the success of the energy strategy in the building sector

The EPC was introduced into the market in 2007. The layout was strongly revised and enhanced in 2013 to become more understandable and to provide added value information that focuses on the relevance of the EPC for a homeowner or building manager. Its importance in the market has been steadily growing. The EPC is now a ‘tool’ that informs citizens about their buildings' efficiency and how to improve it. Of course, the positive impact of this ‘tool’ goes far beyond being an informative label for consumers.

The EPC feeds a database that has now more than 800,000 EPCs. It is currently used to produce statistical information regarding the energy efficiency of the building stock and its energy efficiency evolution. This is key information to developing energy efficiency policy, and it allows for the development of financial incentives that should be introduced into the market.

Concerning economic perspectives, the EPC label also has a significant impact on taxes and building market value. The energy label has been increasingly used by municipalities to reduce taxes for the most energy-efficient buildings. These buildings may also increase their market value as a result of the EPC. Preliminary studies indicate that an increase of about 5% to 10% may occur for higher-grade buildings. The display of the EPC label in advertisements highly promotes the EPC's visibility and influences the decisions of potential building buyers. This creates pressure on building owners to implement the energy efficiency recommendations included in the EPC, to improve their buildings' labels. One of ADENE´s strategies for promoting this is exempting the EPC issuing fee after implementing recommendations.

The EPC also has an environmental component, as for buildings it includes annual CO_2 emissions indicators plus the share of renewables, although it could easily include other parameters to provide indicators of a building's sustainability.

The conclusion is that the EPC has been a key driver for the success of the energy strategy in the building sector, mainly with a revised, 'more appealing' version. In the near future there are still developments to be implemented, namely to provide more information about the TBS, to adapt the EPC to the NZEBs concept and to display, when available, energy labels for building components.

4. Conclusions, future plans

The Portuguese National Building Energy Certification System (known as SCE) has been in place for seven years. During this period, many efforts and developments took place to allow reaching the current high level of Energy Performance of Buildings Directive (EPBD) implementation.

Directive 2010/31/EU brought new challenges to the SCE, which inevitably led to its evolution and the improvement of gaps identified during its development. The new legislation, published in 2013, paves the way towards Nearly Zero-Energy Buildings (NZEBs) and sets up a roadmap for tightening the energy performance requirements progressively. Nevertheless, the legislation by itself will not be enough to push the market towards the EPBD goals. Thus, several other strategies are being implemented to address this issue. This includes enhanced control mechanisms to promote the full SCE implementation.

The NZEB action plan will also be a key tool in reaching real energy savings. However, the challenge will be on how to promote NZEBs in a cost-effective way. The continuous increase in energy prices will certainly stimulate the adoption of energy efficient materials and technologies on top of demand for better buildings. In this process, the end user needs to be aware of how efficient the products are. One of the strategies for achieving that relies on strengthening the role of energy labels and proper communication with the public. Building components and systems are a natural target for these labelling systems, and the aim is to go beyond the building labelling practice and expand into the component labelling practice, in close cooperation with relevant market stakeholders.

To evaluate the impact of the EPBD implementation into the market, it will be fundamental to monitor the implementation of recommendations proposed in the Energy Performance Certificate (EPC). One of the strategies to achieve this is exempting the EPC issuing fee after implementing recommendations. Another one is the implementation of other means of communication.

Implementation of the EPBD in Romania

STATUS IN JULY **2015**

1. Introduction

The improvement of the energy efficiency on the whole chain "resources – production – transport – distribution – end-use consumers" represents one of the priorities of the energy strategy of Romania, taking into account its contribution to achieving a secure energy supply for customers, promoting sustainable and competitive development, saving energy resources and reducing greenhouse gas emissions.

For the building sector, the national implementation of the Energy Performance of Buildings Directive (EPBD) is the overall responsibility of the Ministry of Regional Development and Public Administration (MDRAP).

For transposing Directive 2010/31/EU into national law, the Romanian Parliament approved Law 159/2013, in force since 19 July 2013, which amends Law 372/2005. Law 372/2005 on the energy performance of buildings (recast 2013) was published in the Official Gazette of Romania, No. 451/23.07.2013.

The national act of transposition establishes the following elements:

- *a general framework for the methodology for calculating energy performance of buildings and building units;*
- *the application of minimum energy performance requirements for new buildings and building units;*
- *the application of minimum energy performance requirements for existing buildings, building units and building elements that form part of the building envelope, which are subject to major renovations, or the installation/ replacement/upgrading of Technical Building Systems (TBS);*
- *the energy performance certification for buildings and building units;*
- *the inspection of heating and Air-Conditioning (AC) systems in buildings;*
- *the control of Energy Performance Certificates (EPCs), energy audits and inspection reports for TBS installed in buildings.*

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2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

For the design of new buildings, the technical regulation in force is the Code for thermal calculation of building elements (C 107-2005), published in the Official Gazette of Romania, No. 1124 bis/13.12.2005. In 2010, it was amended to improve the thermal resistance values as shown in Table 1 and was then further amended in 2013 to introduce a catalogue of new thermal bridges.

Envelope building elements	Minimum corrected thermal resistances R_{min} (m².K/W)	Maximum corrected thermal transmittances U_{max} (W/m².K)
External walls	1.80	0.56
External windows	0.77	1.30
Terraces	5.00	0.20
Floors above unheated basement	2.90	0.35
Ground floors (no basements)	4.50	0.22
Floors of heated basements	4.80	0.21
External walls of heated basements	2.90	0.35

(technical regulation C 107-2005 with further amendments)

Table 1: Reference R and U-values (corrected by taking thermal bridges into account) required for residential buildings.

For these buildings, code requirements represent energy performance indicators for the design of building elements (transparent and opaque area) and the entire heated air volume.

In terms of minimum energy performance requirements, the code does not include a global indicator that gathers the consumption from individual elements such as heating, Domestic Hot Water (DHW), ventilation, or lighting, where applicable. However, the code does include a series of restrictions upon individual elements.

The code contains prescriptive/element-based criteria for insulation and the total thermal coefficient (G-value). The global heat transfer coefficient, G (W/m^3.K), of the heated volume, is an overall minimum requirement and varies as a function of the number of floors of a building and the surface-to-volume ratio (A/V).

Residential buildings

For residential buildings, the annual maximum heating demand (per total heated air volume) varies from 15 kWh/m^3.year to 37.5 kWh/m^3.year, depending on the climatic zone and the surface-to-volume ratio. The maximum heat demand does not take the efficiency of the TBS into account.

Technical regulations contain assessment criteria for each building element that forms part of the building envelope depending on the thermal characteristics of the construction products, and calculation rules of the global coefficient for thermal insulation (G-value) that allow energy performance evaluation.

The level of energy requirements for new buildings depends on building type (housing, office buildings, schools, etc.) and building envelope elements, and it refers to:

> the minimum thermal resistance corrected by taking thermal bridges into account (the R value);

> the maximum thermal transfer corrected by taking thermal bridges into account (the U value);

> the global coefficient for thermal insulation (the G value).

Non-residential buildings

For non-residential buildings, no explicit minimum thermal resistance values are given, but there is a reference to the value of the global coefficient G_{max} (total heat transfer coefficient) defined based on coefficients from 'a' to 'e', shown in Tables 2 and 3, and representing values of thermal resistance for external walls, roof, floor (slab and floor laying) above an unheated basement, outer building perimeter of the floor in contact with the soil and windows (W/m^2.K).

Proof of compliance with technical regulations of new buildings is carried out in two steps:

> at the time of building permit request;

> after the completion of the building construction works.

Existing buildings

For existing buildings, new technical regulations have been approved for their energy performance improvement, as follows:

> design code for façades with ventilated structures, NP 135-2013 (technical regulation published in the Official Gazette of Romania, No. 807 bis/19.12.2013);

> guidelines for the design and execution of thermal rehabilitation of housing, GP 123-2013 (technical regulation published in the Official Gazette of Romania, No. 538 bis/26.08.2013);

> framework solutions for the hydro-thermal rehabilitation of the existing building envelope, SC 007-2013 (technical regulation published in the Official Gazette of Romania, No. 540 bis/27.08.2013);

> guidelines for the design and execution of green roofs for new and existing buildings, GP 120-2013 (technical regulation published in the Official Gazette of Romania, No. 803 bis/19.12.2013).

These regulations only deal with thermal rehabilitation interventions on elements of building envelopes to reduce the building energy demand. They do not cover any potential energy savings due to improved efficiency in TBS, including lighting, Heating, Ventilation and Air-Conditioning systems (HVAC) and DHW, nor do they consider the real behaviour of the occupants.

Future updates of the code will include indicators and requirements for global energy performance.

In the case of major renovations, the thermal rehabilitation of the building envelope is first taken into consideration and then the improvement or replacement of the TBS is considered, where necessary. The efficiency of TBS is based on the minimum energy performance requirements set in the appropriate technical regulations listed in section 2.II.i.

I.ii. Format of national transposition and implementation of existing regulations

The technical regulation "Methodology for calculating the energy performance of buildings" (Mc 001 – 2006), published in the Official Gazette of Romania, No. 126 bis/21.02.2007, has been developed to transpose Directive 2010/31/EU and to determine the energy performance of buildings and building units based on their energy consumption (HVAC, DHW, lighting). Later, the methodology was amended based on the provisions of available European standards and results of research activity undertaken in Romania to introduce a calculation handbook on the energy performance of buildings and apartments and a model for issuing EPCs for apartments in 2009, as well as a procedure for the validation of the software used in the calculation of the energy performance for issuing EPCs for apartments in apartment buildings in 2010. In 2013, the technical regulation was amended to include a catalogue of thermal bridges for both new and existing buildings, and for both residential and non-residential buildings.

The calculation of the energy performance of buildings, in accordance with Annex I of the EPBD and the applicable CEN standards, takes the following parameters into account:

> the thermal and structural characteristics of building elements that form part of the building envelope (transparent/opaque area);

Non-residential buildings with full-time occupancy or part-time occupancy and high thermal inertia						
Building Type	**Climatic zone**	**a (W/m².K)**	**b (W/m².K)**	**c (W/m².K)**	**d (W/m².K)**	**e (W/m².K)**
Hospitals, kindergartens and clinics	I	0.59	0.25	0.48	0.71	1.45
	II	0.57	0.22	0.40	0.71	1.45
	III, IV	0.56	0.20	0.34	0.71	1.45
Educational and sports	I	0.59	0.25	0.48	0.71	2.00
	II	0.57	0.22	0.40	0.71	2.00
	III, IV	0.56	0.20	0.34	0.71	2.00
Offices, commercial and hotels	I	0.63	0.29	0.48	0.71	2.00
	II	0.59	0.25	0.40	0.71	2.00
	III, IV	0.56	0.22	0.34	0.71	2.00
Other types (normal conditions)	I	0.91	0.33	0.91	0.71	2.50
	II	0.91	0.33	0.83	0.71	2.50
	III, IV	0.91	0.33	0.77	0.71	2.50

(technical regulation C 107-2005 with further amendments)

Table 2: Maximum thermal transmittance for non-residential buildings with full-time occupancy or part-time occupancy and high thermal inertia.

Non-residential buildings with part-time occupancy but without high thermal inertia						
Building Type	**Climatic zone**	**a (W/m².K)**	**b (W/m².K)**	**c (W/m².K)**	**d (W/m².K)**	**e (W/m².K)**
Hospitals, kindergartens and clinics	I	0.67	0.25	0.50	0.71	1.45
	II	0.63	0.22	0.43	0.71	1.45
	III, IV	0.59	0.20	0.38	0.71	1.45
Educational and sports	I	0.67	0.25	0.50	0.71	2.00
	II	0.63	0.22	0.43	0.71	2.00
	III, IV	0.59	0.20	0.38	0.71	2.00
Offices, commercial and hotels	I	0.67	0.29	0.50	0.71	2.00
	II	0.63	0.25	0.43	0.71	2.00
	III, IV	0.59	0.22	0.38	0.71	2.00
Other types (normal conditions)	I	1.00	0.34	1.00	0.71	2.50
	II	1.00	0.34	0.91	0.71	2.50
	III, IV	1.00	0.34	0.83	0.71	2.50

(technical regulation C 107-2005 with further amendments)

Table 3: Maximum thermal transmittance for non-residential buildings with part-time occupancy but without high thermal inertia.

- the conventional indoor operative temperature (condition for thermal comfort);
- the climatic zone location of the building;
- the air exchange rate, which varies based on building type, exposure and airtightness of windows and doors;
- the solar exposure/sun shading;
- the internal heat gains.

The methodology will be updated in accordance with the umbrella standard under development and the existing energy performance standards under revision pursuant to Directive 2010/31/EU.

I.iii. Cost-optimal procedure for setting energy performance requirements

The cost-optimal methodology aims at identifying technical solutions/packages of improvement measures for developing energy efficient buildings which, according to the EPBD, may be classified as Nearly Zero-Energy Buildings (NZEBs —using conventional, fossil-energy sources).

The analysis was carried out using virtual reference buildings, representative of the building stock, for both residential and non-residential, located in two climatic zones representing the winter temperature zoning of Romania. Figure 1 shows the temperature design values for five climatic zones, where climatic zone II has t_{ext} = -12 ºC and climatic zone IV has t_{ext} = -15 ºC. The design values are to be used only for the energy performance evaluation and the appropriate sizing of the TBS.

Packages of measures for building elements, the TBS, as well as the use of Renewable Energy Sources (RES) were selected and used for the calculation of cost-optimal levels for each reference building. For existing buildings, each package always contained the following measures:

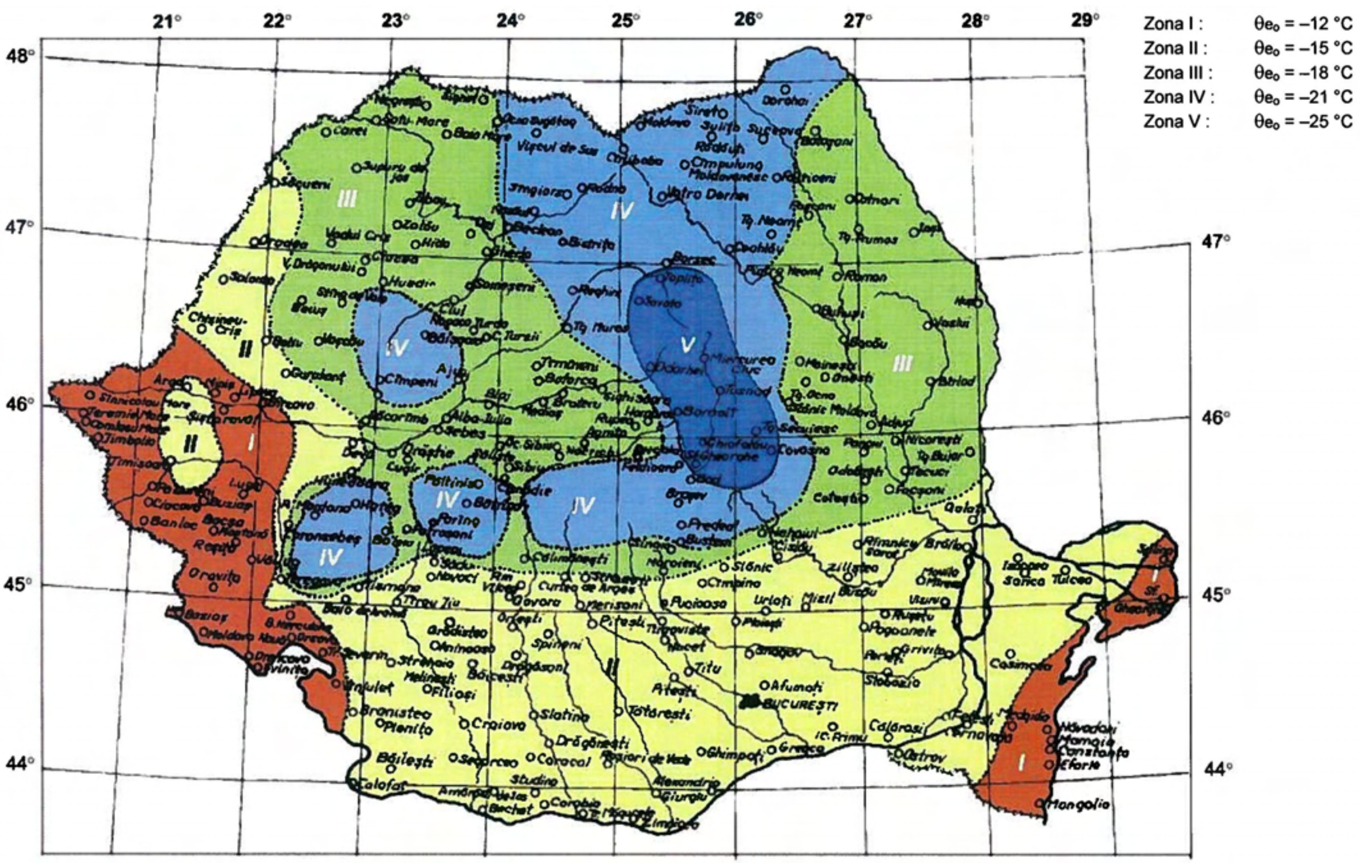
- the modernisation of the envelope elements (external walls, terrace, floor above the basement, where applicable);
- the replacement of windows.

The characteristics of the building envelope elements that were upgraded, or replaced when required, take the values presented in Table 1.

For each reference building, only the packages of measures that complied with the criterion of an economic recovery period of less than 10 years were considered as valid.

The national cost-optimal report is under review until the end of 2016 and no practical information is yet available.

Figure 1: Climatic zones in Romania.



(standard SR 1907-1:2014)

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

A NZEB is a building that has a very high energy performance, for which the resultant energy requirements are very low or nearly zero, and are mostly covered by energy from RES, produced on-site or nearby.

The maximum allowable level of primary energy from conventional sources (fossil fuels) and of CO_2 emissions from running processes in the building are presented in Table 4 for different types of buildings and climatic zones in Romania. To ensure the total energy use of a NZEB, the renewable (non-fossil) sources shall cover at least 10% of its total calculated primary energy needs. The RES shall be used according to their technical, economic and environmental feasibility and produced on the building site or nearby.

For the existing buildings that undergo major renovations, the maximum allowable level of primary energy from conventional sources shall be considered to the extent that the appropriate investments are technically and economically justified, so that the

Climatic zone	Horizon	Office buildings		Education related buildings		Health related buildings		Blocks of flats		Dwellings	
		Primary energy (kWh/m².year)	CO_2 emissions (kg/m².year)	Primary energy (kWh/m².year)	CO_2 emissions (kg/m².year)	Primary energy (kWh/m².year)	CO_2 emissions (kg/m².year)	Primary energy (kWh/m².year)	CO_2 emissions (kg/m².year)	Primary energy (kWh/m².year)	CO_2 emissions (kg/m².year)
I	Reference level (2010)	102	24	135	32	135	48	117	31	271	59
	31 December 2015	75	21	115	28	135	37	105	28	131	36
	31 December 2018	50	13	100	25	79	21	100	25	115	31
	31 December 2020	45	12	92	24	76	21	93	25	98	24
II	Reference level (2010)	113	25	153	39	214	57	132	36	317	70
	31 December 2015	93	27	135	37	155	43	112	30	147	42
	31 December 2018	57	15	120	25	97	27	105	28	121	34
	31 December 2020	57	15	115	30	97	26	100	27	111	30
III	Reference level (2010)	125	29	174	46	241	66	150	41	372	83
	31 December 2015	110	28	154	39	171	49	130	36	172	48
	31 December 2018	69	19	136	37	115	32	122	34	155	41
	31 December 2020	69	19	136	37	115	32	111	30	145	40
IV	Reference level (2010)	147	38	212	58	290	81	182	50	476	109
	31 December 2015	107	28	192	56	190	55	152	38	226	57
	31 December 2018	89	24	172	48	149	42	144	40	201	51
	31 December 2020	83	24	170	49	142	41	127	35	189	42
V	Reference level (2010)	157	43	230	64	314	87	198	55	528	122
	31 December 2015	127	29	210	58	214	58	178	48	248	78
	31 December 2018	98	28	192	56	174	49	152	38	229	57
	31 December 2020	89	24	185	53	167	48	135	37	217	54

Table 4: Maximum allowable level of primary energy and CO_2 emissions for Nearly Zero-Energy Buildings.

renovation work still provides more benefits than costs over the expected lifetime of the building operation.

The NZEB requirements will be introduced gradually, with a first update in 2015, an intermediate value in 2018 and the final values in 2020. This gradual approach is indicated in Table 4. Based on Law 372/2005 (recast 2013) provisions, all new buildings should be NZEB buildings starting 1 January 2019 for public buildings and 1 January 2021 for all others (the deadlines represent the date of starting the construction works).

Figures and statistics on existing NZEBs

As of 2015, there are no newly constructed or existing NZEBs in Romania and no relevant data is available on this topic.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

To increase the energy efficiency and the use of renewable energy in buildings, a national strategy[1] has been established for mobilising investment in renovating the national building stock, for both residential and commercial, as well as public and private buildings. The national strategy has been included in the National Energy Efficiency Action Plan (NEEAP), approved and published in 2015.

The national strategy encompasses the following main items:

> an overview of the national building stock based on statistical sampling;
> the identification of cost-effective approaches to renovations relevant to the building type and climatic zone;
> policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations;
> a forward-looking perspective to guide investment decisions of individuals, the construction industry and/or financial institutions;
> an evidence-based estimate of expected energy savings and wider benefits.

The strategy establishes a staged approach which leads to job creation, improvement of the living conditions in buildings and workspaces, reduction of dependency on external suppliers of energy sources, optimal use of natural resources and improved human resources in several sectors related to the construction of modern energy efficient buildings.

In order to achieve the general objective of reducing energy consumption in buildings, several specific policies are presented in Annex 1 of the national strategy.

To improve the energy performance of buildings owned and occupied by the central government, in which a leading example must be set, reduction measures for energy consumption are to be realised by renovating more than 3% of the total floor area of heated and/or cooled central government buildings in a given year. To achieve this, the MDRAP approved Order 3466/2013, making the inventory of buildings with a total useful floor area over 500 m^2 publicly available. A summary of the central government building inventories is presented in Table 5 and updated information is displayed on the MDRAP website[2].

Table 5: Summary of central government building inventory (implementation of EED Article 5).

Main credit authorising officer	**Number of buildings**	**Technical data**	
		Total useful floor area (m^2)	Built area on ground (m^2)
TOTAL GENERAL of which	**2,749**	**6,395,390.66**	**2,726,453.85**
I. Chamber of Deputies	1	188,172.00	58,132.00
II. Ministries	2,419	5,304,898.71	2,308,587.83
III. Other specialised bodies under the central government authority/ administration	179	437,810.42	201,699.67
IV. Independent administrative authorities	150	464,509.53	158,034.35

[1] *published on the MDRAP website www.mdrap.ro/constructii/metodologia-de-calcul-al-performantei-energetice-a-cladirilor*
[2] *www.mdrap.ro/constructii/metodologia-de-calcul-al-performantei-energetice-a-cladirilor*

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The design of the TBS is based on the energy performance requirements set in the following technical regulations:

> the code for the design, construction and operation of central heating installations, I 13 – 2002 under revision;

> the code for the design, construction and operation of sanitary installations in buildings, I 9, to be published in 2015;

> the code for the design, construction and operation of ventilation and air-conditioning installations, I 5 - 2010;

> the code for the design, construction and operation of lighting installations in buildings, I 7 - 2011.

The calculation of the heating and cooling energy needs is based on the provisions of the following national standards:

> SR 1907-1:2014 – Heating systems in buildings. Calculation of system energy needs. Design requirements;

> SR 1907-2:2014 – Heating systems in buildings. Calculation of system energy needs. Conventional design indoor temperatures;

> SR 6648-1:2014 - Ventilation and air-conditioning systems. Calculation of external heat gains and cooling thermal load (sensible) for air-conditioned buildings. Basic requirements;

> SR 6648-2:2014 - Ventilation and air-conditioning systems. Outdoor climatic parameters.

The energy consumption in buildings is assessed based on the methodology for calculating the energy performance of buildings and building units, MC 001-2006, with further amendments.

The technical regulation “Guidance on the use of renewable energy in new and existing buildings”, implementing the use of energy from RES in buildings or in their vicinity, shall be published and used both in the design of new buildings, as well as for major renovations of existing buildings.

II.ii. Regulation of system performance, distinct from product or whole building performance

The assessment of the energy performance of buildings takes both the level of building thermal protection and the energy efficiency of the building's systems (functioning of the TBS, efficiency of energy production sources, energy transport and distribution, type of fuel used, etc., including use of renewable energy for heating, ventilation/AC, DHW consumption and lighting) into consideration. There are requirements applicable at the building level (e.g., overall performance) and for individual elements (e.g., boiler efficiency).

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

For new, as well as for existing buildings or building units subject to major renovations, the design of the TBS is based on energy requirements set in the specific technical regulations in force at the time of project completion. The requirements refer to TBS dimensioning, correct installation, adjustment and control, and mainly cover the following:

> heating systems;

> DHW systems;

> AC systems;

> large ventilation systems;

> a combination of the above TBS.

For new buildings or existing buildings that undergo major renovations, the owners or managers of the buildings may require, by law, the installation of intelligent metering systems or, where appropriate, the installation of active energy-saving controls which employ automation, control and/or monitoring systems.

Interventions on TBS aim to reduce energy consumption to meet the energy demands for heating and DHW. Measures may affect production, transport, distribution and use. In some particular cases in which the installations are old and equipment has deteriorated considerably, the intervention may require total or partial system replacement, especially if it relates to district hot water supply, and as long as it is technically, functionally and economically feasible.

The selection of a particular equipment as part of a specific TBS is usually based on economic criteria.

II.iv. Applicability to new buildings

For new buildings, the energy requirements relating to the proper dimensioning and installation of TBS are set in applicable technical regulations and mainly cover the following:

> achieving and maintaining the comfortable indoor temperature by

proper dimensioning of the heating/cooling systems for meeting the energy needs that result from the energy balance;

> maintaining the rate of ventilation – natural or mechanical – for appropriate occupancy;
> dimensioning of the climate system, with or without humidity control, including heat recovery contained in exhaust air;
> providing specific needs of DHW, the number of consumers and the actual duration of the period of consumption.

Law 372/2005 (recast 2013) provides that, for new buildings and complexes of buildings, a specific analysis shall be undertaken on the feasibility study (with initial technical and economic documentation for new buildings being elaborated in the design process) which is required by Law 50/1991 for the authorisation of construction works (recast) with further amendments, published in the Official Gazette of Romania, No. 933/13.10.2004. The analysis has to consider the possible use of high-efficiency alternative systems, depending on their feasibility from a technical, economic and environmental point of view.

II.v. Provisions for installation, dimensioning, adjustment and control

Law 372/2005 (recast 2013) requires new buildings and existing buildings subject to major renovations to comply with the energy requirements set in the technical regulations in force at the time of design completion, covering proper TBS installation, dimensioning, technical adjustment and control systems for heating, DHW, AC, large ventilation systems and a combination of these.

Law 121/2014 on energy efficiency, published in the Official Gazette of Romania, No. 574/01.08.2014 and transposing Directive 2012/27/EU into national law, requires that final customers shall be provided with competitively priced individual meters that accurately reflect the final customer's real time actual energy consumption. This requirement only applies if it is technically possible, financially reasonable and proportionate in relation to the potential energy savings.

The individual meters shall provide information on actual time of use of electricity, natural gas, district heating, district cooling and DHW consumption.

II.vi. Encouragement of intelligent metering

Also, to the extent that is technically possible, financially reasonable and proportionate to the potential energy savings, Law 121/2014 provides energy distributors with the possibility of implementing intelligent metering and smart meters for natural gas-powered electricity and other TBS, if this is the case, for better meter reading management and monitoring of the energy consumption in order to at least provide:

> information on actual energy consumption;
> information, upon customer request, on the electricity exported to the grid from the final customer facility or premises;
> accurate billing information.

II.vii. Encouragement of active energy-saving control (automation, control and monitoring)

In order to obtain energy savings in buildings, Law 372/2005 (recast 2013) allows that, for new buildings and existing buildings subject to major renovations, the owners and/or managers of the buildings may have active control systems using automation, control and monitoring systems that aim to save energy installed.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

For the uniform application of legal provisions on the energy performance of buildings and inspections of heating/AC systems and in order to achieve and maintain both the essential requirement of "energy saving and thermal insulation" and six other essential requirements of Law 10/1995 on construction quality, with further amendments, the State Inspectorate for Construction (ISC) exercises state control following a specific control procedure.

The control procedure establishes the necessary steps to be taken in case of random checking and control based on specific themes and/or official complaints received by the ISC.

The flowchart of the control procedure on exercising the uniform application of legal provisions on the energy performance of buildings and the inspection of heating/AC systems and ordering measures, recommendations and sanctions, as provided by Law 372/2005 (recast 2013), is shown in Figure 2. All the EPCs are to be recorded in a database under development.

How flats are certified in apartment buildings

Issuing of an EPC for a flat in case of sale or rental does not require or imply issuing an EPC for the building as a whole.

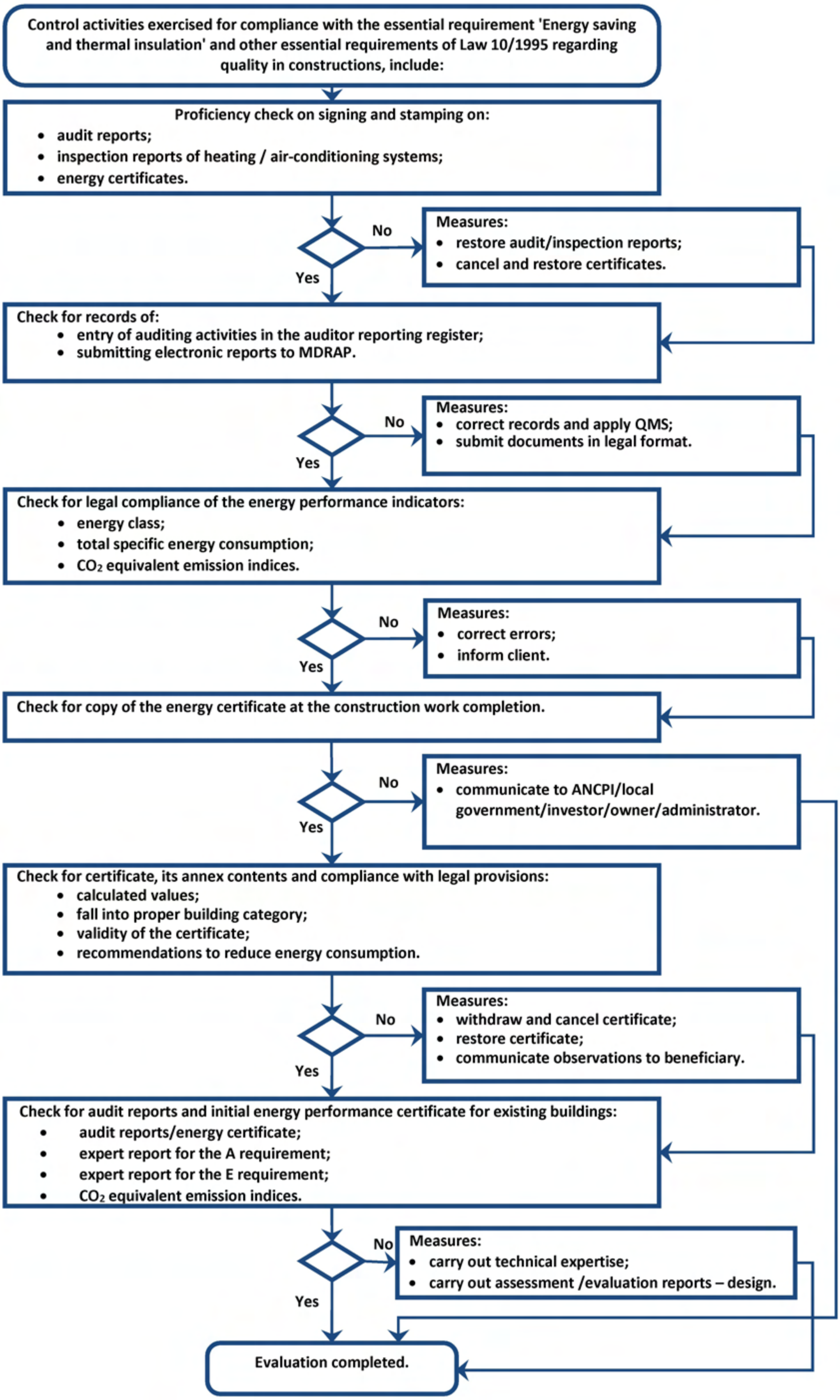


Figure 2: Flowchart of the control procedure for the uniform application of legal provisions on the energy performance of buildings and inspection of heating and AC systems.

QMS – Quality Management System.

ANCPI – Agentia Nationala de Cadastru si Publicitate Imobiliara.

In order to inform the potential buyer/tenant, the EPCs for individual apartments can include specific information regarding energy needs for heating, DHW, ventilation/AC and lighting. The certificate may also include the specific CO_2 emissions.

Issuing an EPC for a building as a whole is done at the time of starting the construction works for new buildings and thermally renovated buildings (in this latter case, an EPC is issued before the works begin and after completion of the major renovations).

Format and content of the EPC

The EPCs shown in Figures 3 and 4 have two pages. The first page includes the energy class for the apartment or building, the calculated energy needs

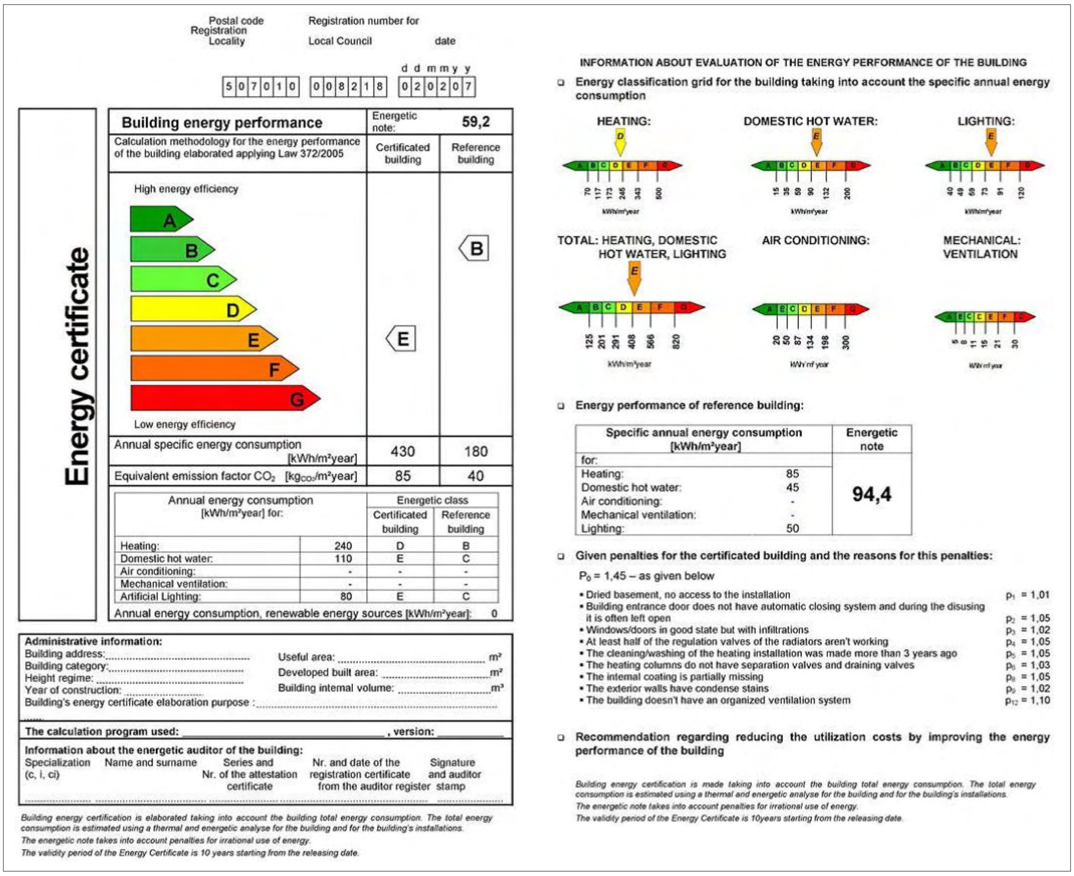


Figure 3: Energy Performance Certificates for buildings.

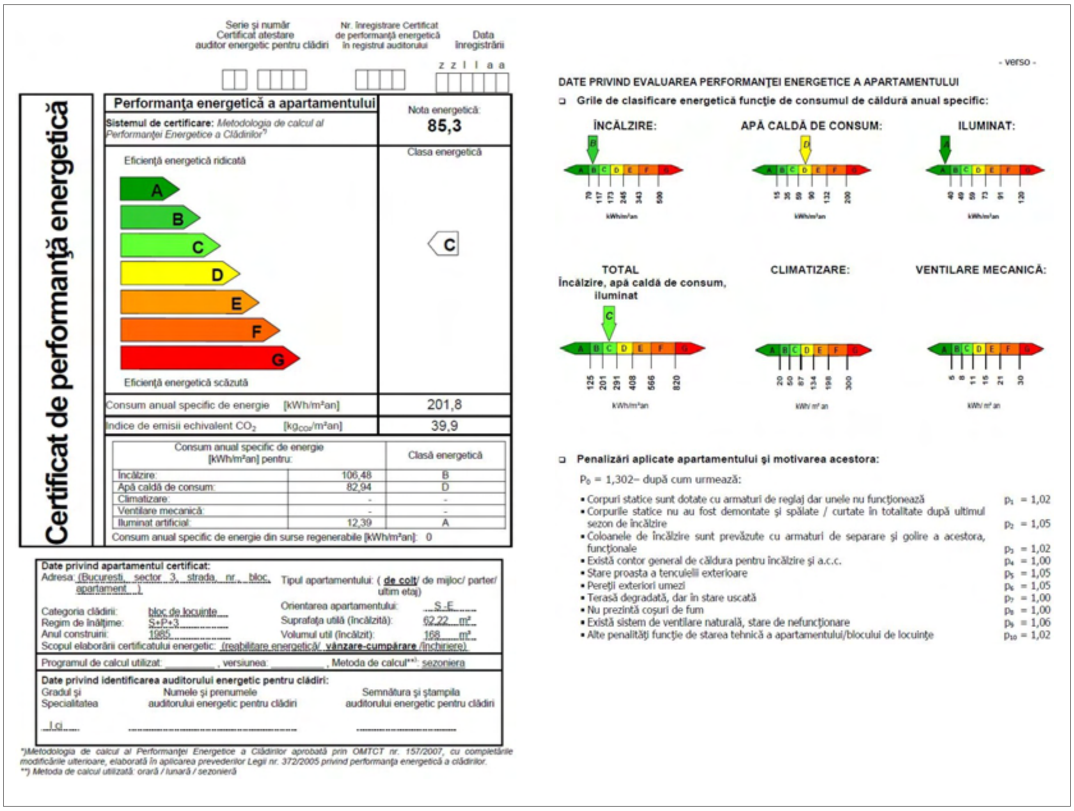


Figure 4: Energy Performance Certificates for apartments.

evaluated using a calculated numerical index, and the performance characteristics of the apartment or building, e.g., the total specific annual final energy consumption for heating, cooling, ventilation, DHW and lighting, total energy use and CO_2 equivalent emissions.

For buildings, the second page includes the energy scales, ranging from A to G, for each class of energy consumption, as well as energy performance information about the reference building (a new building with the same layout and occupancy that meets the energy performance requirements indicated in the technical regulations). The energy performance is presented in terms of final specific annual energy needs (kWh/m².year), including all specific energy consumption for heating, ventilation/AC, DHW and lighting during the building's normal operations.

The energy classes range from A (most efficient - 125 kWh/m².year for heating, DHW and lighting identified as ‘energy services’) to G (highest energy consumption - 820 kWh/m².year for total energy consumption). A building with no cooling/mechanical ventilation systems is considered to fall into the A energy class for this particular aspect. The vast majority of buildings fit into energy classes C and D.

Each building and the reference building are characterised by the calculated energy needs. The existing building is penalised accordingly (with 12 penalisation indices based on envelope and TBS type, age and condition in relation to rational/ appropriate minimum hygiene standards, as well as building and TBS maintenance).

EPC activity levels

By the end of 2014, the EPC database listed almost 249,800 certificates issued by energy auditors for buildings and apartment buildings, as shown in Figure 5.

The preliminary analysis over almost 69,200 EPCs produced an estimate of the energy performance of existing buildings, shown in Figures 6 and 7, based on final energy use and CO_2 emissions indicators.

Typical EPC costs

The typical EPC issuing costs vary between 50 € and 150 € for an apartment, to 500 - 1,000 € for a collective residential building, and more for other building types. Lately, the market for EPCs has grown considerably due to enforcing specific provisions of Law 372/2005 (recast 2013).

Figure 5:
Energy Performance Certificates for apartments and buildings issued in 21 counties by 2014 (EPC database).

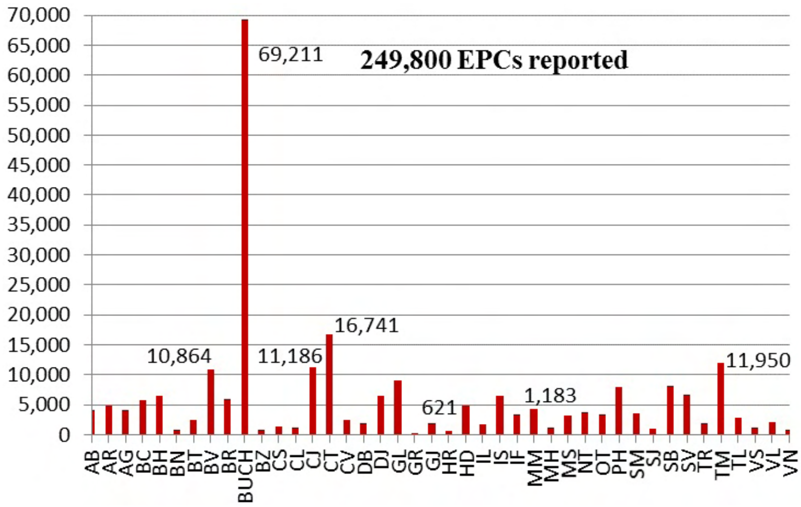


Figure 6:
Average final energy consumption for different building categories.

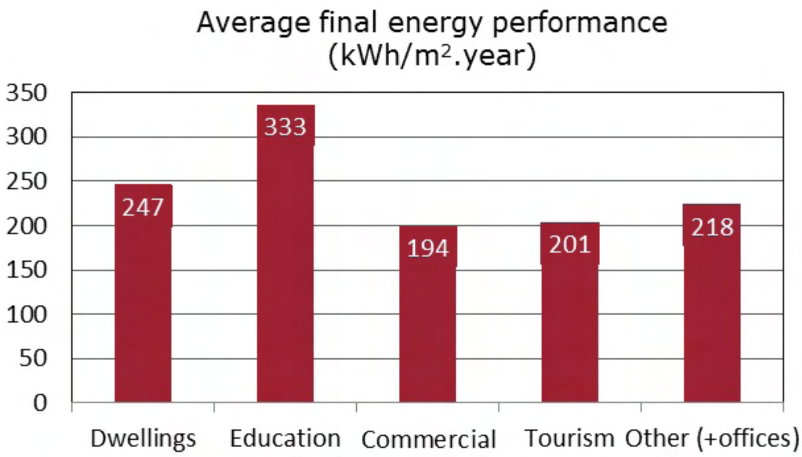
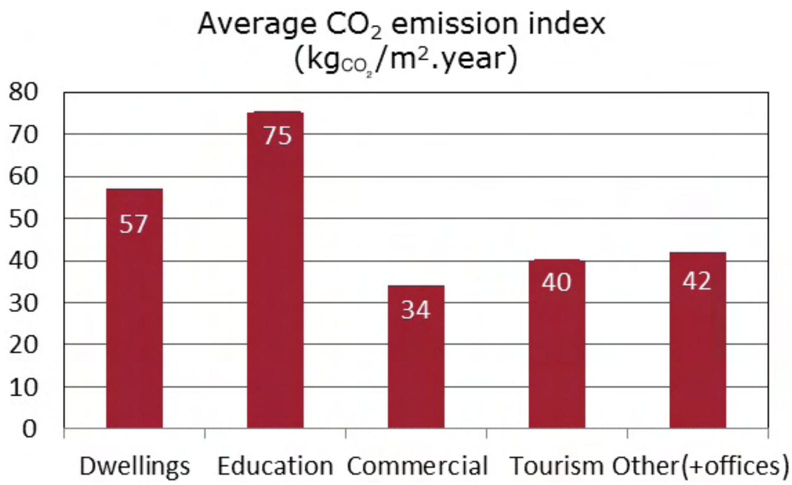


Figure 7:
Average CO_2 emissions indicator for different building categories.



Assessor corps

Only certified energy auditors are entitled to issue EPCs and carry out system inspections. In order to be certified, the candidates should be engineers (graduates in civil or power engineering); or architects, with at least three years of professional experience for the certification of apartments and apartment buildings, and at least five years of professional experience for the certification and energy audits of all types of buildings.

In addition, the candidates must attend an initial training (short-term courses of 80 hours, or master classes in 1 to 2-year programmes on energy efficiency, or the energy performance of buildings), and take part in a national examination of their knowledge of the energy requirements set in the technical regulations in force, as well as of the EPC issuance procedure for buildings. The examination takes place in two parts: an exam of specific knowledge, and an interview based on presenting a properly drafted energy audit which includes the certification of an existing building, an audit report with detailed solutions for building modernisation, and a financial evaluation of the proposed measures and their economic efficiency. Accredited training courses, approved by the MDRAP, are offered by technical universities in Bucharest, Timisoara, Iasi and Cluj-Napoca.

The MDRAP coordinates the certification of energy auditors for buildings and is responsible for all procedural aspects of energy certification. Energy auditors are certified for 5 years, which may be extended based on evidence of continuous training. The requirements imposed on the certification of energy auditors are a guarantee of their proper professional attitude and EPC issuance credibility.

Certified energy auditors may operate in a self-employed capacity, or be employed by public bodies or private enterprises.

As of mid-2015, there are 1,597 certified energy auditors for buildings that may issue EPCs and perform energy audits of buildings. The database of certified energy auditors is managed by the MDRAP and published on the ministry's website.

Enforcement with building owners and real estate actors

For buildings or building units that are sold or rented out, Law 372/2005 (recast 2013) sets the following requirements:

> The investor/owner/manager is obliged, as appropriate, to make a copy of the EPC available to the prospective buyer or new tenant before concluding the sale or lease, so that they can learn about the energy performance of the building or the building unit they want to buy or rent.

> The owner is obliged to hand over the EPC (official document) to the buyer at the time of signing the contract.

> The seller/landlord is required to submit a copy of the EPC to the tax authorities so that the original document remains in the possession of the owner on the date of registration of the contract of sale or lease.

> Contracts of sale concluded without observing the law are considered null and void and in non-compliance with the Civil Code.

Quality Assurance (QA) of EPCs

The ISC has conducted random checks on 1,034 new and existing buildings, finding 970 deficiencies (multiple deficiencies on the same EPC – the actual EPC number is not available) in which specific actions/measures were taken. In 7 such cases, the inspectorate imposed sanctions on energy auditors amounting to a total of approximately 540 €, in compliance with Law 372/2005 (recast 2013).

The control focused mainly on:

> the display of the EPC in buildings with the total useful floor area over 500 m^2 owned and occupied by public authorities and institutions providing public services;

> energy auditor certification requirements (specific higher education, area of expertise), signatures and stamps on the EPCs and energy audit reports for buildings based on the legal provisions in force;

> the completeness and accuracy of information presented in the EPCs and energy audit reports.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

The inventory of buildings with a total useful floor area over 500 m^2 conducted at the end of 2013 indicated that there are 2,749 buildings owned by central public administration authorities. A summary of the data in this respect is posted on the MDRAP website (listed on the first page of this report).

The format and content of the EPC for this type of building are the same as for other kinds of buildings (section 2.III.i.).

The EPC is valid for 10 years from the issuing date shown on the certificate, except for the case of a building or building unit that is subject to a major renovation that modifies its energy consumption and performance.

The cost of the EPC is similar to those of residential buildings (section 2.III.i.).

Law 372/2005 (recast 2013) and the national regulation of certification of energy auditors for buildings make no certification distinction for public buildings. Energy auditors must comply with the general requirements.

The control procedure for public buildings is also similar (section 2.III.i.). The control has focused on the display of the EPC in public buildings.

III.iii. Implementation of mandatory advertising requirement

In order to inform potential buyers or tenants, the investor/owner/manager of the building or the building unit shall specify the following energy performance indicators as stated in the EPC in sale or rental advertisements in commercial media:

> energy class;
> total specific annual energy consumption;
> CO_2 equivalent emissions.

The compliance of EPC visibility in advertising has not been monitored so far.

For buildings that are sold before construction work has been completed, the investor/owner/manager, as appropriate, shall make specific data/information available to the buyer so that they can learn about the energy performance of the building or the building unit they are interested in, as presented in the technical documentation of the building as enforced by law.

The setting up and implementation of programmes to increase the energy performance of buildings, including appropriate funding mechanisms, are presented on the MDRAP website.

III.iv. Information campaigns

To encourage owners and tenants to improve the energy performance of their building or building unit, information campaigns are organised in compliance with Law 372/2005 (recast 2013) and announce initiatives for:

> programmes to inform and educate the owners/managers of buildings, and other activities having information disseminated through the media on implementing different methods and practices to increase energy performance and for using high-efficiency alternative systems, and awareness programmes on available financial instruments, including the use of funds for promoting green technologies by developing green investment schemes;
> the promotion of policies and programmes to increase the number of NZEBs using energy from conventional sources by 2020;
> the promotion of programmes for installing and operating alternative energy supply systems in buildings.

Information regarding ongoing thermal rehabilitation programmes, including funding mechanisms, is presented on the MDRAP website.

III.v. Coverage of the national building stock

From data gathered by the National Institute for Statistics during the last census, the built area is equal to 493 million m^2, 86% of which corresponds to residential buildings, but does not indicate a corresponding total number of buildings. Out of 8.1 million housing units, 61% are single-family houses. Almost 47.5% of all households are located in rural areas, in which 95% of the housing units are single-family houses.

The existing buildings were erected mainly between 1950 and 1990 and have poor energy performance due to the lack of technical regulations before 1973 (when the energy crisis started) regarding the building envelope and its thermal protection design. Thus, they do not comply with current energy performance requirements. The final energy consumption of these buildings varies between 150 and 350 kWh/m^2.year.

It may also be noted that buildings constructed in the early years after 1990 have a low energy performance (150 - 250 kWh/m^2.year), while buildings constructed after 2000 have a better energy performance (120 - 230 kWh/m^2.year).

For non-residential buildings, the final energy consumption varies between 120 and 400 kWh/m^2.year according to each building category (offices, commercial, educational, cultural, hospitals, hotels, etc.).

The structure of the national building stock by the end of 2013, for both non-residential buildings and buildings which, based on the buildings' inventory, are owned and occupied by the central government and have a total useful floor area over 500 m², is presented in Figures 8 and 9.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

In order to reduce energy consumption and limit CO_2 emissions, inspections of heating and AC systems are carried out as follows:

> every 5 years - inspections of heating systems with boilers that use natural gas, non-renewable liquid or solid fuel, of an effective rated output for space heating purposes between 20 kW and 100 kW;

> every 2 years - inspections of heating systems with boilers of an effective rated output for space heating purposes greater than 100 kW; periodic inspections every 4 years are carried out as well for heating systems with gas boilers;

> inspections of heating systems with boilers of an effective rated output for space heating purposes of 20 kW and older than 15 years;

> every 5 years - inspections of AC systems of an effective rated output of more than 12 kW.

Inspections are carried out by technical experts certified for inspection in compliance with energy performance requirements for TBS set in technical regulations in force at the date of inspection.

IV.i. Progress and current status on heating systems

Law 372/2005 (recast 2013) establishes regular inspections of heating systems in buildings or building units to be carried out by certified technical experts, and based on the provisions in the technical regulation "Guidelines for energy performance inspection of boilers and heating systems in buildings", as described before.

Technical experts are professionals specialised in heating systems, certified by the MDRAP in compliance with Law 10/1995 on construction quality, with further amendments, and the technical regulation "Guide for technical and professional certification of professional working in construction" approved by Ministerial Order 777/2003, with further amendments.

The certified expert is entitled to carry out inspections in terms of energy

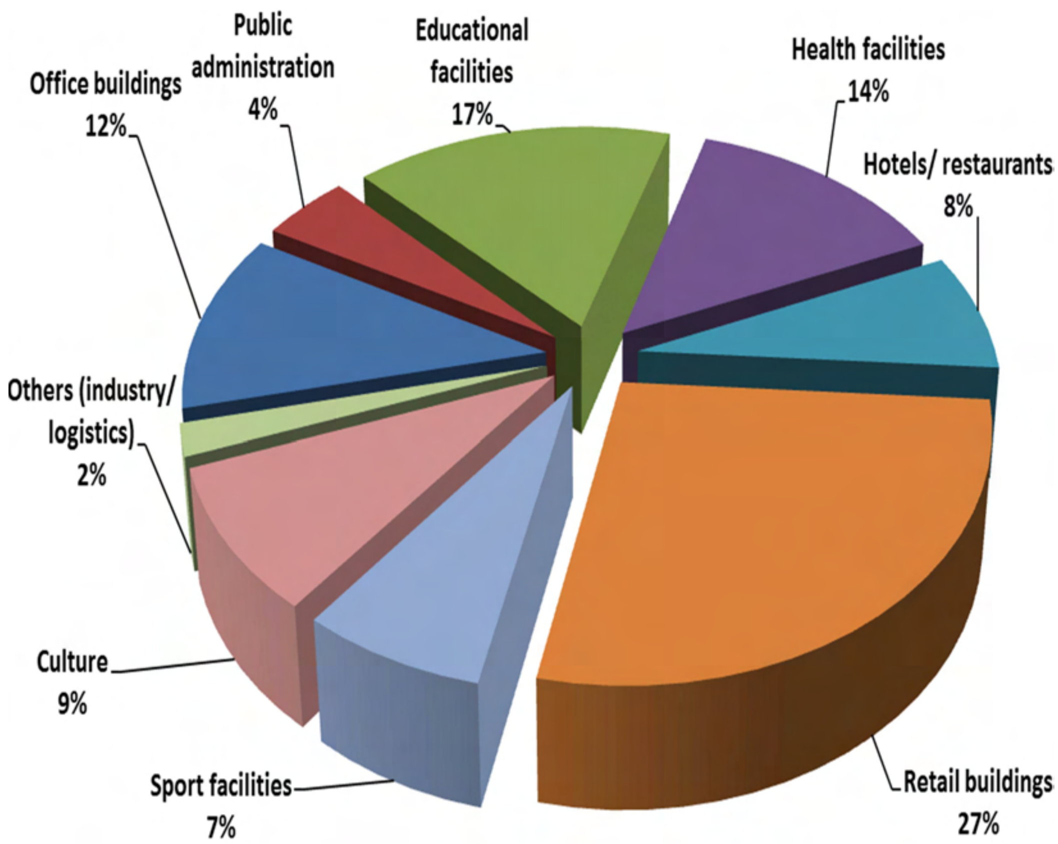


Figure 8: Non-residential building stock. (Source: National Institute of Statistics, INCD URBAN-INCERC)

No.	Category/Subcategory	Number of buildings	Total floor area (built-up area) (m²)	Total useful conditioned floor area (heated and/or cooled area) (m²)
1	Residential	174	510,616	470,819
1.1	Social housing			
1.2	Service housing	49	88,705	77,099
1.3	Student housing	125	421,911	393,720
2	Offices/Public administration	1,770	4,163,792	3,670,931
2.1	Central Authorities	1,770	4,163,792	3,670,931
2.2	Regional Local authorities			
3	Educational buildings	213	566,650	488,539
3.1	Kindergardens			
3.2	Schools	64	85,841	83,973
3.3	Universities/High schools	149	480,809	404,566
4	Health-care facilities	125	684,707	585,994
4.1	Hospitals	98	538,161	466,751
4.2	Other institutional care	27	146,545	119,243
5	Hotels and restaurants	73	210,176	172,730
5.1	Hotels	22	65,567	55,599
5.2	Other short-stay accomodation buildings	51	144,609	117,131
6	Sport facilities	162	362,148	324,572
7	Wholesale and retail trade service buildings	39	334,329	292,260
8	Other types of energy consuming buildings	328	515,564	482,287
	Without detailed data	63	337,415	269,932
	TOTAL	**3,020**	**7,685,396**	**6,758,064**

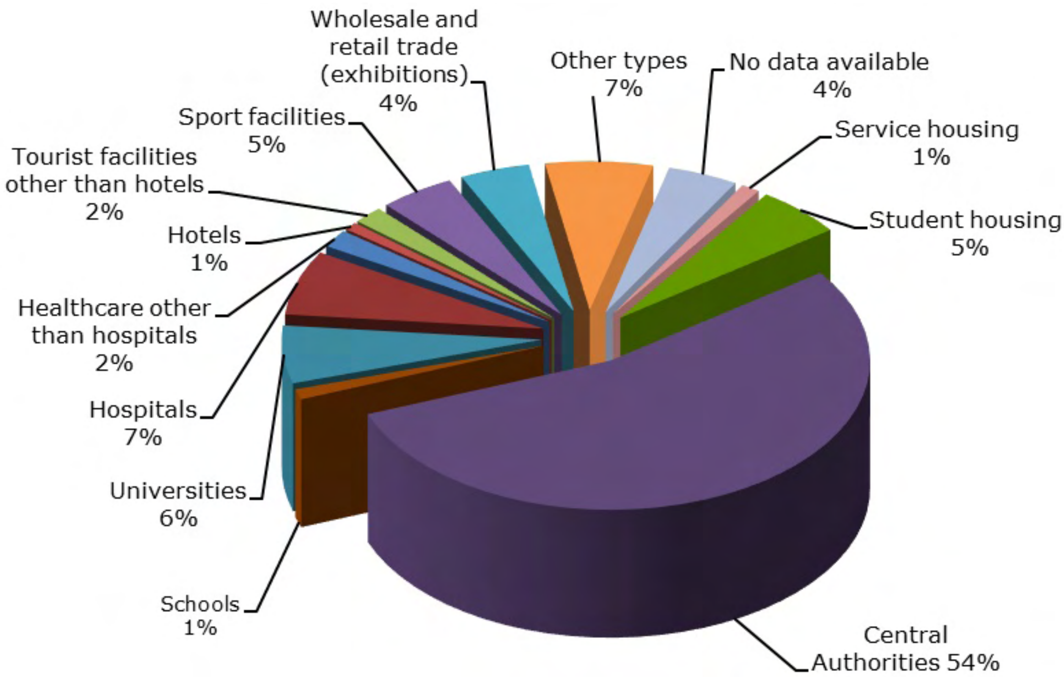


Figure 9: Stock of buildings with total useful floor area over 500 m² owned/occupied by the central government. (Source: RePublic_ZEB project)

performance of the heating and/or AC systems and to issue reports on inspections. The technical expert operates in either a self-employed capacity, or is employed by public bodies or private enterprises, in accordance with legal provisions.

After each heating system inspection, an inspection report is issued containing results of the inspection and recommendations for cost-effective improvement of the energy performance and reduction of CO_2 emissions. Law 372/2005 (recast 2013) establishes the following duties for technical experts:

> the obligation to register identification data of documents issued, e.g., inspection reports for heating systems, in their own register of evidence of activity;

> the obligation to electronically send inspection reports on heating systems to the MDRAP, no later than 30 days after their issuance, in order to input appropriate information into a specific database which is under development at the end of 2015.

Failure to fulfil their obligations leads to sanctions imposed on technical experts by the ISC.

There is currently no information available on the reports and costs for the inspection of heating systems.

The ISC administers state control of heating systems and quality control of their inspection reports following a specific control procedure approved by the MDRAP Order 3152/2013. The control is exercised based on bilateral collaboration protocols signed between the ISC and national institutes for research and development in construction, main trade and construction product industry associations, civil engineering and building service designer associations and the order of architects.

The ISC carries out the control along with designated professionals from the above organisations, certified as energy auditors for buildings, and/or technical experts for heating and AC systems.

Annual reporting on the control of reports concerning the inspection of heating systems and measures imposed is presented by the ISC to the MDRAP, or whenever requested. There is no information available yet.

Regular maintenance and inspection of heating systems by qualified personnel contributes to maintaining their correct adjustment in accordance with the technical specifications of the equipment, which ensures environmental protection, safety in exploitation systems and energy saving.

IV.ii. Progress and current status on AC systems

Law 372/2005 (recast 2013) establishes 5-year inspections of AC systems in buildings to be carried out by certified technical experts and based on the provisions of the technical regulation “Guidelines for energy performance inspection of AC systems of an effective rated output of more than 12 kW”.

During the inspection, the effective rated output is assessed, as well as the design performance of the AC system based on building ventilation needs. Consumers shall be informed of necessary system improvements or replacements and other possible solutions to be considered.

Inspection of AC systems is carried out by technical experts certified by the MDRAP following the same rules described for the inspection of heating systems.

There is no information available yet on the reports and costs for the inspection of AC systems.

During the inspection of the buildings’ AC systems, proper functioning is assessed along with the influence on energy consumption (energy balance of ventilated buildings, large share of energy demand for cooling due to solar contribution, and inside heat sources emission), and proper dimensioning is also checked in relation to the cooling/heating needs of the ventilated area in the building.

The AC systems inspection focuses on the following:

> the assessment of the building/area energy demand compared to the installed AC system;

> the identification of any problems related to the building envelope which, once tackled, could lead to a reduction in energy demand (direct radiation requiring interior or exterior shading, window replacement, etc.);

> the examination of building operations (occupancy, general/local lighting, distribution of heat release sources, etc.);

> the identification of smoking areas for proper functioning and inspection of the ventilation/AC systems.

Following the inspection of the AC systems, the use of alternative energy sources may be recommended in the inspection report.

3. A success story in EPBD implementation

In order to improve the energy performance of residential buildings, national programmes were promoted using various funding mechanisms in compliance with:

> Government Emergency Ordinance 18/2009, for increasing the energy efficiency in residential buildings, approved by Law 158/2011, with further amendments;

> Government Emergency Ordinance 69/2010 regarding the thermal

rehabilitation of residential buildings, with bank funding based on a governmental pledge, approved by Law 76/2011;

> European funding mechanism provided by the Structural and Cohesion Funds for programmes implementing the thermal rehabilitation of apartment buildings.

For the efficient use of public funding in implementing various thermal rehabilitation measures to increase the energy performance of buildings, the standard for costs of housing thermal rehabilitation was developed and approved by Government Decision 363/2010, with further amendments.

The national and local programmes established by Government Emergency Ordinance 18/2009, amended by Ordinance 63/2012, establish the following financing mechanisms for rehabilitation works on building envelopes to increase the energy performance of residential buildings and achieve the annual target on specific energy for heating consumption of 100 kWh/m^2:

a) the national funding programme, providing:

> 50% of funds from state budget allocations approved annually for this purpose in the MDRAP budget;

> 30% of funds approved annually for this purpose in local budgets and/or other legal sources;

> 20% of funds from the owner association's building repair fund and/or other legal sources - representing owner contribution;

b) Structural and Cohesion Funds from the European Union, in compliance with EU regulations and procedures:

> 60% of funds from European funds and state budget allocations approved annually for this purpose in the MDRAP budget;

> 40% of funds approved annually for this purpose in local budgets and/or other legal sources, as well as from the owner association's building repair fund and/or other legal sources;

c) local programme funding.

It should be noted that, through this programme, owner contributions may only be covered by the local budget for the following people:

> disabled individuals, or families with disabled members who need care;

> single people and families whose average net monthly income (per single person/family member) is below the national average, as determined by local public administration authorities and concerning the three months prior to the enquiry;

> veterans and their surviving spouses;

> pensioners, irrespective of their social status, whose average net monthly income (per single person/family member) is below the national average.

By 31 December 2014, thermal rehabilitation works have been carried out under:

> the national programme for 1,518 housing units, accounting for 58,255 apartments, and under the local programmes for almost 210 housing units, accounting for 9,626 apartments. The energy saving output following the implementation of thermal rehabilitation measures for residential buildings under these programmes was about 35% - 40% of the final energy consumption (approximately 82 Mtoe) before the rehabilitation work was carried out;

> the operational programme financed by the Structural and Cohesion Funds of the EU, in accordance with the regulations and procedures for accessing these funds and the conditions established in this respect, based on about 108 ongoing contracts aimed at achieving a better energy performance for 680 housing units representing 31,427 apartments.

In all the above programmes, EPCs have been required and issued for all buildings as part of the technical and financial documentation.

4. Conclusions, future plans

To increase the energy efficiency in buildings, the National Energy Efficiency Action Plan (NEEAP) 2014-2017 was developed to achieve Romania's assumed target of 19% energy consumption reduction in the building sector (both residential and non-residential buildings) by 2020, in compliance with the requirements of Directive 2012/27/EU. The national plan established thermal rehabilitation targets regarding:

> government buildings;

> public buildings (e.g., town halls, schools, hospitals, etc.);

> apartment buildings;

> single-family housing.

In order to increase the energy efficiency in buildings owned or occupied by public authorities, the Regional Operational

Programme 2014-2020, “Priority Axis 3: Supporting the transition to a low carbon economy”, and “Priority Investment 3.1. - Energy efficiency in public buildings, residential buildings and public lighting”, provides potential investment funding for these categories of buildings.

The main activities supported under this investment programme are related to measures to be taken to increase energy efficiency in public buildings and to carry out annual renovations of buildings owned or occupied by the central government, and they refer to:

> the thermal insulation improvement of the building envelope;
> the rehabilitation and modernisation of Technical Building Systems (TBS) for heat and Domestic Hot Water (DHW) preparation and transport, ventilation and Air-Conditioning (AC), including passive cooling systems, as well as related equipment acquisition and installation, followed by its connection to the central heating systems, as appropriate;
> the use of renewable energy to cover needs for heating and DHW preparation;
> implementing energy management systems aimed at improving energy efficiency and monitoring energy consumption;
> the replacement of fluorescent and incandescent lighting luminaries with high energy efficiency and long life ones;
> other activities that lead to fulfilling the objectives of energy efficiency.

To implement measures for improving energy efficiency and for using Renewable Energy Sources (RES) in buildings owned by or under the management of public administration, as well as for setting an example in reducing energy consumption, a mechanism for developing and co-financing energy efficiency projects with the participation of Energy Service Companies (ESCOs) is taken into consideration.

In order to increase the quality of energy efficiency work, as well as the installation and operation of RES in buildings, the following have been established:

> the qualification roadmap for the workforce in construction, provided by the BUILD UP Skills project - Romania, in April 2013[3];
> the qualification scheme for installers of insulation systems for opaque building areas and thermally isolated windows for buildings[4].

To raise awareness and increase the number of public Nearly Zero-Energy Buildings (NZEBs) with energy consumption from conventional sources, the project “Renovation of public buildings to almost ZERO ENERGY LEVEL[5]” was developed.

[3] *available at www.iee-robust.ro/downloads/BUILD-UP-Skills_Roadmap_final_RO.pdf*
[4] *information available at www.iee-robust.ro/qualishell*
[5] *findings available at http://oer.ro/wp-content/uploads/1.Conf_OER_Horia-Petran_RePublic_ZEB.pptx*

Implementation of the EPBD in the Slovak Republic

STATUS IN DECEMBER **2014**

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1. Introduction

The implementation of the Directive 2002/91/EC (EPBD) in the Slovak Republic started under Act 555/2005 on the Energy Performance of Buildings (EPB) which came into force on 1 January 2006. The implementing Decree 625/2006 of the then Ministry of Construction and Regional Development of the Slovak Republic (MVRR) entered fully into force on 1 January 2007 and with it, in order to obtain a building permit, designers had to present proof that the energy rating of the designed building met the legally required minimum performance. Minimum performance requirements were defined and established as mandatory as of 1 January 2007. Energy Performance Certificates (EPCs) have been issued since January 2008. A new Decree of the MVRR came into force on 1 October 2009, introducing specific changes to the calculation process following European standards instead of prEN standards, while specifying energy factors and changing the template of the EPC. As of 1 November 2010, construction and regional development issues fall under the authority of the Ministry of Transport, Construction and Regional Development (MDVRR), along with the responsibility for the energy performance of buildings, whereas the Ministry of Economy is responsible for the regular inspection of boilers and of Air-Conditioning (AC) systems in buildings.

The implementation of the Directive 2010/31/EU started on 18 September 2012, by the Act 300/2012 on the Energy Performance of Buildings (EPB Act) which both amended and supplemented Act 555/2005. A new Decree 364/2012 of the MDVRR entered fully into force in January 2013, together with the 2012 Act. This brought a change to the definition of major renovations, introduced the definition of Nearly Zero-Energy Buildings (NZEBs), as well as responsibilities connected to the preparation of the NZEB national action plan and a global indicator for primary energy use instead of total energy use in buildings. It also altered the EPC template.

2. Current status of implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Since the Act 555/2005 (EPB), which came into force in January 2006, the basic principles regarding the assessment of the energy performance of buildings have remained unchanged. As of January 2007, at the building permit stage, the designer must demonstrate compliance with the minimum requirements regarding the design energy rating. Since January 2008,

NATIONAL WEBSITES

www.mindop.sk, www.inforeg.sk, www.tsus.sk, www.mhv.sk, www.siea.sk, www.sksi.sk

the issuance of Energy Performance Certificates (EPCs) is mandatory (vis-à-vis standardised energy rating) for new buildings, existing buildings being sold or rented, as well as for buildings undergoing major renovation.

The implementation of the Directive 2010/31/EU has led to changes in the definition of major renovation. Currently, the definition applies to alterations with regard to the quality of thermal protection in more than 25% of the building envelope. Major renovation can take place either for a complete building, or only for a part of the building. In case of a partial renovation, individual construction elements must achieve the established thermal protection requirements. The former 'global indicator', which was the total energy use in the building (the sum of the energy use for various technical systems – total delivered energy) has now been replaced by the primary energy. For residential buildings (apartments and family houses), only the energy use for heating and for Domestic Hot Water (DHW) preparation are taken into account. For non-residential buildings, also the energy use for ventilation and cooling (when more than 80% of the total floor area is conditioned), as well as lighting, are taken into consideration. In addition, the EPB sets a requirement for parts of a building or flat, and reduces the total floor area of public buildings covered by the energy certification to 250 m^2.

Further developments include changes to the EPC template. In particular, it is now required to provide information on the use of Renewable Energy Sources (RES), as well as suggestions on measures which shall have a payback time (return on investment) of less than 75% of the life cycle of the building or system.

A tightening of minimum energy performance requirements is set for 2016 and will be followed by NZEB requirements for new buildings, starting in 2021.

I.ii. Format of national transposition and implementation of existing regulations

Procedures and measures to improve the energy performance of buildings are stipulated by the EPB Act in force since January 2013, while the energy performance requirements are laid down by the Ministerial Decree 364/2012 of the MDVRR. Calculation of the energy use for heating, cooling, etc. (using the monthly calculation method), as well as the calculation of the thermal properties of building structures and that of heat losses, are carried out in accordance with CEN standards fully integrated into the Slovak technical standards system (STN), and amended by the respective national annexes (e.g., STN EN ISO 13790/NA, STN EN 15603/NA). Moreover, the EPB defines the conditions for control and penalties, which, however, have not been fully applied yet.

Specific energy requirements, based on primary energy, are provided for all building categories listed in the EPBD. There are also specific indicators which have been set separately for different technical systems (heating, DHW, ventilation and cooling, and lighting). The current minimum requirement is equivalent to the upper border of the numeric interval of the energy class B for primary energy, whereas in January 2016 this requirement will change to the upper border of the numeric interval of energy class A1. From January 2021 onwards (for public buildings as of 1 January 2018), the minimum requirement will be equivalent to the upper border of the numeric interval of the energy class A0 for new NZEBs (presented in Table 1). The upper border of class A0 is determined as 0.25 R_r (reference value determined as upper border of the numeric interval of energy class B).

The primary energy is calculated based on the total delivered energy using primary factors (Table 2). RES are also taken into consideration for the calculations. The

Table 1: Scale of energy classes for the global indicator – primary energy in kWh/m^2.year.

	Categories	Energy Performance of Buildings Classes							
		A0	A1	B	C	D	E	F	G
Global indicator - primary energy	Single-family houses	≤ 54	55-108	109-216	217-324	325-432	433-540	541-648	> 648
	Apartment blocks	≤ 32	33-63	64-126	127-189	190-252	253-315	316-378	> 378
	Office buildings	≤ 60	61-120	121-240	241-360	361-480	481-600	601-720	> 720
	Education buildings	≤ 34	35-68	69-136	137-204	205-272	273-340	341-408	> 408
	Hospitals	≤ 96	97-192	193-384	385-576	577-769	770-961	962-1,153	> 1,153
	Hotels and Restaurants	≤ 82	83-164	165-328	329-492	493-656	657-820	821-984	> 984
	Sport facilities	≤ 38	39-76	77-152	153-258	259-304	305-380	381-456	> 456
	Wholesale and Retail trade services buildings	≤ 85	86-170	171-340	341-510	511-680	681-850	851-1,020	> 1,020

requirements for new buildings apply also to major renovations, unless this is not feasible due to technical, functional or economic reasons. Internal air conditions are set out by the national standard STN 73 0540-3: 2012 (standardised parameters for winter θ_{ai} = 20 °C and relative humidity φ_i = 50%; for summer $\theta_{ai,\,max}$ = 26 °C), which also determines the climatic conditions for the EPB calculation, including degree-days as set in detail for all the locations of the Slovak Republic by STN EN ISO 13790/NA. The impact of thermal bridges is calculated using standardised values (ΔU = 1.0 one step before renovation and ΔU = 0.5 for insulated and new masonry structures), or using default data available for different types of structures in the Atlas of thermal bridges[1]. Furthermore, infiltration is calculated by taking into account the window airtightness at a minimum rate of 0.5 air-changes per hour, while the influence of solar and internal gains is also taken into account.

The requirements for U-values in buildings will be tightened under the same schedule as the EPB (see Figure 1). Tighter U-value requirements are set for all new buildings, but they also apply to renovated buildings, unless this is not feasible due to functional, technical or economical reasons.

I.iii. Cost-optimal procedure for setting energy performance requirements

The cost-optimal calculation procedure was created in accordance to the Commission delegated Regulation (EU) 244/2012. Based on statistical data, 11 reference buildings were proposed (2 existing and 1 new building for family houses, apartment and office buildings, one school and one sport facility building). To this end, 5 sets of measures with varying levels of requirements were identified, while 12 different levels of measures were taken into account in order to determine the cost-optimal requirements of the building envelope individual structure's U-values. A package for calculating cost-optimal primary energy requirements was made from a combination of technical systems, including RES and different levels of thermal protection. The package included 7 - 10 (depending on the type of reference building) heating systems, 5 cooling types and 3 lighting levels as reference for non-residential buildings. In total, the analysis included 584 packages of measures and

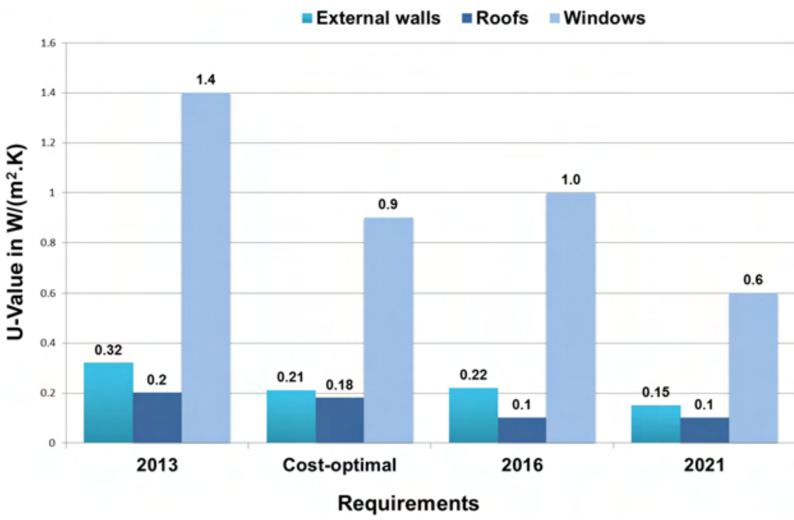
[1] *Sternova et al, Jaga Ltd., 2006*

Table 2:
Examples of primary energy factors and CO_2 emission coefficients.

Energy carrier	Primary energy factors	CO_2 emission coefficient kg/kWh
Gas	1.36	0.277
Coke	1.53	0.467
Anthracite	1.19	0.394
Lignite	1.40	0.433
Solid biomass (Logs)	0.10	0.020
Wood Chips	0.15	0.020
Pellets	0.20	0.020
Electricity (mix)*	2.764	0.293
CHP (waste heat from nuclear power plants)	1.00	0.016

* electric mix assessed according to the energy mix., i.e., 66% nuclear power, 13% hydroelectric power, 21% fossil fuel power plants.

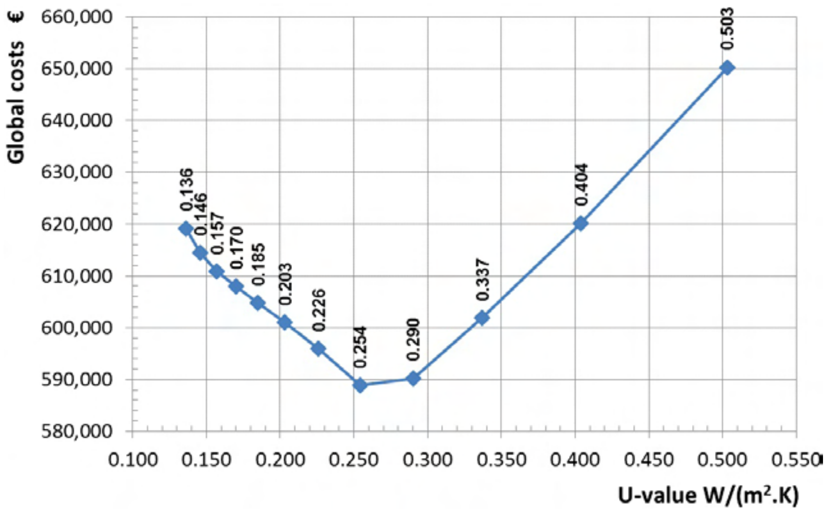
Figure 1:
Required standardised and cost-optimal U-values for building structures.



the calculation period was 30 years for residential and 20 years for non-residential buildings. For the calculation of the global costs (without VAT) and primary energy, different generators and energy carriers (e.g., district heating – gas, condensing boilers, biomass boilers, heat pumps, solar thermal collectors) for heat and DHW supply were taken into account (Figure 2). The discount rate was set at 2% and discount rates of 3% and 5% per year were used for the sensitivity analysis. The energy costs reflected costs separately for heat, gas and electricity with an annual increase of 2%. Maintenance costs were considered to be 2% of the investment costs for building structures, and 4% for technical systems per year.

The results from the cost-optimal calculation were set and compared with both current values and those expected to enter into force from January 2016 (Table 3).

Figure 2:
Calculation of cost-optimal level of primary energy – existing apartment buildings.



I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The definition of Nearly Zero-Energy Buildings (NZEBs) has been transposed into law and the requirements on thermal protection of components and primary energy have been set out in the Ministerial Decree of the MDVRR 364/2012.The definition of NZEBs is a mere reiteration of the equivalent definition in the Directive 2010/31/EU. In practice, the primary energy should be less than the upper border of energy class A0. Related requirements on U-values set for building components and heat use for space heating, cooling, DHW and lighting (depending on the building category) will help designers achieve the A energy class.

The law stipulates that, as of 31 December 2018 all public buildings, and as of 31 December 2020 all new buildings should be constructed as NZEBs.

The approved national plan starts from the then current state of play (current requirements in 2014) and defines the future energy level requirements needed to reach NZEB level. It describes the prerequisites, conditions and methods for increasing the number of NZEBs. The first step towards tightening the requirements on construction is planned for January 2016. In new buildings, 12% of the energy consumption in the housing stock and 8% in the public sector should be covered by RES. The plan includes an analysis on the effective use of RES and the establishment of support programmes to increase the energy performance of buildings together with motivational tools to improve the quality of construction required for NZEBs. The payback time of proposed measures should be less than 15 years.

Finally, there is no record of NZEBs designed or constructed in Slovakia by the end of 2014.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The first draft of the Strategy on the rehabilitation of the residential and non-residential building stock in the Slovak Republic towards improved energy efficiency, prepared under Art. 4 of the Energy Efficiency Directive (EED), was approved by the Government Resolution 347/2014 (in July 2014). Renovation of buildings shall continue for a total of 29,000

Table 3:
Comparison between 2014 and cost-optimal requirements on U-values for new and existing buildings.

Building structure	Final value for reference buildings U_{opt} W/m^2.K	Current requirement valid from 1.1.2013 (standardised value) W/m^2.K	Requirements valid from 1.1.2016 (recommended value) W/m^2.K	Cost optimal values (recommendation) W/m^2.K
External walls	0.209	0.32	0.22	0.21
Deviation from current requirements		-53 %	-5 %	
Roof	0.177	0.20	0.10	0.18
Deviation from current requirements		-13 %	44 %	
Internal division structures - heat flow downwards – separating indoor spaces with a temperature difference of 20 °K or more	0.310	0.75	0.50	0.31
Deviation from current requirements		-142 %	-61 %	
Windows	0.836	1.40	1.00	0.90
Deviation from current requirements		-67 %	-20 %	

Note: The required solar radiation transmittance (g) is 0.62.

flats in apartment buildings and 22,000 family houses annually, targeting thus the building stock massively constructed in the period 1948 - 1992. Renovated buildings have to meet minimum energy performance requirements in force at the time of the renovation, i.e., at least class B since 2014 and at least Class A1 from 2016 onwards. Renovated buildings must meet new building requirements if functionally, technically and economically feasible.

Following this trend, by the end of 2020 the number of renovated apartments should be increased by 203,000, reaching thus a total of 672,319 renovated units. This would represent 72% of all existing apartments in 2014. If this rate of renewal continues, all flats in apartment houses in Slovakia would be renovated by 2029 and all family houses by 2043. The implementation of the planned housing renovation strategy will require approximately 110 M€ per year from public funds until 2030, in addition to loans from European funds and banks, as well as the financial resources of flat owners themselves.

The calculation method for the target buildings according to the EED (Art.5) is based on a list of buildings owned by central government authorities that do not meet the minimum requirements for energy performance of buildings, with a total floor area over 500 m^2. This represents a total public building area of 445,791 m^2 and an annual target for renovation of 13,374 m^2 (3% of the total) (Table 4). Information about energy consumption for space heating is available from the database and the yearly monitoring results. The Slovak Republic will use the alternative approach and the projected energy savings target is 52.17 GWh per year. The Government is prioritising the energy rehabilitation of buildings with the highest energy consumption and with poor physical conditions.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

There are no regulations defining the minimum efficiency of any Technical Building System (TBS) as a whole, but only specific requirements in regulations related to individual elements (e.g., boilers, pipework insulation, etc.). TBS requirements are mainly based on European (EN) or national (STN) standards.

Furthermore, there are minimum requirements set for heating, cooling and ventilation, as well as for DHW. In addition, the building designer must assess the possibility of technical, environmental and economic utilisation of high-efficiency alternative energy systems (active solar systems and other heating systems, electrical systems based on RES, combined generation of electricity and heat, as well as district or block heating and cooling) before the construction begins.

The energy requirements are not prioritised over health and safety, or over other technical requirements (e.g., pressure vessels, fire equipment, etc.).

II.ii. Regulation of system performance, distinct from product or whole building performance

Regulations 422/2012 and 328/2005 define minimum combustion efficiencies of boilers, while Regulation 282/2012 defines the technical requirements on thermal insulation of the distribution network for heating and DHW. In particular, this regulation sets a maximum level of 10 W/(m.K) for thermal losses of the

Buildings/total floor area	Number of buildings	Total floor area (m^2)	Built volume (m^3)
All buildings	3,806	4,773,344	21,678,102
All buildings – total floor area not identified	189	0	9,408
Buildings – total floor area over 500 m^2	**1,893**	**4,370,709**	**19,571,523**
Buildings over 500 m^2 constructed from 1947 to 1993 (incl.)	1,364	3,175,872	14,026,720
Buildings over 500 m^2 - year not identified	62	112,392	536,336
Buildings over 500 m^2 - before 1947	135	365,202	1,860,893
Buildings – total floor area over 250 m^2	**2,631**	**4,641,021**	**21,070,474**
Buildings over 250 m^2 and constructed from 1947 to 1993 (incl.)	1,938	3,386,048	15,178,299
Buildings over 250 m^2 - year not identified	1,938	3,386,048	15,178,299
Buildings over 250 m^2 - before 1947	192	385,754	1,999,936

Table 4: Number of buildings owned and occupied by central government, total (gross) floor area, built volume.

distribution pipework and ductwork. With regard to other products used in TBS, there are specific requirements in implementing regulations related to the Eco design directive.

In addition, there are specific requirements depending on the size of the building.

The owner of a large building (with total floor area larger than 1,000 m^2) with a central water based heating system is obliged to:

> ensure and maintain hydronic balancing of the heating system in the building;
> furnish the heating system with equipment used for automatic control of heating medium parameters for every heating appliance depending on the air temperature in heated rooms.

The owner of a building with central DHW generation is obliged to:

> ensure and maintain hydronic balancing of the DHW distribution system in the building.

The Act 476/2008 on energy efficiency introduces the obligation, for the owner of a large building, to foresee the heat and DHW distribution network of suitable thermal insulation.

There is no specific requirement related to the energy performance of TBS as a whole. After completing the works in a building, the owner should have the necessary technical measurements performed as one of the preconditions for obtaining the building permit. If these obligations are not fulfilled, and non-compliance is identified by the State energy inspection, a fine from 200 € up to 8,000 € could be imposed to the owner.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

Buildings must only meet global minimum energy performance requirements as well as those described in the previous section. There are no specific further requirements for installations in new buildings and buildings undergoing major renovation.

If this is technically, functionally and economically feasible, the existing building must comply with the minimum energy performance requirements for new buildings following the renovation. According to Act No. 555/2005 as amended, the owner of a building is required to apply the new or renewed technical systems in case of a major renovation, provided that this is technically, functionally and economically feasible. In addition, the renovation should assess the possibility of using alternative systems (see section II.i).

For other types of system renovation, the requirements described above (section II.ii) apply only to exchanged or new parts of the renovated system.

Finally, the whole system must in all cases comply with functionality and safety regulations.

II.iv. Provisions for installation, dimensioning, adjustment and control

There are no specific requirements or provisions for safety, hygienic, ergonomic, efficiency and functionality criteria except those used in technical designer practice. Those are defined in relevant regulations (e.g., Construction Act) and CEN and STN standards that apply explicitly to particular systems. These regulations were adopted before the EPBD transposition, so they are not directly linked to the EPBD and are generally valid for buildings and specific systems.

II.v. Encouragement of intelligent metering

Based on a cost-benefit analysis of Distribution System Operators (DSOs), the government adopted Decree 358/2013 stipulating that at least 80% of delivery points of final customers with an annual electricity consumption of more than 4 MWh, who will be identified by the end of 2018, shall be equipped with intelligent metering systems installed not later than 31 December 2020. The supplier of heat and DHW is obliged to provide customers with a meter that shows the actual heat consumption and the time of consumption. Similar obligations are valid also with regard to gas supply.

Since intelligent metering as such does not generate energy savings (savings are generated by the actions of the occupants based on information from the metering system), such systems are not part of the normalised energy performance calculation and therefore do not have an impact on the energy class of the building, on the EPC, or on the energy label.

II.vi. Encouragement of active energy-saving control (automation, control and monitoring)

According to Act 555/2005, in case of a major renovation, the owner of the building is required to install automated management, control and monitoring systems for energy savings, provided that this is technically, functionally and economically feasible. This does not have a direct impact on the EPC or the energy label, neither does it influence the frequency of inspections.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The issuance of Energy Performance Certificates (EPCs) started in January 2008, as specified by the EPB Act (555/2005). EPCs are compulsory for new buildings and major renovations, as well as for buildings that are being sold and rented.

Depending on the type of building, each EPC is produced by a number of experts specialised in one of the following areas: thermal protection, heating and DHW preparation, ventilation and cooling, and/or lighting. Only 2 experts (one for thermal protection, and one for heating and DHW) are required for the energy certification of residential buildings. However, for non-residential buildings, experts specialised in all four above mentioned areas are required.

In the Slovak Republic there is a total number of 357 experts: 188 for thermal protection, 119 for heating systems and DHW, 34 for lighting and only 16 for ventilation and cooling. The register of experts is administrated by the Slovak Chamber of Civil Engineers (SKSI) and is published on the SKSI website. The EPC register is managed by the MDVRR through a portal titled ‘Inforeg’, while a database of EPCs is available on the website of the MDVRR. After respective data have been entered on-line, the EPCs are issued by the energy certification expert for thermal protection.

How flats are certified in apartment buildings

Currently, flats are not evaluated separately from the building. According to the law, it is possible to issue a specific EPC for a flat only in the case that there is already an EPC for the whole residential building. At the end of 2014, there was an on-going research study on the methodology of energy certification of flats, as parts of buildings.

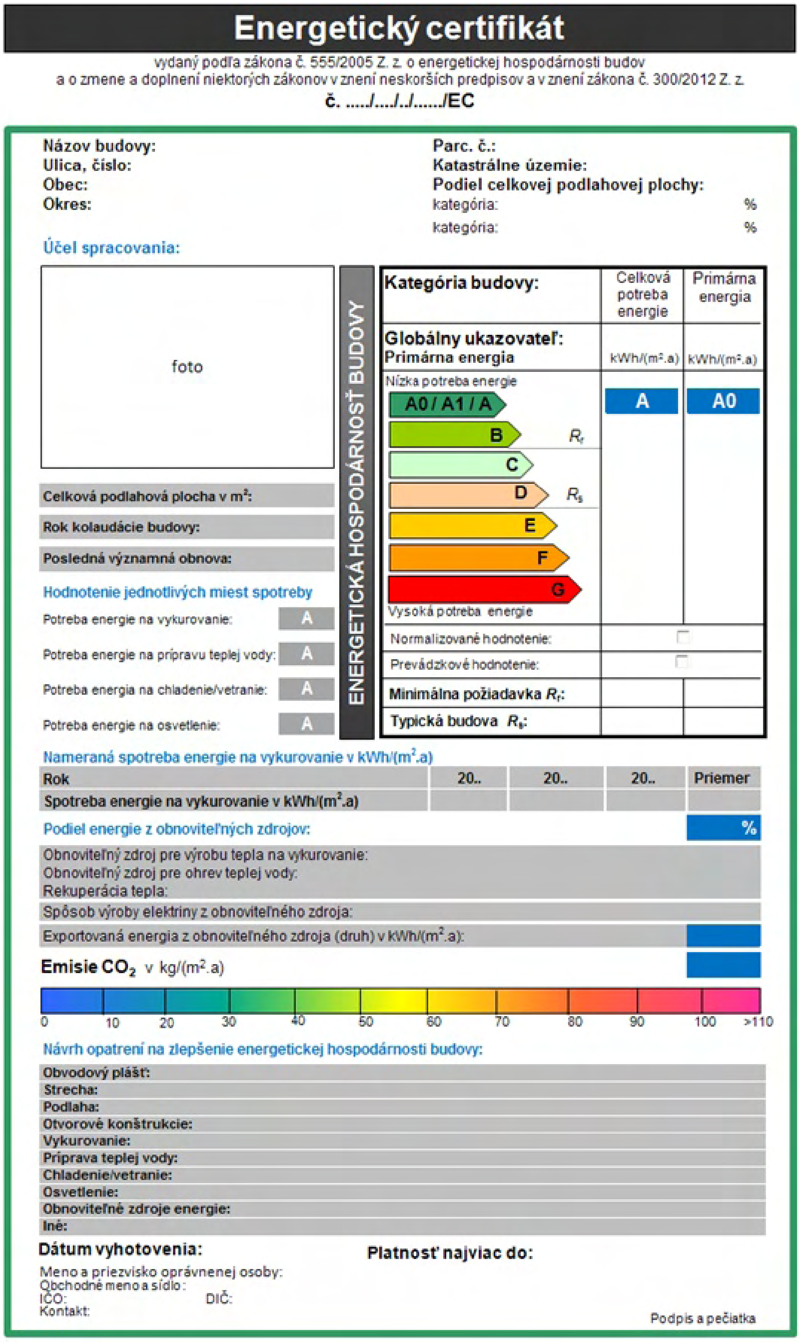
Format and content of the EPC

The EPC consists of 8 pages. The cover page showcases the information on the rating of the technical systems, the total energy use of the building and the final score. The cover page also includes information on the recommended measures (Figure 3). Separate pages are used for the description of the actual condition of the relevant technical systems and recommendation measures. The expert is responsible for adding to the report particular information about the building, the process of rating and the calculation results. The maximum validity of the EPC is 10 years. In case of substantial changes in the performance of the building (e.g., additional insulation, change of heating generator) a new EPC is required.

EPC activity levels

The precise number of issued certificates can be established based on statistical values from the register managed by the MDVRR. From the beginning of 2010 until December 2014, a total of 58,201 EPCs were issued, of which 36,125 concerned new buildings, 21,183 were issued for

Figure 3: Cover page of the Energy Performance Certificate template.


Energetický certifikát

vydaný podľa zákona č. 555/2005 Z. z. o energetickej hospodárnosti budov
a o zmene a doplnení niektorých zákonov v znení neskorších predpisov a v znení zákona č. 300/2012 Z. z.
č. ...../...../../../....../EC

Názov budovy:
Ulica, číslo:
Obec:
Okres:

Parc. č.:
Katastrálne územie:
Podiel celkovej podlahovej plochy:
kategória: %
kategória: %

Účel spracovania:

foto

Celková podlahová plocha v m²:
Rok kolaudácie budovy:
Posledná významná obnova:

Hodnotenie jednotlivých miest spotreby
Potreba energie na vykurovanie: A
Potreba energie na prípravu teplej vody: A
Potreba energia na chladenie/vetranie: A
Potreba energie na osvetlenie: A

ENERGETICKÁ HOSPODÁRNOSŤ BUDOVY

Kategória budovy:	Celková potreba energie	Primárna energia
Globálny ukazovateľ: Primárna energia	kWh/(m².a)	kWh/(m².a)
Nízka potreba energie A0 / A1 / A B R_r C D R_s E F G Vysoká potreba energie	A	A0
Normalizované hodnotenie:		
Prevádzkové hodnotenie:		
Minimálna požiadavka R_r:		
Typická budova R_s:		

Nameraná spotreba energie na vykurovanie v kWh/(m².a)

Rok	20..	20..	20..	Priemer
Spotreba energie na vykurovanie v kWh/(m².a)				

Podiel energie z obnoviteľných zdrojov: %

Obnoviteľný zdroj pre výrobu tepla na vykurovanie:
Obnoviteľný zdroj pre ohrev teplej vody:
Rekuperácia tepla:
Spôsob výroby elektriny z obnoviteľného zdroja:
Exportovaná energia z obnoviteľného zdroja (druh) v kWh/(m².a):

Emisie CO_2 v kg/(m².a)

0 10 20 30 40 50 60 70 80 90 100 >110

Návrh opatrení na zlepšenie energetickej hospodárnosti budovy:

Obvodový plášť:
Strecha:
Podlaha:
Otvorové konštrukcie:
Vykurovanie:
Príprava teplej vody:
Chladenie/vetranie:
Osvetlenie:
Obnoviteľné zdroje energie:
Iné:

Dátum vyhotovenia:
Platnosť najviac do:

Meno a priezvisko oprávnenej osoby:
Obchodné meno a sídlo:
IČO: DIČ:
Kontakt:
Podpis a pečiatka

major renovations, and the rest (893 EPCs) for existing buildings (without renovation). In 2013 alone, the number of EPCs issued was 14,017 (Figure 4) accounting to 10,156 for new buildings, 2,788 for existing buildings and the remainder for sold and rented buildings. There is no information available on the EPCs issued in 2008 and 2009.

Typical EPC costs

The typical cost of an issued EPC is 100 € for a single-family house and 300 € for an apartment building. The cost of an EPC for an office building may vary depending on, e.g., size, technical systems, equipment and complexity of the building, and can even exceed 1,500 €. In general, the cost of an EPC does not reflect the actual work and time needed, having thus a negative impact on the quality of the EPC.

Assessor corps

The required qualification of experts is set by law. Requirements include a university degree (e.g., in civil engineering, architecture, etc.) and an examination process. At the examination, the candidate must prove knowledge and experience in calculation, evaluation and design of building structures and technical systems. An optional training is provided by the Slovak Chamber of civil engineers, however, a Continuous Professional Development (CPD) system is not in place.

Compliance levels by sector

New buildings must fulfil the requirements of the EPB at the time a construction permit is applied for. An EPC is requested for new buildings immediately after construction, and all relevant documents are under the control of the Inspector's Office.

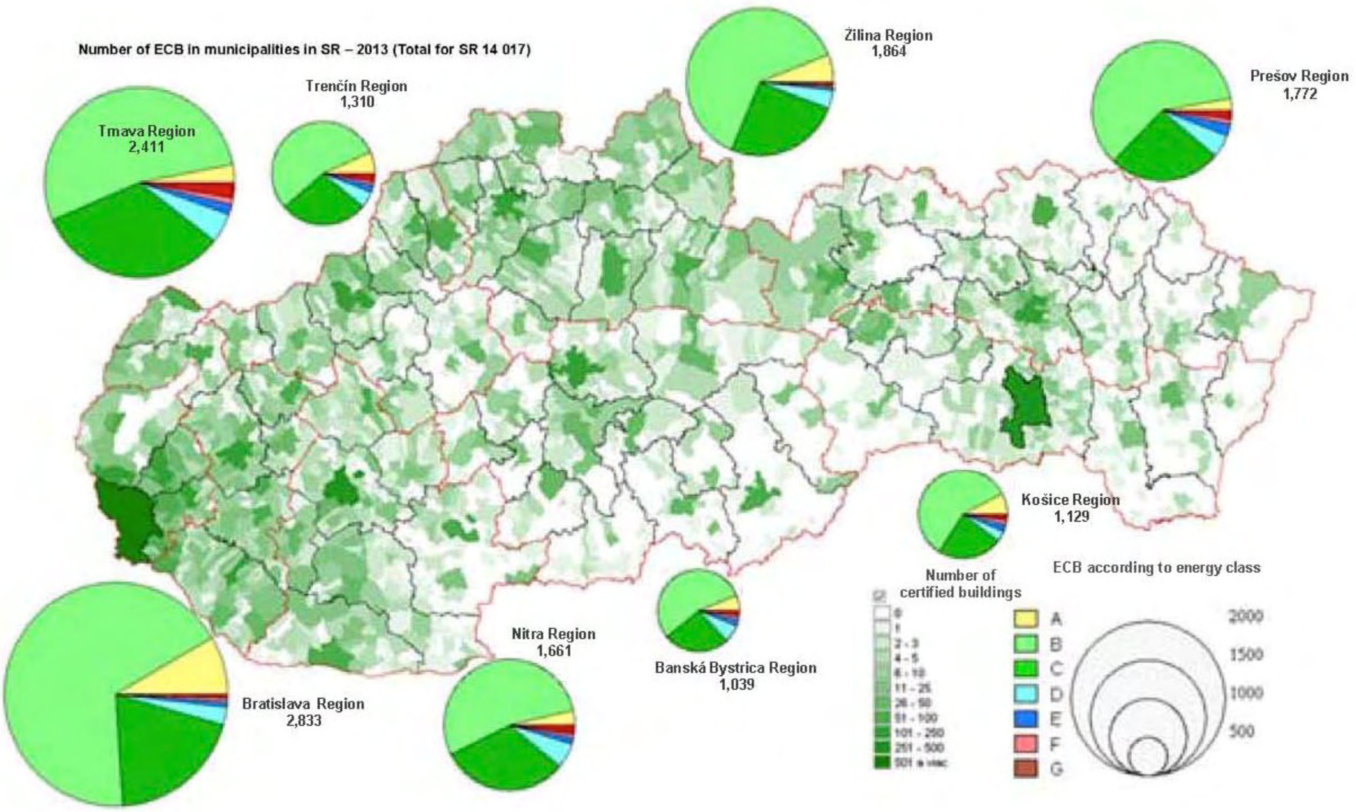
Enforcement with building owners and real estate actors

The ministry and its entities involved in the energy certification process engage with building owners and real estate actors through different activities (conferences, seminars, workshops, articles, etc.). Consultancy is also offered. The Slovak Trade Inspection may impose fines from 500 € to 3,000 € if the owner fails to provide an EPC, or if the EPC is in breach of the regulations. The fines imposed are not separately published.

Quality Assurance (QA) of EPCs

The State Energy Inspection, as part of the Slovak Trade Inspection since 2014, is responsible for the Quality Assurance (QA) of EPCs. In 2013, 103 EPCs from the total number of 14,017 EPCs issued in 2013 were checked. This represents 0.035% of the EPCs issued in 2013. There is no official data on EPCs found to be incorrect.

Figure 4: Number of issued EPCs in each region.



III.ii. Progress and current status on public and large buildings visited by the public

Energy certification is mandatory for buildings in which more than 500 m^2 (until 31 December 2012 it was for more than 1,000 m^2) of the total floor area are used by public authorities, or which are frequently visited by the public.

In total, there are 15,435 buildings (114,703,652 m^3 of built volume) owned and used by central government and municipal authorities that are visited by the public. They are located in 2,898 communities and administrated by 867 bodies. Of these, 3,806 buildings are owned and used by central government authorities (Table 4), 2,556 are office buildings and 6,943 are schools.

There is no relevant information about the display of EPCs available at the moment. Most public buildings display their Energy Performance Labels, although this is not always the case. The Slovak Trade Inspection is responsible to check if public buildings display EPCs, but the control had not been completed by the end of 2014.

The format and content of the EPC for public and large buildings visited by the public are the same as for other buildings. The assessors, the costs and the QA system are also the same, while standard costs are approximately 1,500 €. EPCs for public and large buildings visited by the public are also valid for 10 years, unless the building is renovated and there is a change in the energy use.

III.iii. Implementation of mandatory advertising requirement

Act 555/2005 on EPB implements the mandatory advertising requirements, which have entered into force since January 2013. In case of sale or rental, the building owner is required to indicate in commercial media advertisements the information about the energy class of the global indicator from the energy certificate. The Slovak Trade Inspection is in charge of control checks.

III.iv. Information campaigns

Information campaigns are organised through TV specials (broadcasted monthly), with focus on energy certification, measures recommended for major building renovation, construction products, as well as information about technical systems and components. Similarly, there are also radio broadcasts focusing on energy certification.

Information about the energy performance of buildings is available at www.mindop.sk. A new information campaign “Live with Energy” is currently underway.

III.v. Coverage of the national building stock

The housing stock in the Slovak Republic consists of buildings manufactured mainly during the second half of the past century. The number of buildings is approximately 875,000, comprising mostly family houses. Apartment buildings are estimated at 21,800, with non-residential buildings being less than 40,000. By the end of 2013 there were 58,201 buildings with an EPC, corresponding to 7% of the total number of buildings. Information about energy performance of buildings is available at www.mindop.sk.

Until September 2014, from the registered number of EPCs (58,201) 88.2% concerns residential buildings, and only 11.8% non-residential. Of the total number of registered buildings with EPCs, 10,437 buildings were registered following a major renovation. Of these renovated buildings, 53% were rated energy class B. The 58,201 buildings with an EPC represent ca. 7% of the total building stock.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Slovakia has opted for regular inspections, both for heating systems and Air-Conditioning (AC) systems in response to Articles 14 and 15 of Directive 2010/31/EU. Regular inspections are mandatory since 1 January 2008.

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

The Ministry of Economy is responsible for the regular inspection of building heating systems according to the Act 314/2012. This Act replaces the previous Act 17/2007 which came into force on 1 January 2008. There are two relevant decrees linked to these inspection requirements:

> Decree 422/2012 that sets out the requirements on the procedure of regular and extended inspection of heating systems;

> Decree 44/2013 that defines the details of the examination procedure that qualified experts need to follow, in order to carry out the regular inspection of heating and AC systems.

Inspections of heating systems are based on the assessment of efficiency under defined normal working conditions. Currently, inspections of heating systems must follow the referred methods, which are partially based on EN standards, (e.g., EN 15378). A detailed national methodology is defined in Decree 422/2012. Regular intervals of inspection depend on the thermal output of the heating system, the type of fuel and building (residential/non-residential). Intervals for boilers fuelled by biomass and biogas were decreased by the 2012 Act (Table 5).

Inspections are ordered and paid by the owner or the contractual administrator of the building or system. Building owners (or administrators of buildings or systems) are required to:

> arrange regular inspection of the heating system;
> keep the inspection report until the receipt of the report of the next periodic inspection;
> in case of transfer or assignment of ownership of the building, they must submit the last inspection report to the new owner;
> when renting a building or heating system, they must provide a copy of the latest inspection report to the tenant.

Arrangements for assurance, registration and promotion of competent persons

In Slovakia, only companies and Qualified Experts (QEs) licensed for the regular inspection of heating systems are allowed to perform inspections. There are 239 registered experts licensed to carry out regular inspections. In this context, there is a common set of required minimum information in the inspection reports and a report template is provided by the Slovak Innovation and Energy Agency (SIEA).

Training and examination of QE candidates is provided by the SIEA. Candidates must fulfil the required education level, i.e., secondary vocational education of technical orientation, or university education in one of the following fields: computer science, mathematics, information and communication technologies, engineering, technology, manufacturing and communications, or natural sciences with focus on physics or chemistry. There is at least one examination process per year. The list of QEs is administered by SIEA and published at its website. QEs are required to attend an upgrade training organised by the SIEA at least once every five years.

Promotional activities

Comprehensive information on requirements for regular inspection is provided at the SIEA website. A specific part of this information is focused on raising awareness amongst building owners. The SIEA also offers the necessary information for applicants and QEs on training and examination. Finally,

Table 5: Intervals of regular inspection of boilers and heating systems (from 1 January 2013 onwards. In grey, boilers that had to be inspected in 2013).

Nominal output of boiler (kW)	**Fuel**	**Interval of regular inspection (year)**	
		Single-family houses and residential houses	Office buildings, school and educational buildings, hospitals, hotels and restaurants, sport facilities, wholesale and retail trade buildings, other types of energy-consuming buildings
In the range of 20 (incl.) to 30	Fossil solid, liquid and gaseous fuels except natural gas	10	7
	Natural gas	15 (first inspection latest by 31.12.2022)	12 (first inspection latest by 31.12.2019)
	Biomass, biogas	15	12
In the range of 30 (incl.) to 100	Fossil solid, liquid and gaseous fuels except natural gas	4	4
	Natural gas	6	6
	Biomass, biogas	6	6
Above 100 (incl.)	Fossil solid, liquid and gaseous fuels except natural gas	2	2
	Natural gas	3	3
	Biomass, biogas	2	2

information is also provided by specific lectures on professional conferences, seminars and trade fairs, articles in newspapers and magazines, and through the three professional advisory centres of the SIEA addressing the general public.

Enforcement and penalties

In accordance to the Act, for monitoring purposes, QEs are required to send once a year (latest by 31 January) to the SIEA (on behalf of the Ministry), an electronic copy of all the inspection reports produced in the previous year. The owner or administrator of a building or system may be fined in the following cases:

a) if he/she does not arrange an inspection before the set date (i.e., until the end of 2013 for the inspection of all boilers under Act 314/2014 in buildings with nominal thermal output of boiler above 30 kW, see Table 5);

b) if he/she does not keep the inspection report until receipt of the report of the next periodic inspection;

c) if he/she does not submit a report of the last inspection to a new owner; and

d) if he/she does not provide a certified copy of the report of the last inspection to a tenant.

Owners, however, are not fined for a negative inspection result. The owner (or administrator) is in no way required to implement the recommendations that the QE includes in the inspection report.

The market surveillance is now subject to the State Energy Inspection. If a control check finds that the inspections of a certain QE are not performed in line with the regulations, the Ministry is allowed to remove the particular QE from the QE register. So far, only one QE has been removed from the respective list in 2013, for reasons other than shortcomings identified by the supervisors. If a QE does not send the inspection's report to the ministry he/she will be fined. Because of a restructuring of the surveillance bodies and their staff expertise that has only been completed shortly before the end of 2014, there were no fines imposed yet by the end of 2014.

Quality control of inspection reports

All the inspection reports received are registered in the monitoring system administered by the SIEA. The Ministry (or the SIEA on behalf of the Ministry) controls a randomly selected statistically significant percentage of inspection reports received every year, but including at least one inspection report done by each authorised person. In 2013, 33 QEs filed their heating system inspection reports and 50 of these reports were controlled for quality. Quality control is focused on formal fulfilment of the legislation requirements, but the content is also checked and in particular the calculation procedure and the final results stated in the specific report. Key findings are then reflected in the training process.

Inspection activity figures

Once a year the SIEA is required to send to the Ministry a summary report on the results of all inspections performed during the previous year. The first summary report was prepared with regard to inspections carried out in the year 2010. For 2013, inspections should have been performed for all heating systems with boilers with a heat output over 30 kW (Table 5). The main summary data for the period 2010 – 2013, for inspections still under the requirements of Directive 2002/91/EC, are given in Table 6.

IV.ii. Progress and current status on AC systems

The Ministry of Economy is responsible for the regular inspection of AC systems in buildings according to the same act and decrees that apply also to the regular inspection of heating systems. Inspections of AC systems are based on the assessment of efficiency under defined normal working conditions, and must follow the referred methods, which are

Data	Unit	Year			
		2010	2011	2012	2013
Number of inspected boilers	-	1,018	363	227	1,201
Total heat output of inspected boilers	MW	273.13	52.28	40.09	163.67
Number of QEs who filed the reports	-	18	22	20	33
Share of boilers not fulfilling the required combustion efficiency out of the total number of inspected boilers	%	6.5	6.1	3.1	5.3
Share of boilers older than 15 years out of the total number of inspected boilers	%	23.1	28.7	36.2	19.8
Number of performed expanded heating systems inspections when the boiler was over 15 years old	-	65	27	47	134

Table 6: Summary data on performed inspections of heating systems incl. boilers between 2010 and 2013 according to received inspection reports.

Table 7: Intervals of regular inspection of AC-systems (grey – AC systems which had to be inspected in 2013).

Nominal cooling output of AC-system (kW)	Interval of regular inspection (year)
In the range of 12 (incl.) to 50	8
In the range of 50 (incl.) to 250	6
In the range of 250 (incl.) to 1000	4
Above 1000 (incl.)	2

partially based on EN standards, e g., EN 15240. A detailed national methodology is defined in Decree 422/2012 Coll. The regular periods of inspection depend on the cooling output of the inspected AC system (Table 7) and remain unchanged as to the periods defined for implementation in the Directive 2002/91/EC. Moreover, inspections are ordered and paid by the owner or the contractual administrator of the building or system. The requirements on building owners (or administrators of buildings or systems) are the same as for heating systems' inspections. Promotional activities are also similar to the activities performed in heating systems' inspections.

There are 73 licensed bodies registered for regular inspection of AC systems. A common set of minimum required information is included in the inspection reports, and a report template is provided by the SIEA. The training and examination procedure is the same as in the case of inspection of heating systems. Support is also provided by the Slovak Association for Cooling and Air-Conditioning Technology.

Once a year, the SIEA is required to send to the ministry a summary report on the results of all inspections performed during the previous year. The first summary report was prepared with regard to inspections carried out in the year 2011. In 2013, inspections should have been performed for all AC systems with a cooling output over 50 kW (Table 7). The main summary data for the period 2011 - 2013 is featured in Table 8. The quality control system for AC system inspection reports is similar to the quality control system in force for heating system inspection reports described in section IV.i.

Table 8: Summary data on performed inspections of AC systems between 2011 and 2013 according to received inspection reports.

Data	Unit	Year		
		2011	2012	2013
Number of inspected AC systems/cooling units	-	32/32	2/10	49/49
Total cooling output of inspected system units	MW	4.32	4.50	12.00
Number of QEs who filed reports	-	2	1	11
Number of inspected AC systems/units installed in office buildings	-	13	2	27
Number of inspected AC systems/units installed in retail buildings	-	0	0	13

Building owners (or administrators of buildings or systems) are required to comply with the same obligations as described for the inspection of heating systems and are also subject to the same penalties when violating pertinent legislation. The same applies to the QEs as well. The market surveillance system is equal to the system used for inspections of heating systems. No fines have been issued yet, for the same reasons as explained above with regard to the inspection of heating systems.

3. A success story in EPBD implementation

The success story of Slovakia is notably linked to the creation of the implementation system with focus on the energy performance of buildings. Slovakia was implementing the EPBD already in 2005. At the same time all the prEN and prEN ISO standards had also started being used and translated into the Slovak language (mainly technical standards for thermal protection).

Research work conducted since 1992 included pilot and demonstration projects which aimed at reducing the energy use and at least the energy consumption. The obtained results were used for the revision of thermal protection standards, but also for setting regulations on energy demand for heating. The research also produced the climatic data currently in use, including degree days.

A database of apartment buildings and non-residential buildings was created, encompassing all gathered information describing the buildings and energy consumption for heating and DHW. Since 1992, there have also been developments, consisting of providing information on relevant applied technologies and building products relating to the improvement of thermal protection. This portal thus evolved towards a platform for the implementation of the EPBD energy rating, including the possibility of estimation of the EPC energy classes.

A very important aspect for the successful implementation of the EPBD was the introduction of definitions related to the energy performance of buildings that were extended by terms cited in the EED, i.e., major renovation of technical systems, deep renovation, comprehensive renovation and partial renovation. Defining these concepts requires also identifying the scope of provisions, as well as determining the conditions to grant loans to carry out major renovations. Upon request of grants or loans, the documentation should indicate that all the requirements of the EPB can be achieved (e.g., insulation or performance). Furthermore, an updated EPC is required following renovation.

The implementation process was supported by EN and EN ISO standards relating to the EPBD that were translated into Slovak. All of these standards were transposed into the Slovak technical standards system. The National Annex EN ISO 13790/NA contains detailed climatic data for 2,884 localities in Slovakia, as well as a more accurate calculation method of the total floor area and built volume of a building. In addition, the National Annex STN EN 15603/NA includes a method for calculating the operating rating of energy use for heating.

With the implementation of the Directive 2010/31/EU, the Slovak Republic has further tightened the requirements for building design and energy needs. The analysis of cost-optimal levels of minimum energy performance requirements has been completed. The Decree of the MDVRR contains not only the requirements that have been introduced since 2013, but also those which shall be required from 2016 onwards. A relevant ministerial decree also sets the requirements for building construction and for primary energy that must be met by NZEBs by 2021.

Specific requirements for the thermal envelope following major renovation of buildings using External Thermal Insulation Composite System (ETICS), have been implemented in Slovakia since 1992 and the use of EITCS has increased significantly in recent years. At the end of 2013, 455,915 flats in apartment houses had been renovated, accounting for 48.94% of the total number of flats. With regard to residential units, the number of renovated houses and apartments at the end of 2013 was 321,415 (31.86%) and by the end of 2020 the respective number should increase by 154,000 reaching 475,415 (47.13%). The high number of renovated residential units shows the successful implementation of measures, the great shift in people's view and also in their behaviour towards energy savings (Table 9).

4. Conclusions, future plans

The Energy Performance of Buildings Directive (EPBD) was implemented under Act 555/2005 and amended by the new Ministerial Decree 364/2012 that came into force in January 2013. Since January 2008, Energy Performance Certificates (EPCs) have been issued for new buildings and buildings undergoing major renovation, either sold or rented. The template has also changed and a new one is presented in the 2013 decree. Moreover, research work with regard to energy certification for individual flats or parts of buildings is conducted, and energy certificates should start to be issued from 2016 onwards. A register of EPCs and inspection reports has been established, as well as a register of experts.

Description	**Apartment buildings Number of flats**	**Single-family houses**	**Total**
2011 national census survey data; both occupied and not occupied flats	931,605	1,008,795	1,940,400
Renovated houses/flats by the end of 2010 according to 2011 survey	382,319	272,415	654,734
Renovated houses/flats in 2011 and 2012	46,092	31,000	77,092
Total renovated by end of 2012	*428,411*	*303,415*	*731,826*
Renovation share by 2012	45,99%	30.08%	37.72%
Renovated houses/flats in 2013	27,504	18,000	
Renovation until 31.12.2013 / flats	*455,915*	*321,415*	
Share of renovated buildings in 2013	*48.94%*	*31.86%*	

Table 9: Number of residential units renovated until 2013 (major renovations).

The set of requirements on U-values and on primary energy will be tightened as of January 2016, with a further revision of the NZEB levels scheduled for January 2021. The requirements to be set from 2016 onwards match the results from the calculation of cost-optimal levels of minimum EPB requirements. It is to be noted that the compliance control system is under development and should be fully functional as of 2015.

The NZEB definition is completed and the construction of such buildings will be one of the major challenges in order to achieve actual energy savings. In particular, it will be important to prompt extensive renovation of buildings, so as to achieve the level of NZEBs, which will require additional training for experts, especially on Quality Assurance (QA). In addition, it will be necessary to extend information campaigns targeting owners.

The main challenge is to engage all involved groups (designers, developers, providers, owners and tenants) in the process to change their attitude towards the construction of NZEBs, which will require a new architectural view, the use of new materials and technical systems, as well as the integration of RES.

Finally, Slovakia has implemented all the EN and EN ISO standards related to EPBD into the system of the Slovak Technical Standards (STN) through two National Annexes. The process of the second wave of implementation of standards will start in 2015 with their translation into Slovak.

Implementation of the EPBD in Slovenia

STATUS IN DECEMBER **2015**

1. Introduction

In Slovenia, the implementation of the Energy Performance of Buildings Directive (EPBD) is the overall responsibility of the Ministry of Infrastructure. The EPBD was transposed into national legislation by the already existing Building Construction Act (giving the legal basis for Building Codes with minimum requirements and the calculation methodology), the Environmental Protection Act (addressing the inspection of boilers), and by the Energy Act which on 17 November 2006 was amended to include the rest of the EPBD requirements. The secondary regulation announced in 2008, set out new minimum requirements, the calculation methodology, feasibility studies, and regular inspection of Air-Conditioning (AC) systems, while the regulation on energy performance certification was adopted in 2009. The training and licensing of independent experts working on the energy performance certification and AC system inspections of buildings, as well as the protocols relating to the registry of the Energy Performance Certificates (EPC) were defined in detail in the 2010 Regulation on training of independent experts[1]. The regular inspection of boilers was implemented in 2004 under an existing scheme for chimney sweeper services[2] and upgraded with details on concessions in November 2007.

A revision of the relevant legislation was initiated in mid 2010 in order to comply with the requirements of the Directive 2010/31/EU, which on 22 February 2014 resulted in the adoption of a new Energy Act. In December 2014, a new regulation on the methodology for energy performance certification was adopted, while revision of other regulations is planned in 2015/2016. This includes the Building Codes PURES 2010 which on 1 January 2015 put in place more severe minimum energy performance requirements according to the existing transitional provisions. Further changes are planned in line with the new set of CEN EPBD standards and the results of the cost-optimal study. Furthermore, the national plan for Nearly Zero-Energy Buildings (NZEBs) was adopted on 22 April 2015. Slovenia is also in the process of improving the energy performance certification process by developing an official electronic registry which is due by the end of 2015.

This report presents an overview of the status of the EPBD implementation in Slovenia in 2015 and outlines the plans for successful completion of pending topics.

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NATIONAL WEBSITES www.mzi.gov.si, www.energetika-portal.si

[1] *Rules on the training, accreditation and register of accredited independent experts for energy performance certificate production www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV10090*

[2] *Decree amending the Decree on the method, subject and conditions for the performance of the compulsory public utility service of measurement, inspection and cleaning of combustion installations, flue ducts and ventilation shafts for the purpose of environmental protection and efficient use of energy, health protection and fire protection www.uradni-list.si/1/content?id=52301*

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

In order to implement the Directive 2010/31/EU, Slovenia updated the minimum energy performance requirements for new energy-efficient buildings and, if relevant, existing buildings upon major renovations and maintenance works, in the 2010 Building Codes (PURES 2010). After the announcement of the regulation in July 2010 and the corresponding transitional period, the requirements came fully in force on 1 January 2011. The 2008 Regulation (PURES 2008) had already introduced an intensive reduction of transmission losses through the building envelope, as well as a mandatory 25% use of Renewable Energy Sources (RES) in the final energy used. The 2010 Building Codes built on the 2008 version, placed the focus on the calculation of primary energy and CO_2 indicators, set additional minimum requirements for energy systems, as well as for primary energy for heating, and limited the heating and cooling needs both in terms of useful and primary energy. The 2010 Regulation added also many new minimum requirements for technical building systems.

In line with Directive 2010/31/EU and according to the long term planning integrated in the rules of PURES 2010, as of January 2015 more severe minimum requirements for maximum energy needs for heating have entered into force[3]. This change had already been integrated in the transitional provisions of PURES 2010. Minimum requirements are expressed using performance-based and energy-related requirements, and detailed technical requirements for building components and systems. In 2015 the Building Codes were put under revision in order to take into account the outcome of the cost-optimal study, to include further details associated with the national definition of NZEB, and to make the necessary changes in the calculation methodology pursuant to the new CEN EPBD standards. The revision process shall be finalised by the end of 2016.

Table 1: Maximum U-values of the envelope elements (PURES 2010).

minimum requirements for U-values of the envelope	
walls	0.28 W/m^2.K
floors between flats	0.90 W/m^2.K
flat roofs	0.20 W/m^2.K
windows	1.3 W/m^2.K
glazing	1.1 W/m^2.K
doors	1.6 W/m^2.K

I.ii. Format of national transposition and implementation of existing regulations

Performance-based minimum requirements in the PURES 2010 are focused on bioclimatic architectural concepts and on low energy losses in building envelopes with high airtightness. They also treat thermal bridges by limiting the linear thermal transmission coefficients (therefore, the simulation of thermal bridges is becoming a frequent design practice). A special set of minimum requirements refers to the energy efficiency of components and systems. As required by Directive 2010/31/EU, before the design of Heating, Ventilation and Air-Conditioning (HVAC) systems, the potential of shading, passive cooling and night ventilation must be utilised to reduce the energy needs below the required levels. Fixed shading devices and automatically controlled shading are considered in energy performance calculations. Mechanical ventilation with heat recovery is not a mandatory technology (natural ventilation is also allowed), but in practice it is needed for buildings with an Energy Performance Certificate (EPC) of class B or higher. If mechanical ventilation is used, then heat recovery is mandatory. Thermal comfort and indoor air quality requirements are given in the Regulation on ventilation and AC systems of buildings (2002), together with the relevant design rules.

Compliance with PURES 2010 must be demonstrated by fulfilling minimum requirements related to the maximum allowed specific transmission heat losses (H'_T), maximum annual heat demand for space heating (Q_{nh}) and, for residential buildings only, maximum energy needs for cooling (Q_{nc}) and maximum primary energy for the energy systems operation (HVAC and lighting). Maximum U-values of the envelope elements are prescribed for all buildings (Table 1).

Public buildings must comply with 10% stricter requirements. The energy-related minimum requirements expressed in annual heating needs (Q_{nh}) are imposed in two steps: for the period from 2010 to 2014, and for the period after 1 January 2015 (Figure 1).

[3] *www.uradni-list.si/1/content?id=98727*

The gradual reduction of minimum requirement values over time is presented in Figure 2.

The use of RES is mandatory for all new buildings since 2008, i.e., a minimum of 25% of the total final energy used for the building's energy systems' operation must be covered by RES. Alternatively, the RES requirement is considered to be fulfilled if the share of RES used for space heating, space cooling and Domestic Hot Water (DHW) is obtained in one of the following ways: 25% from solar energy, 35% from gas biomass, 50% from solid biomass, 70% from geothermal energy, 50% from heat from the environment (through heat pumps), 50% from Combined Heat and Power (CHP), or 50% from energy efficient district heating/cooling. The requirement is also considered fulfilled if the building demonstrates at least 30% lower annual heat demand than the demand defined in the minimum requirements, or if solar collectors for hot water are installed (minimum 6 m^2/residential unit).

The additional minimum requirements refer to the maximum U-values of the building envelope and windows, and to the airtightness of the envelope ($n_{50} < 3\ h^{-1}$ for naturally ventilated buildings, and $n_{50} < 2\ h^{-1}$ for buildings with mechanical ventilation and obligatory heat recovery). Blower door tests are not obligatory under the 2010 Building Code. However, if implemented, a specific protocol (SIST EN 13829) is prescribed. In practice, the airtightness tests are done frequently as they are also a prerequisite to be eligible for the Eco fund[4] subsidy for passive buildings ($n_{50} \leq 0.6\ h^{-1}$) and for the low energy renovation of existing buildings ($n_{50} \leq 1.2\ h^{-1}$).

At the design stage, it is obligatory to prepare a summary of the building thermal characteristics, where the main building and system characteristics, as well as the energy and CO_2 indicators are given. After the building is completed, the calculation and the summary have to be repeated (by the designer, for the building as it was actually built). This is the proof for the final control of compliance with the regulation. This final proof is part of the building certificate of compliance with the essential requirements, and it is a precondition for obtaining the use permit. Fulfilment of the minimum requirements has to be

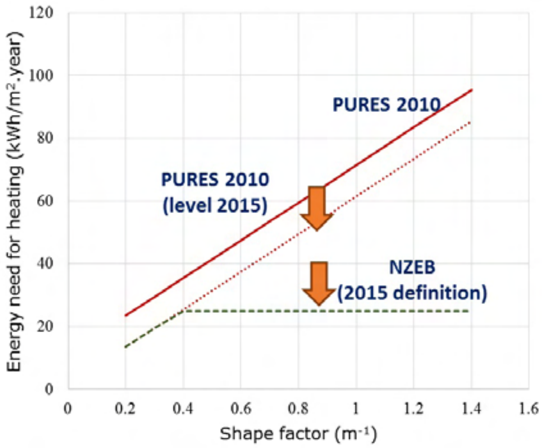


Figure 1: Minimum requirements (from 2010 to 2015 for NZEB level) expressed in annual energy needs for heating, reflecting the thermal quality of the building and the building envelope.

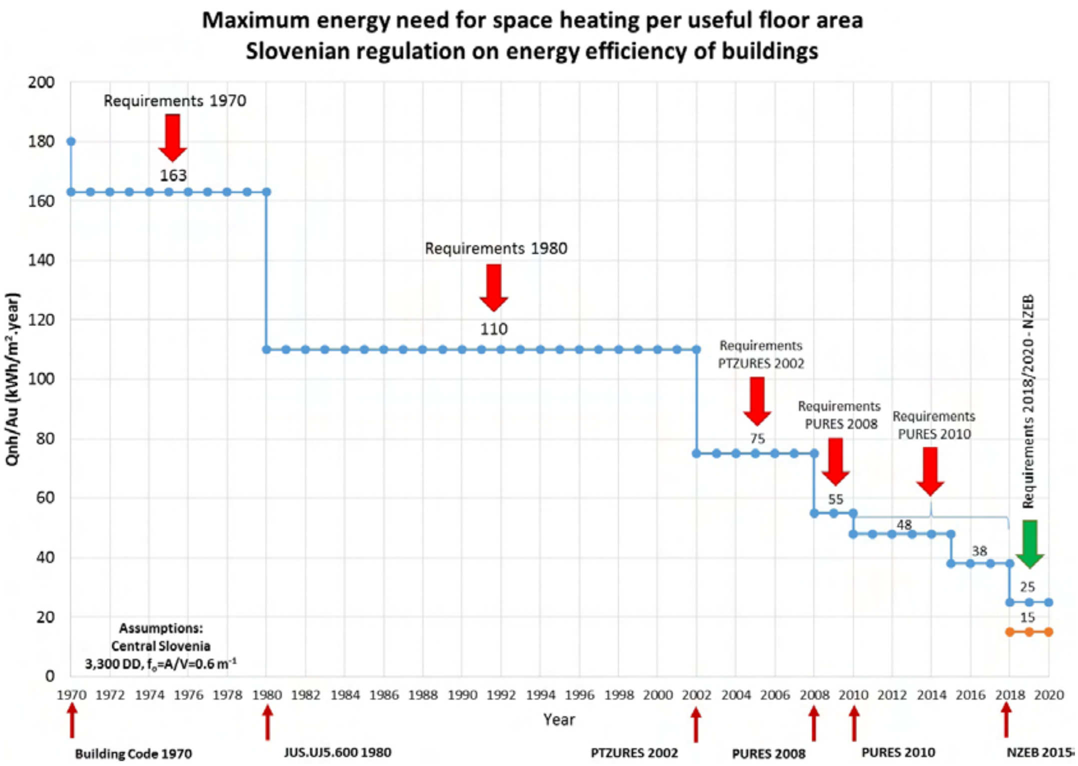


Figure 2: Evolution of energy efficiency regulations for buildings since 1970. Maximum energy needs for space heating per useful floor area according to Slovenian Building Codes, Q_{nh} / A_u (kWh/m^2.year) (A_u: useful floor area).

[4] *Slovenian environment public fund, a subsidy system that requires blower door tests www.ekosklad.si/information-in-english*

demonstrated at the design stage in order to obtain a building permit, and after the building is completed, when applying for a use permit. This is the core technical documentation used by the independent expert in the next step, when preparing the EPC.

Minimum requirements apply to all new buildings, as well as to major renovations, i.e., if at least 25% of the area of the building envelope is subject to renovation.

In case of maintenance works on the building envelope, if a renovation (when a building permit is needed) is less than 25% of the thermal envelope area, and for buildings with a floor area smaller than 50 m^2, only the minimum requirements for the U-values of the envelope must be considered (i.e., an additional insulation layer will be mandatory).

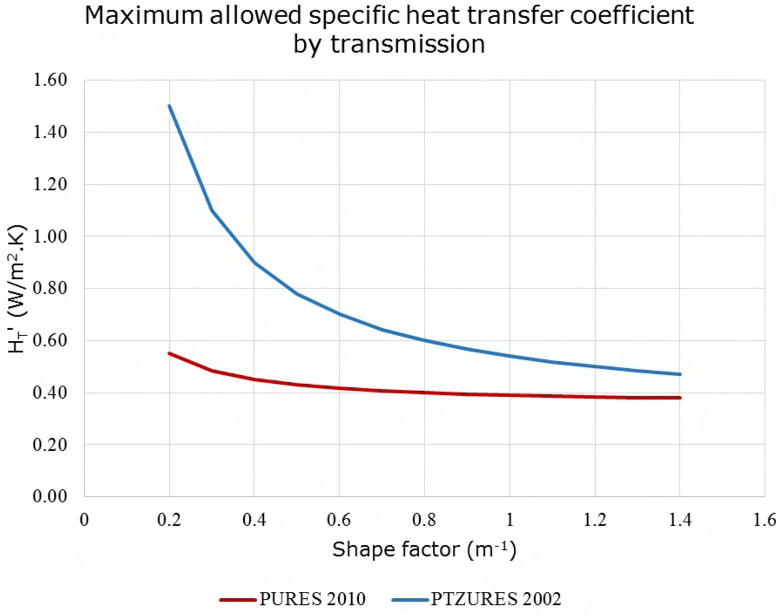
For major renovations of the heating system, and in case of maintenance and replacement works, minimum requirements for the systems, subsystems and elements are of the same level as those required for new buildings.

I.iii. Cost-optimal procedure for setting energy performance requirements

The conclusions from the revised national cost-optimal study submitted to the EC in December 2014 showed that, for new buildings, the deviation between the calculated cost-optimal levels of minimum performance requirements and those in force from 2010, based on the selected financial perspective and the primary energy as a performance indicator, is -14%. For existing buildings, the gap was evaluated based on the same principles, but presented at the level of building elements, whereas the mean envelope thermal transmittance H'_T (W/m^2.K) was used as a performance indicator. The deviation varies between -26% and 5%, with an average of -14%. Current maximum U-values and H'_T are presented in Table 1 and Figure 3 respectively.

The calculation of cost-optimal minimum requirement levels was done for 18 reference buildings representing the typical building stock in Slovenia (Figure 4), i.e., two types of a single-family house (small and large), an apartment building, a non-residential/ office public building, and two alternatives of a non-residential/ commercial building (with different amounts of glazing in the envelope). In the case of new buildings, the reference buildings used reflect PURES 2010 minimum requirements. For existing buildings, the reference buildings were defined according to the 1960 (old existing buildings) and 1980 (old buildings, equivalent to partly renovated buildings from the sixties) building practices. The revision of PURES, which started in 2015 and is expected to be completed in 2016, will consider the findings of the cost-optimal study and improve minimum requirements in a way that makes a smooth transition between 2010 levels and NZEB minimum requirements.

Figure 3: Evolution of the maximum allowed specific heat transfer coefficient of the building envelope according to Slovenian Building Codes.

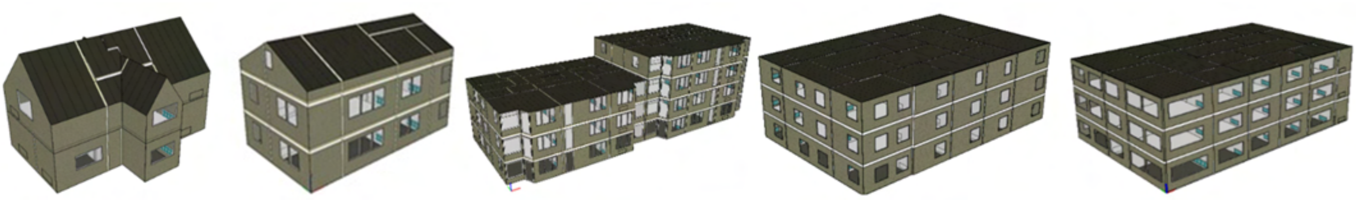


I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The national definition of NZEB is based on the cost-optimal study for reference buildings where the primary energy as a core performance indicator of NZEB, is complemented by the requirement of a 50% share of RES in the final energy use.

Figure 4: Reference buildings used for the cost-optimal study in Slovenia.



RES are selected with consideration to their availability and the NZEB acceptable technologies. In the future, the use of RES will be increased due to the growing share of RES in district heating systems which are subject to comply with the 2020 energy efficiency targets set in the Energy Act. In addition to that, the nearly zero or very low amount of energy required is achieved by further limitation of energy needs for heating to a maximum value between 25 kWh/m^2.K and 15 kWh/m^2.K, depending on the shape factor[5] and the local climate. Although not directly prescribed, the very high energy performance of NZEB will be demonstrated with NZEB buildings ranked in class A1, A2 or B1, according to each building's heating needs.

According to EPBD Annex I, the NZEB definition provides minimum requirements for primary energy for all energy use in new buildings (including lighting in residential buildings), major renovations, single-family houses, apartment buildings and non-residential/office buildings. The NZEB action plan with the national definition of NZEB passed the consultation process successfully and was adopted on 22 April 2015 (Table 2).

Intermediate targets for early implementation of the NZEB standard in new buildings and the renovation of existing buildings are presented in Table 3[6].

Figures and statistics on existing NZEBs

There are no statistics available on the number of existing NZEBs. However, based on the data from the national Eco fund[7], over 800 new passive and low energy buildings were subsidised since 2008.

Most frequently, single-family houses are built as NZEBs. In 2014, a NZEB high-rise apartment building was also built (Figure 5).

Building category	**Maximum primary energy per conditioned floor area** per year (kWh/m²·year)**		**Minimum share*** of RES (%)**
	New buildings	Renovation	
Single-family houses	75	95	*50*
Apartment buildings	80	90	*50*
Non-residential buildings*	55	65	*50*

* for non-residential/office buildings and for EPBD related energy use
** conditioned floor area – i.e. closed heated /cooled net floor area
*** in final energy use

Table 2: National definition of NZEB as given in the national plan for NZEB (April 2015).

Table 3: Intermediate targets for early implementation of NZEB standards in new buildings and in renovation of existing buildings according to the national plan for NZEB (NP NZEB) (April 2015).

NP NZEB intermediate targets – new buildings (m²)	**2015**	**2018**	**2020**
Single-family houses	76,850		267,500
Apartment buildings	9,753		73,650
Public buildings	53,320	84,126	
Other non-residential buildings	50,030	115,970	

NP NZEB intermediate targets – major renovation of existing buildings (m²)	**2015**	**2018**	**2020**
Single-family houses	241,000		2,395,000
Apartment buildings	88,000		596,000
Public buildings		123,000	
Other non-residential buildings		190,000	
3% of buildings owned and occupied by central government (Art. 5 of Directive 2012/27/EU)	2,000	20,000	

Figure 5: The residential highrise NZEB demonstration building Eco Silver House with 128 flats, built in 2014 in Ljubljana. EPC class A1, standard annual heat demand 8 kWh/m^2.year, total delivered energy 48 kWh/m^2.year and primary energy 76 kWh/m^2.year with additional 6.5 kWh/m^2.year of exported (primary) electricity from PV (FP7 EE-HIGHRISE, www.ee-highrise.eu).

[5] *Ratio between the area of the envelope and the volume (m^{-1}).*
[6] *www.energetika-portal.si/dokumenti/strateski-razvojni-dokumenti/akcijski-nacrt-za-skoraj-nic-energijske-stavbe/*
[7] *www.ekosklad.si/information-in-english*

In the public sector it is common practice for kindergartens to be built according to NZEB principles and with significant share of wood, while environmentally conscious investors in the tertiary and commercial sectors occasionally follow NZEB principles in spite of the higher initial costs involved. The shift towards NZEB in the national building practice in the last decade is presented in Figure 6.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The long-term strategy for mobilising investment in the renovation of the national building stock in Slovenia was adopted on 29 October 2015[8].

The intermediate objectives of the long-term strategy for renovation of buildings by the year 2030 are:

- a 15% reduction of the final energy used in buildings by 2020, and 30% by 2030, when compared to 2005;
- at least 2/3 of energy use to be covered by RES;
- a 60% reduction of greenhouse gas emissions in the building sector by 2020, and at least 70% by 2030, when compared to 2005;
- the energy renovation of 26 million m^2 of buildings, or between 1.3 and 1.7 million m^2 per year, one third from that reaching NZEB standard.

The operative measurable goals of the long-term strategy for the renovation of buildings by the year 2020 and 2030 comprise, respectively:

- 3% of annual renovation of buildings owned and occupied by the central government (i.e., between 15,000 m^2 and 25,000 m^2 per year, and 180,000 m^2 in total, in the period 2014 - 2023);
- deep renovation of 1.8 million m^2 of public buildings within the 2014 - 2023 period;
- improved ratio (1:3) between invested public resources and initiated investments in energy renovation in the public sector;
- the implementation of five demonstration projects of energy renovation of different building types.

According to the long term strategy, the renovation rate of residential buildings is planned to be 1.7% in the period 2016 - 2020, 1.8% in the period 2031 - 2040

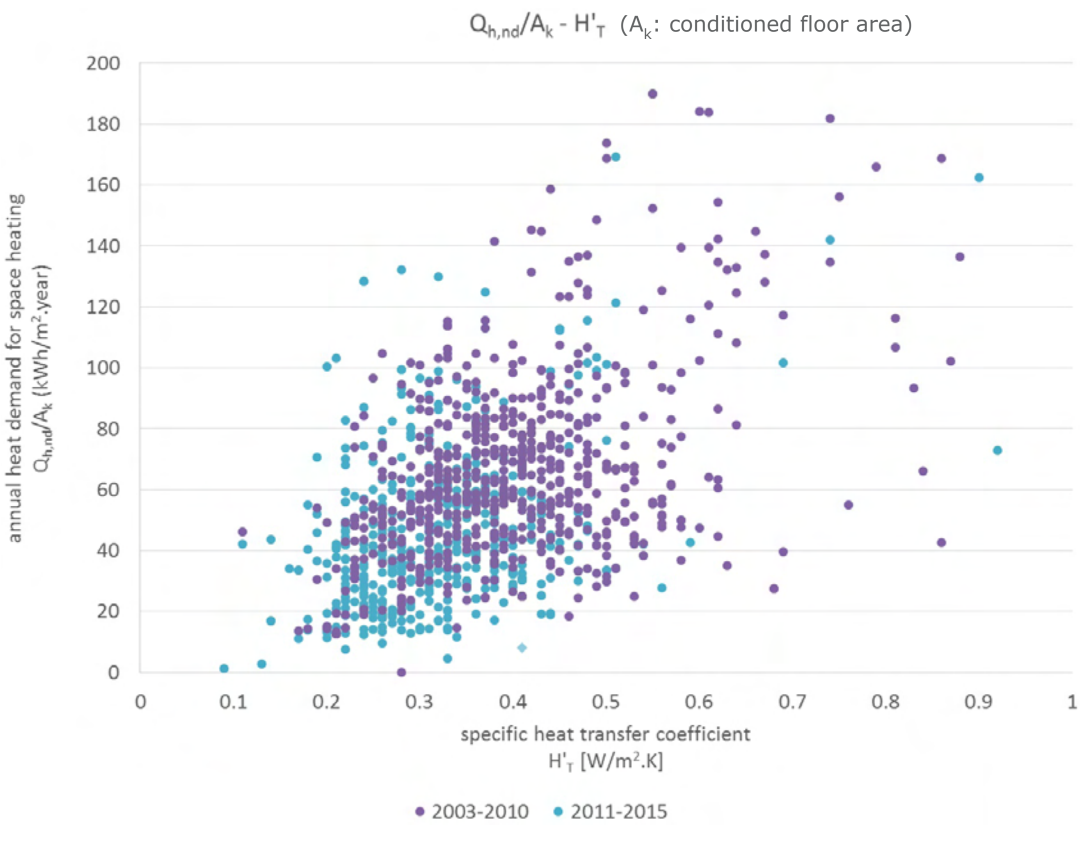


Figure 6: The shift towards NZEB in the national building practice based on calculated energy indicators (energy needs for heating and specific heat transfer coefficient) for real buildings constructed in 2003-2010 and 2011-2015. Source: ZRMK.

[8] *www.energetika-portal.si/dokumenti/strateski-razvojni-dokumenti/dolgorocna-strategija-za-spodbujanje-nalozb-energetske-prenove-stavb/*

and 2.3% in the period 2041 - 2050. The planned renovation rates for buildings in other sectors are presented in Figure 7.

By 2030, 12.8 million m^2 of single-family buildings, 4.1 million m^2 of apartment buildings, 3.1 million m^2 of public buildings (including governmental buildings) and 4.9 million m^2 of buildings in the tertiary sector will be renovated. Five demonstration projects for deep and NZEB renovation are planned for different types of public buildings in order to demonstrate renovation of heritage buildings, energy performance contracting and NZEB renovation, respectively.

The necessary investments in energy renovation are estimated to a total of 6,700 M€, three quarters of which are in the residential sector, 10% in the public sector and 15% in the private tertiary sector. Annually, between 350 and 400 M€ will be invested in energy restoration of existing buildings, around 300 M€ in the residential sector and 100 M€ in non-residential buildings (from which 40 M€ in the public sector and 60 M€ in the private sector).

Due to the building renovation, the energy use for heating and for preparation of hot water will be reduced by 10% by 2020, and 25% by 2030. It is estimated that deep renovation of existing buildings shall contribute around half of the targeted 27% increase of energy efficiency by 2030.

Financial resources for renovation of public buildings, mitigation of fuel poverty in households and demonstration projects are planned in the Operational Programme for the implementation of the European cohesion policy in the period 2014 - 2020. A strong focus is placed on the mobilisation of private resources.

Therefore, a budget line in the operational programme is also planned to support the development of energy performance contracting. The Eco fund will further provide grants and soft loans for the renovation of existing residential buildings, while new financial products are available as soft loans from commercial banks for the renovation of residential buildings. Energy renovation of existing buildings will rely to a great extent on the funds from the European Investment Bank (EIB), the funds of the Republic of Slovenia, private funds, and on the European Fund for Strategic Investments (EFSI).

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

In PURES 2010 and in the corresponding Technical guidelines TSG-01-004[9], requirements refer to energy efficiency characteristics of installations in new buildings and major renovations. The requirements are given for heating, hot water systems, AC and large ventilation systems. The system energy efficiency is achieved by selecting products that fulfil the energy efficiency requirements, with corresponding design and construction rules for sub-systems. Overheating must be reduced through passive measures (fixed and movable shading, night ventilation), and the remaining cooling needs must be covered by energy efficient cooling systems. Heat recovery in mechanical and hybrid ventilation systems is mandatory.

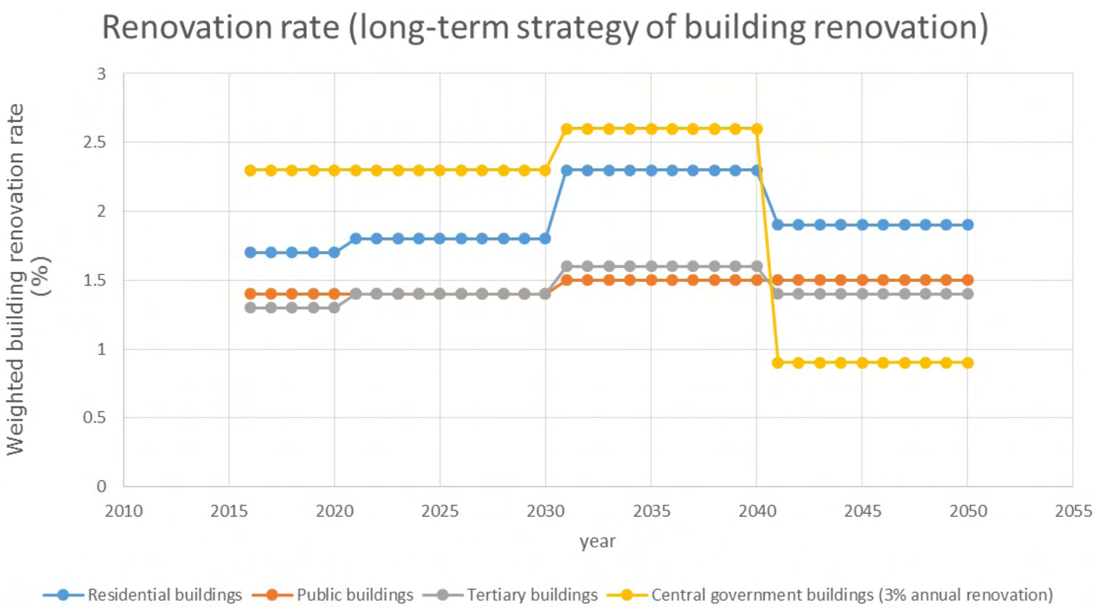


Figure 7: Renovation rates per building type according to the long-term strategy for mobilising investment in the renovation of the national building stock in Slovenia.

[9] *www.arhiv.mop.gov.si/fileadmin/mop.gov.si/pageuploads/zakonodaja/prostor/graditev/TSG-01-004_2010.pdf*

II.ii. Regulation of system performance, distinct from product or whole building performance

The regulation has imposed system performance requirements via many rules on product and sub-system energy efficiency.

Heat recovery in ventilation must be used in line with strict requirements for the maximum allowed heat losses through ventilation. The required airtightness of ventilation ducts is defined and must be controlled. The minimum required heat recovery in ventilation and/or AC systems is 65%, and 75% in low-energy buildings. Individual electrical heaters for DHW are not allowed unless they are economically reasonable.

Low temperature heating systems (max. 55 ^{0}C), as well as condensing gas boilers or, alternatively, high efficiency gas heat pumps, are obligatory in new buildings. As a rule:

> heat generators must be placed inside the thermal envelope;

> thermal losses of the distribution system must be less than 5%;

> specific use of electricity for transport in the heat exchanger must be below 16 $W_{electricity}/kW_{heat}$;

> variable speed drives are obligatory;

> automatic control of operation of heating devices and distribution systems is required;

> only energy efficient heating devices in case of liquid and gaseous fuels are allowed;

> heat losses of heating generators below 100 kW on stand-by are limited to 2.5%, and to 2% for generators with power above 100 kW;

> minimum COP is defined for heat pumps for heating and DHW preparation;

> the minimum insulation of the pipes in distribution systems is defined;

> thermostatic valves on the heat emission systems are obligatory.

In case of district heating and cooling, the heating and cooling energy consumption must be measured per individual building. In case of central heating, the allocation of heating costs according to the energy use per individual unit is subject to a separate regulation.

Additional requirements for cooling refer initially to obligatory shading of the envelope, and then to efficiency requirements for cooling systems. Taking into account the glazing characteristics, the total shading factor resulting from the positioning of natural or artificial objects, as well as from the position and type of the shading devices on windows, must be lower than 0.5 (g < 0.5). Internal shading devices are not considered as solar protection. There is a requirement for minimum allowed efficiency for cooling generators (Table 4), cooling bodies must

Table 4: Minimum allowed efficiency of cooling generators (CG) required by the PURES 2010 Building Code.

Type of cooling generator (CG)	EER	COP	ESEER	COP*	IPVL
Test by:	SIST EN 14511	SIST EN 14511	Euro vent	ARI 550/560/590	ARI 550/560/59
air-cooled CG	2.9	3	3	2.8	3.1
air-cooled CG with connection channels	2.5	2.8	3	–	–
air-cooled CG for radiant heating / cooling	3. 7	3.9	4.2		–
water-cooled CG - all up to 1,500 kW	4.7	4.2	4.3	–	–
with GC piston compressors				4.5	5.1
water-cooled CG – helical. screw compressor up to 500 kW	–	–	5	4.5	5.2
water-cooled CG - screw compressor 500 kW – 1,000 kW			5	4.9	5.6
water-cooled CG - spin. compressor up to 500 kW	–	–	5.2	5	5.3
500 kW - 1,000 kW			5.8	5.6	5.9
above 1,000 kW			6.3	6.1	6.4
air-cooled CG for radiant heating / cooling	4.9	4.2	5	–	–
CG with remote condenser	3.4	–	3.6	3.1	3.5
absorption - air/water-cooled single-stage	–	–	–	0.6/0.7	–
two-step	–	–	–	1	1

* COP is valid for measurements according to ARI (The American Refrigeration Institute), and it is equivalent to EER – Energy Efficiency Rating without taking into account the additional electrical power.

ESEER – European Seasonal Energy Efficiency Ratio

IPVL – Integrated Part Load Value

permit local adjustment in the range of 1.5 K, and central control is obligatory for large cooling systems.

The minimum requirement for lighting defines the maximum allowed specific power of lighting devices per building category (Table 5). Energy-saving lamps are obligatory. A maximum of only 20% of lighting may be provided by incandescent light bulbs.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

The systems' requirements are binding for all new buildings and for major renovations requiring a building permit if the old building's energy systems are replaced. In existing buildings, the compliance with relevant systems' requirements must also be achieved in case of maintenance works on systems, and also when components or whole systems are replaced. The general rules are given in PURES 2010, while the technical details are listed in the accompanying Technical guideline TSG-01-004, from July 2010.

II.iv. Provisions for installation, dimensioning, adjustment and control

The dimensioning of heating systems is done based on the SIST EN 12831 standard, replacing DIN 4701 since 2003. PURES 2010 brings additional energy efficiency requirements, while for sizing various components the engineers use mostly German technical guidelines (e.g., VDI 2050, VDI 2067). The ventilation and AC systems are sized according to the regulation for ventilation and AC (2002), keeping in mind the specific energy efficiency requirements from PURES 2010.

II.v. Encouragement of intelligent metering

Slovenia encourages intelligent metering in existing programmes with incentives for energy efficiency investments in public buildings (financed in the frame of cohesion funds) and the residential sector (financed by Eco fund), in a way that the installation of meters, devices and related software is an eligible cost of the renovation investment. The National Energy Efficiency Action Plan (NEEAP 2020) has provided for the optimisation of the operation of energy systems (retro-commissioning) in public buildings, for which also an alternative financing option exists in the form of energy performance contracting. According to the Operational Programme for the implementation of European cohesion policy, in the period 2014 - 2020, the introduction of energy management, including e-info points, will be supported, along with the automatic monitoring of consumption (energy monitoring) that facilitates the monitoring of performance indicators associated with an investment.

II.vi. Encouragement of active energy-saving control (automation, control and monitoring)

The Decree on energy management in the public sector passed the public consultation in mid March 2015 and introduced obligatory monitoring and targeting of measured energy indicators in public buildings. By December 2015, all public buildings over 250 m^2 are obliged to have energy management in place. The energy data shall be collected electronically by special applications for energy management and then stored in a national e-registry.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The EPC was first introduced by the Energy Act of 2006 (revised in 2012). The current system is prescribed in the most recent Energy Act (EZ-1) adopted in February 2014 (Articles 333 to 347)[10].

The current regulation on the certification methodology was adopted in December 2014[11].

Table 5: Maximum allowed lighting power density required by the PURES 2010 Building Code.

Description of the space	Lighting power density (W/m²)
Residential buildings	8
Hotels, office buildings	11
Restaurants	15
Libraries, industrial buildings	14
Conference rooms, courts, pavilions, educational and research buildings, health buildings	13
Post offices, dancing halls, museums, galleries, sports halls	12
Small shops	16
Shopping malls	9
Garages	3

[10] www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO6665
[11] www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV11883

The certificates are completed by licenced independent experts and issued by authorised organisations.

The database of issued EPCs is maintained by the Ministry of Infrastructure. All EPCs are stored in an electronic registry, currently available in beta version, while the official e-registry linked to the national real estate database is in testing phase. From the beginning of 2015, all issued EPCs are also publicly accessible via the national real estate registry at the Geodetic Administration of the Republic of Slovenia[12] (Figure 8).

An EPC is obligatory for new buildings, where it is part of the documentation of the completed construction works. All existing buildings must have an EPC when sold or rented and, by law, the building owner must show the EPC to the buyer/tenant before the contract is concluded. Display of the energy performance indicator is obligatory in advertisements, and, in all public buildings with more than 250 m² floor area, the EPC must be displayed in a clearly visible place.

The Energy Act EZ-1 defined the penalties for non-compliance with EPC rules. On 24 February 2014 penalties between 1,000 € and 10,000 € were introduced for public building owners/users if an EPC is not displayed. A fine is also set for the person responsible for the task (from 100 € to 500 €). The penalties (250 €) for building owners advertising the selling/renting of the building without displaying the energy indicators from an EPC are in place from 1 January 2015, while as of 24 February 2015 the penalty for selling/renting a building without an EPC is 300 €.

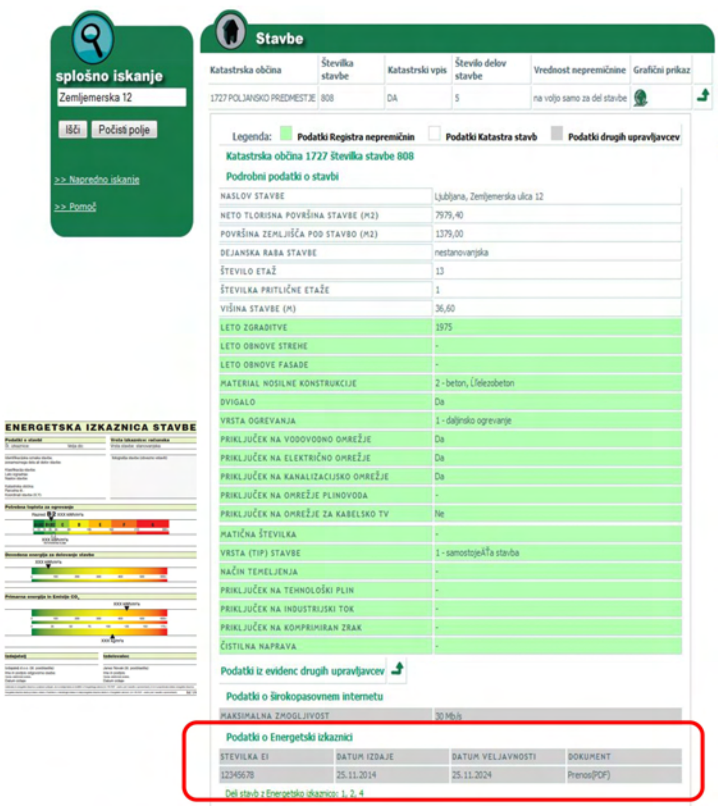


Figure 8: Presentation of EPCs in the real estate registry at the Geodetic Administration of the Republic of Slovenia

How flats are certified in apartment buildings

For residential buildings, there is provision only for calculated EPCs. Residential buildings can be certified as a whole, or per apartment. In existing buildings both options are used, depending on the decision of the building owners and their interest in further building renovation. The new EPC methodology from 2014 defined an adjusted method for certification of apartments in a building with a common heating system. The EPC issued for a building as a whole cancels the previously issued EPC for an apartment: once the whole building is certified, an EPC for an individual apartment is no longer possible.

Format and content of the EPC

The 'calculated' EPC contains four calculated indicators (based on the SIST EN ISO 13790):

> A first indicator ranks the energy needs for heating (kWh/m².year) during one year in 7 energy efficiency classes ranging from A to G, whereby classes A and B are further divided into two sub-classes (Table 6).

> A second indicator covers the final energy (kWh/m².year) delivered for space heating and space cooling, hot water preparation, operation of ventilation systems, (de)humidification and lighting.

> The third and fourth indicators describe primary energy (kWh/m².year) and CO_2 emissions (kg/m².year), calculated from the primary energy demand.

Table 6: The classes for annual energy needs for heating reflect the thermal quality of the building and the building envelope.

A1	0 to 15 kWh/m².year
A2	10 to 15 kWh/m².year
B1	15 to 25 kWh/m².year
B2	25 to 35 kWh/m².year
C	35 to 60 kWh/m².year
D	60 to 105 kWh/m².year
E	105 to 150 kWh/m².year
F	150 to 210 kWh/m².year
G	above 210 kWh/m².year

[12] http://prostor3.gov.si/javni/login.jsp?jezik=sl

All four indicators are presented on the front page of the certificate, in a coloured scale.

For existing non-residential buildings, there is the alternative of a ‘measured’ EPC (based on the SIST EN 15603) if the energy consumption data are insufficient, or not reliable. The final decision is made by the independent expert. In residential buildings only calculated EPCs are provided for.

The core indicators in the operational rating are: final energy for heating (kWh/m^2.year), electricity consumption (kWh/m^2.year), primary energy (kWh/m^2.year) and CO_2 indicator (kg/m^2.year). The indicators are presented with the use of a sliding scale.

In both versions of the EPC (Figure 9), the other pages contain a detailed structure of the energy use, a description of the building and its systems, and recommended energy efficient measures with a link to more information on financing options.

EPC activity levels

The full implementation of the EPC started in July 2013. By the end of 2015, almost 28,000 EPCs were issued, 77% for residential and 23% for non-residential buildings and building units (Figures 10 and 11).

The crisis in the construction sector is reflected in the relatively low number (approximately 500) EPCs for new buildings. Over 2,200 EPCs were issued for public buildings due to the obligatory display of the certificate. The increase of EPCs issued since December 2014 (Figure 12) is a consequence of the penalties imposed for failure to present EPC indicators in advertisements and in the selling/renting process.

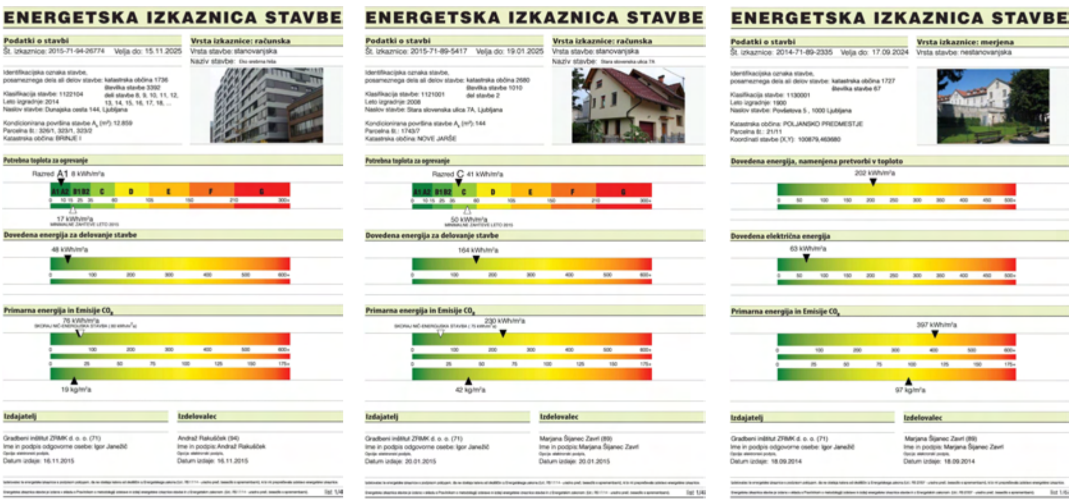
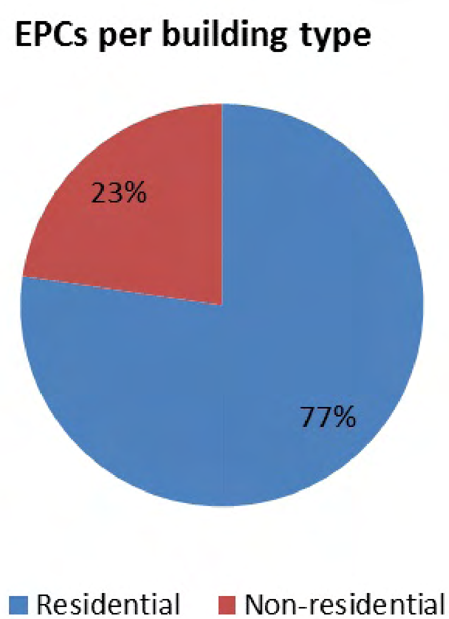
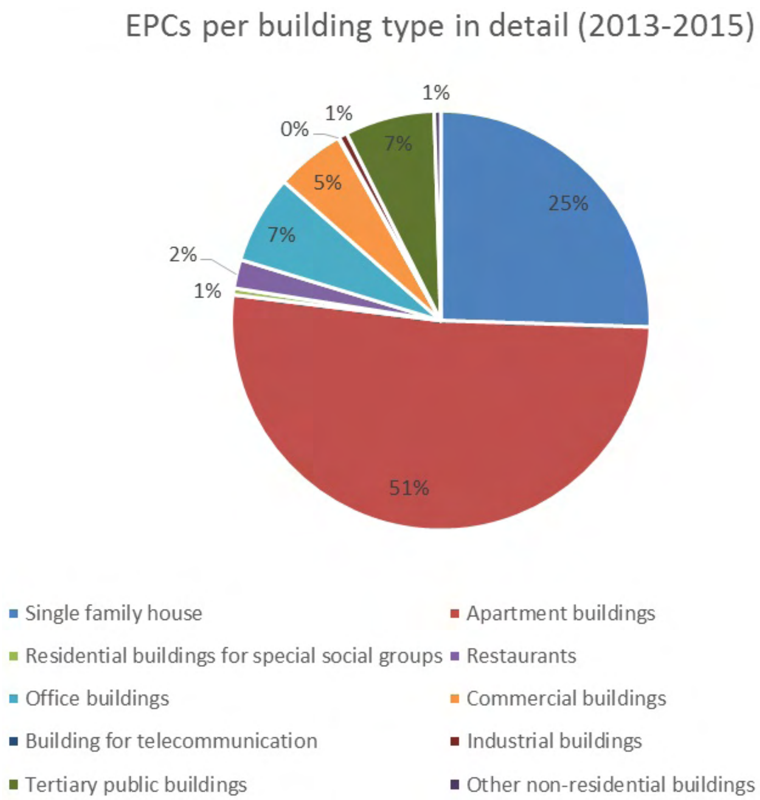


Figure 9: Examples of EPCs: for a NZEB apartment building, for an existing single-family house, and a metered EPC for a public building.

Figure 11: Energy performance certificates issued per month in the period 2013-2015 in Slovenia.

Figure 10: The structure of issued EPCs per building type in the period 2013-2015.





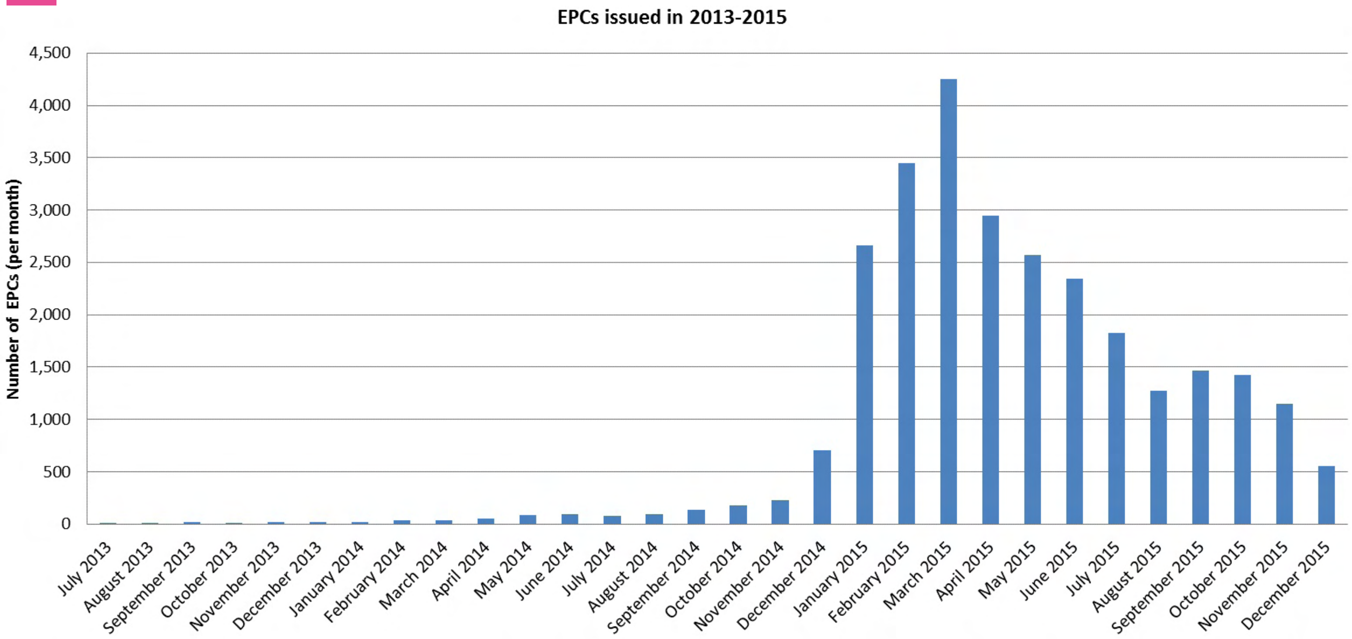


Figure 12: The detailed structure of issued EPCs in the period 2013-2015.

Typical EPC costs

The price of an EPC is defined by the market and it is not monitored systematically. The typical cost of the EPC for a single-family house is by rough estimation between 150 € and 400 €, depending on the quality of the available technical documentation and the location of the building. For a single apartment, the EPC price varies between 80 € - 200 € and for a whole apartment building the price is between 20 €/apartment and 50 €/apartment. The price of a measured EPC in public buildings is part of the public procurement process and is subject to building complexity and competition. Sometimes the assessor's expected amount of work is underestimated, resulting in very low prices of EPCs.

Assessor corps

In the period 2011 - 2014, the training courses and exams for Qualified Experts (QEs) were conducted by an authorised organisation (the Building and Civil Engineering Institute - ZRMK). For the period 2014 - 2019, an additional organisation is authorised to provide these courses and conduct the exams (ZRMK and Chamber of Architects – ZAPS). The obligatory training (27 hours in classes and 2 weeks of homework for both 'calculated' and 'measured' EPCs) covers regulations for energy performance certification, special topics relating to the energy efficiency of building elements and systems, brief information on the calculation and measurement rules, evaluation of the energy efficiency data for the certificate, recommended measures, as well as certification protocols and issuing procedures. Basic knowledge about energy flows in buildings is not a subject of the training, as candidates are professionals with a technical university degree in architecture or engineering. The preparation of the training material is coordinated at state level. By the end of 2015, around 360 persons had been trained as independent experts on energy performance certification and they were granted the state licence, and 444 institutions were authorised to issue EPCs prepared by licenced independent experts[13].

The experts are offered further technical support from the ministry and the authorised training providers[14].

There are periodic workshops organised by the Association of independent EPC experts and the training provider ZRMK on the occasion of new regulations or technical novelties.

The ministry prepared a web page with information on frequently asked questions for the general public[15].

Compliance levels by sector

EPCs for new buildings are part of the technical documentation of the building once constructed. They are submitted as part of the process of obtaining permission for use of the completed building. As an EPC is a precondition for permission to use the building, the

[13] *prostor3.gov.si/javni/login.jsp?jezik=sl*
[14] *www.energetika-portal.si/podrocja/energetika/energetske-izkaznice-stavb/register-strokovnjaki-izdajatelji/*
[15] *www.energetika-portal.si/podrocja/energetika/energetske-izkaznice-stavb/za-drzavljane/*

compliance rate in new buildings is good. In other sectors, compliance is growing due to intensive information and awareness campaigns, strong publicity on EPCs in the period 2013 - 2015, and also due to the imposed penalties for non-compliance in 2014.

Enforcement with building owners and real estate actors

In case of existing buildings put on the market, the real estate agents play an important role in informing and raising the awareness of sellers and buyers/tenants. The rental market is quite small in Slovenia due to the fact that most of the houses/apartments (over 90%) are occupied by the owners themselves.

Compliance with EPC requirements in case of a sale or rental is checked during the building inspection. The ministry can cross-link the database of real estate transactions with the EPCs' database and verify the compliance. Upon completion of the e-registry of EPCs (due by the end of 2015), such control will be obligatory.

Quality Assurance (QA) of EPCs

In 2013, the Ministry of Infrastructure first checked the validity of the input data for 234 EPCs, and then also verified the results and recommendations for 5 EPCs. The Quality Assurance (QA) in 2014 and 2015 was focused on the control of all basic data in EPCs and it was supported by the beta version of the e-registry, which allowed the plausibility check of input data and energy indicators in EPCs. The building's spatial data in all EPCs were checked by the ministry when the link with the real estate database for public access to EPCs was established. With the electronic registry of EPCs fully operative, from 2016 the ministry will be able to perform an automatic quality check supported by a system software, where the credibility of the input data and the plausibility of selected indicators will be checked in order to avoid potential mistakes even before issuing the EPC.

Slovenia is establishing an additional QA check step after the EPC is issued. This will be the last step in the QA check process of selected EPCs, to become operational in 2016. By legislation, the ministry can hire technical support to implement a full data review of the calculations, as well as a building audit in order to check the accordance with the requirements and methodologies. The e-registry will facilitate the selection of EPCs for a thorough QA procedure.

III.ii. Progress and current status on public and large buildings visited by the public

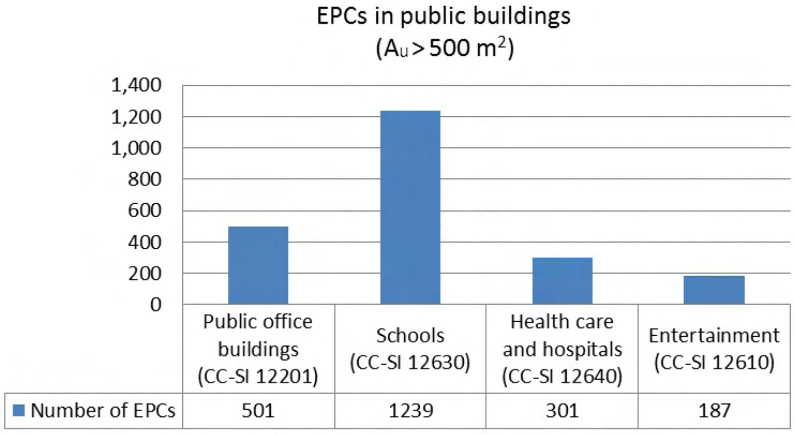
Overview

The Slovenian regulation (Energy Act EZ-1 and Regulation on EPC methodology) defines in detail the type of public buildings visited by the public and thus subject to public display of the EPC. From approximately 25 million m^2 of non-residential buildings, 35% are public buildings. The EPC must be displayed in all public buildings used by public authorities for health care (e.g., hospitals), education and research, and for culture and entertainment (Figure 13). These buildings represent over 6 million m^2, or 25% of the non-residential building stock. The public authorities are rigorously implementing the necessary procurement steps in order to comply with the energy performance regulation, as penalties are in place since February 2014. Most of the EPC procurement processes were completed in 2014, but additional ones are in progress to cover also the display of EPCs in public buildings with a floor area between 250 m^2 and 500 m^2, as required by legislation after July 2015.

Displayed EPCs are also valid for a maximum of 10 years. However, with the anticipated centralisation of the energy related data in the electronic registry, the energy monitoring in the public sector required by the forthcoming decree on energy management (drafted in 2015, adoption planned for 2016) will give new options for further development of display certificates (e.g., annual update of the display EPCs based on the energy consumption figures from energy management data).

Since the same QA rules are used for EPCs in public buildings as in other buildings, no separate statistics are available.

Figure 13: Number of displayed EPCs per building type.



Format and content of the EPC

The measured EPCs defined for public buildings have the same format as EPCs for non-residential buildings. Only the first page has to be displayed.

Activity levels

By now, up to 8% of all EPCs (over 2,200) are issued for large public buildings visited by the public. Most of these EPCs were issued for buildings that were renovated.

Costs

The actual costs of the EPCs in public buildings are not available. However, in practice, the price of the cheapest bid winning the public procurement is very low.

Assessor corps

Formally, the same licence is required for independent experts issuing EPCs in housing and in large buildings. So, there are no differences in qualification from sector to sector. Experience and references are listed by the bidders, but they are usually not evaluated in the procurement process, with a selection made based mostly on the lowest cost.

III.iii. Implementation of mandatory advertising requirement

Display of the energy performance indicator of the EPC is obligatory in case of advertising. For calculated EPCs the energy class must be presented in advertisements, while for metered EPCs the annual primary energy must be shown. The Energy Act includes certain exemptions to the requirement for displaying the EPC. These exceptions are valid for heritage, religious and worship buildings, industrial buildings and warehouses, non-residential agricultural buildings if unheated, buildings not intended for living and therefore with no demands for heating or AC, and all self-standing buildings with a floor area below 50 m^2. All of the above buildings are also exempted when rented as a whole or in part for a period shorter than one year. If the building is exempted in the Energy Act, this must be clearly indicated in the advertisement.

Approximately 20% of advertised buildings and apartments were withdrawn from the real-estate web portals for not fulfilling the requirements of EPC advertisement. After a transitional period in 2014, on 1 January 2015 penalties for non-compliance with the mandatory advertising of the EPC came in force (250 € fine for a building owner). Enforcement of the requirement on obligatory display of the EPC in advertising is the responsibility of the building inspector. Currently, approximately 2,500 EPCs are issued per month, 20,000 units are advertised on the real estate market and 10,000 units are sold per year. Therefore the progress of compliance with the regulations is considered good.

III.iv. Information campaigns

In spite of the fact that the ministry did not implement an information campaign to launch EPCs and support their implementation, various information and awareness raising activities in the last few years familiarised building owners with the EPC. Workshops, lectures, numerous articles, student's theses, web sites, forums, round tables, interviews on radio and television, even political discussion, as well as negative publicity in the media (additional financial burden and time barrier for owners selling the building, complaints about very high prices of EPCs on one side and very low prices on the side of experts), made the EPC known to practically everyone in the country. Many persons loudly opposed to it, while on the other hand there are also many supporters that understand the EPC as a trigger for investments in renovation, as well as a business opportunity. The imposed penalties had a deterrent effect and initiated a massive certification process in 2014 and 2015 as buyers started to ask for EPCs. Incentives for having an EPC issued for an apartment building as a whole are planned in the frame of a longterm strategy for deep renovation of existing buildings, where EPCs are also considered a precondition in the deployment of energy performance contracting.

III.v. Coverage of the national building stock

EPCs are issued for every new building since, under PURES 2010, the design certificate is followed by an EPC reflecting the building 'as built' for obtaining the permit for use. It is estimated that nearly 60% of the new buildings (in terms of total floor area) are checked for compliance when the building is finished, and that also includes an EPC. Around 40% of new buildings are single-family houses and, if built for investors' personal use, they do not need a permission to use. Consequently, such a single-family house will get an EPC only if put on the real estate market. The 40% share is relatively high, but in the period 2013 - 2015 there was significant reduction of construction of new apartment buildings due to the saturated market after the real-estate crisis in 2009.

Almost 28,000 issued EPCs for all building types (at the end of 2015) approximately correspond to as much as 4.4% of the total number of apartments certified, and to at least 4.5% of certified residential buildings in total (houses and apartments) (Tables 7 and 8). Public buildings subject to EPC for display have been successfully certified according to the legal requirements. The share of EPCs issued in the non-residential sector has not been assessed yet due to difference in the data structure.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Slovenia has a combined system including inspections and alternative measures in the inspection of heating systems. A mandatory inspection of the installations of heat generators with a power above 600 kW is required, undertaken by qualified independent experts (in 2015 the new regulation on this topic has successfully passed the public consultation, with the adoption expected in 2016). For nominal heat output of the generators between 20 kW and 600 kW, the use of alternative measures is in place under the existing scheme of chimney sweepers' inspections.

Inspections are required for AC systems with more than 12 kW nominal power. The methodology is defined in the regulation for regular inspections of AC systems (adopted in 2008).

IV.i. Progress and current status on heating systems

In Slovenia, the owner of a building or building unit shall ensure the carrying out of regular inspections of accessible parts of systems used for heating, with boilers of an effective rated output for space heating purposes above 600 kW. As a minimum, inspections shall include the heat generator, control system and circulation pumps. The inspections must also include an assessment of the efficiency of the heating systems and their suitability to the use of the building.

The ministry drafted a regulation on the systematic inspection of heating systems that passed public consultation in 2015 and is expected to be finalised and published in 2016. It defines the content, type and time intervals of regular inspections of heating systems, the data to be collected, the method for keeping the register and for reporting new entries, the method of training of experts, as well as criteria for determining the price of the inspection report, though the price itself will be subject to the market.

The inspections of heating systems must be carried out by independent experts with a state licence, as defined in Article 341 of the Energy Act. During the inspection, independent experts authorised by the ministry shall take into account the methodology laid down in the regulation governing regular inspections. Based on the inspections carried out, when drawing up the inspection report independent experts must advise users on possible improvements or replacement of parts of the heating system. The inspection report on the heating system shall be handed over to the owner of the building or building unit, and must be submitted by the independent expert for entry in the register of inspection reports on heating systems.

As the inspections of heating systems are carried out by the open market, the prices are neither regulated nor monitored.

By 2015, a total number of more than 80 pilot inspections of heating systems were carried out in Slovenia in the frame of various projects (e.g., Energy Advisory ENSVET, IEE Movida[16], etc.).

Table 7: Number of issued EPCs by December 2015 according to building type.

Building type (CC-SI classification of buildings*)	Number of EPCs (December 2015)
Single-family house	7,076
Apartment buildings (incl. apartments)	14,288
Residential buildings for special social groups	142
Restaurants	615
Office buildings	1,895
Commercial buildings	1,474
Buildings for telecommunication	26
Industrial buildings	180
Tertiary public buildings	1,920
Other non-residential buildings	140

* CC-SI – Classification of types of Construction in Slovenia (EUROSTAT)

Table 8: Residential buildings in Slovenia (single-family houses and apartment buildings) according to the Census 2012.

	Single-family houses (1 or 2 flats)	Apartment buildings	Total
Buildings (number)	493,283	25,315	518,598
Apartments (number)	526,825	325,868	852,693
Useful floor area (1,000 m^2)	50,349	16,814	67,163

[16] *www.movida-project.eu/*

Arrangements for assurance, registration and promotion of competent persons

The Ministry of Energy is responsible for the database of inspectors and inspected heating systems.

Qualification requirements for entrance in the scheme are defined in accordance with Article 341 of the Energy Act, i.e., independent experts shall be accredited for inspections of heating systems provided they meet the following requirements:

> they have at least a high professional education degree[17], with the subjects of study falling within a specific field of engineering, (except specific fields of chemical engineering and process engineering or the field of motor vehicles, vessels and aircraft), in accordance with the regulations governing higher education;
> they have at least two years of appropriate work experience in the professional field of heating systems, after attaining the educational level referred to in the preceding requirement;
> during the last five years prior to their application for the accreditation, they have successfully completed a training course for independent experts for inspections of heating systems.

Candidates who pass the training course and examination shall be accredited at their request upon proof of successful completion of training and they will receive the license for inspector of heating systems by the ministry.

The Ministry of Infrastructure prescribed the training programmes which independent experts should complete in order to produce EPCs or carry out regular inspections of AC and heating systems.

A more comprehensive monitoring system for quality control is planned in 2016.

Penalties and promotional activities

Promotional activities are carried out through web portals, various brochures and presentations at events. A stronger promotional campaign effort is envisaged for the future.

Penalties are prescribed by the Energy Act, and the energy inspection is responsible for checking compliance. A penalty of 300 € is foreseen when the owner of a building or building unit fails to ensure regular inspections as provided in Article 338 of the Energy Act.

IV.ii. Progress and current status on AC systems

In Slovenia, the owner of a building or building unit must ensure regular inspections of every AC system with more than 12 kW nominal power. The methodology is defined in the regulation on regular inspections of AC systems (adopted in 2008). Inspections of AC systems shall include at a minimum: an inventory and review of documentation, visual and functional check of the AC system and air-conditioned rooms, preparation of proposals for improvement and alternatives, and creation of the inspection report.

The ministry defined the details concerning the content, type and time intervals of regular inspections of AC systems (every five years), the type of data to be collected, the method for keeping the register and for reporting new entries, the method of training of experts, as well as criteria for determining the price of the inspection report, though the price itself will be subject to the market.

AC system inspections must be carried out by independent experts with a state licence, as defined in Article 341 of the Energy Act. During inspection these experts, authorised by the ministry, shall take into account the methodology laid down in the regulation governing regular inspections of AC systems.

As the inspections of heating systems are carried out in an open market, the prices are neither regulated nor monitored.

Arrangements for assurance, registration and promotion of competent persons

The qualification requirements for obtaining the licence and registration of AC inspectors in the national database are the same as described for inspectors of heating systems.

The registry of accredited independent experts with licence from the state is kept by the ministry along with the registry of inspection reports for AC systems.

Promotional activities are carried out through web portals[18], various brochures and presentations at events. In the future, the ministry plans to organise a stronger promotional campaign.

Inspections of AC systems in Slovenia have been carried out in the form of pilot projects in the tertiary building sector in

[17] *A 3-year university degree. At least Bachelor degree: B.Eng. (professional) or B.Sc. (scientific).*
[18] *www.energetika-portal.si/podrocja/energetika/redni-pregledi-klimatskih-sistemov/*

the framework of the IEE HARMONAC project[19]. So far, from the period 1978 – 2001, 25 inspections of AC systems were performed in buildings sized between 720 m² and 36,000 m². The outcomes from such pilot inspections were integrated in the current regulation on inspection of AC systems.

Enforcement and penalties

Penalties are set by the Energy Act. A penalty of 300 € is foreseen when the owner of a building or building unit fails to ensure regular inspection of the AC systems of buildings or parts of buildings in which AC systems of a nominal output capacity exceeding 12 kW are installed.

The first formal quality controls of AC inspection reports will be finished in 2016.

IV.iii. Alternative measures

The mandatory inspection of heating systems is prescribed for heating systems of 600 kW and more, while the use of alterative measures is in use for heating systems with power between 20 kW and 600 kW. One of the alternative measures is the existing scheme of chimney sweepers' inspections, a public service that includes an examination of small boilers, chimneys and vents. Other alternative measures are under development.

3. A success story in EPBD implementation

The web platform *Energetskaizkaznica*[19], which was instrumental in supporting the further development of EPCs, is dedicated to professional training of EPC experts and support to licenced independent experts in completing EPCs, as well as to building owners. The web platform acts as an e-learning environment, a simulated e-registry of EPCs, an e-club supporting licenced independent experts for issuing certificates, and an e-advisory corner for building professionals.

The web platform was developed to support an effective implementation of the EPC by upgrading the traditional training process with complementary e-training of experts (Figures 14 and 15). This was achieved by developing a mock-up tool for issuing EPCs and by implementing the electronic registry of issued EPCs. The training part of the web platform enables the elaboration of a school certificate, with the presentation of the building assessment in ten slides. This ensures an interactive e-communication within the team of trainees on technical elements of EPCs. Optimisation of the training by e-learning elements facilitated the exchange of trainees' experiences gained by doing the certificates on actual buildings. The service was evaluated very positively by the candidates during the training.

Stakeholders obliged to comply with the EPC regulation (independent experts, private and public building owners, buyers and tenants, general public), are supported via the web platform with the following information and services: information on EPC legislation and resulting obligations, structured database of licenced independent experts amended with professional references and regional coverage information, as well as a frequently asked questions section. Experts are offered technical details on filling out and issuing EPCs through a training environment that simulates the

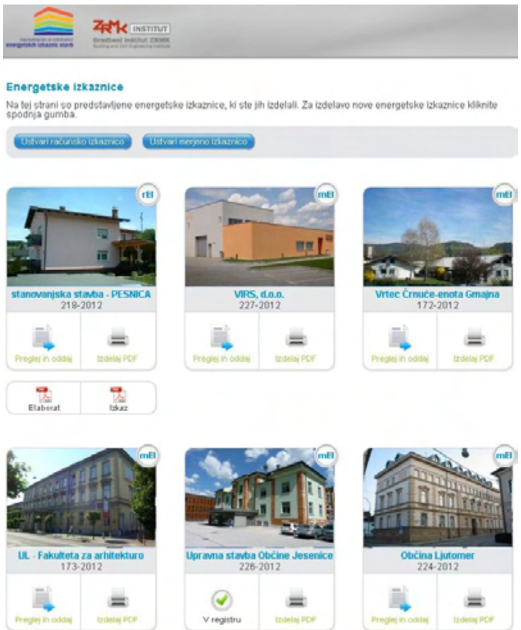


Figure 14: Registry of EPCs used for the training of EPC experts.

Figure 15: Independent experts training for energy performance certification in January 2015.

[19] *ec.europa.eu/energy/intelligent/projects/en/projects/harmonac*
[20] *energetskaizkaznica.si/*

completion and issuing of EPCs, as well as a club of independent experts with a web forum on actual topics relating to EPCs and building renovation. A special part of the web platform is an advisory section dedicated to the improvement of buildings' energy efficiency. In that section, there is commercially independent information available, concerning the application of cost-effective measures on buildings and building systems, the potential use of renewables, as well as cost-optimal measures that lead to NZEB. Building owners are provided with comprehensive information on the references and professional specialisation of independent experts who may further cooperate with the building owner during the implementation of recommended measures in an EPC.

The e-registry of EPCs in the *Energetskaizkaznica* web platform is informally and provisionally used as a national electronic database of EPCs in Slovenia. Within 2015, the data from this tool was integrated in the official e-registry of EPCs linked to the building cadastre. The web platform has a public part and an internal part, used daily by approximately 300 licenced independent experts, and periodically by almost 1,000 interested stakeholders and trainees in energy performance certification.

4. Conclusions, future plans

The implementation of the Energy Performance of Buildings Directive (EPBD) has been a complex process for Slovenia. Certain parts of the requirements, e.g., energy performance certification and EPBD-based building codes, were successfully implemented and are already well accepted by professionals and the general public, while for other elements there is still progress to be booked.

Further plans are oriented to optimising certain parts in the regulation, e.g., upgrade of the energy performance calculation methodology in accordance with the new CEN EPBD standards, energy performance certification for complex non-residential buildings, as well as inspection of heating and Air-Conditioning (AC) systems, and to finding a balance between more effective implementation procedures, reasonable application of penalties in case of non-compliance and creating a high level of acceptance of EPBD obligations.

Implementation of the EPBD in Spain

STATUS IN DECEMBER **2014**

1. Introduction

In Spain, responsibility for the Energy Performance of Buildings Directive (EPBD) lies with the Ministry of Industry, Energy and Tourism, the Ministry of Public Works and Transport, and regional administrations.

Spain began to implement the energy certification of buildings in 2002, though different methodologies already existed for the energy evaluation of newly constructed buildings, as did requirements for energy efficiency in new buildings.

It was not until 2007 that the LIDER/CALENER tool, the official tool created to simulate and evaluate energy efficiency in Spanish buildings, was produced. Use of the tool became compulsory for practitioners, in order to demonstrate compliance with the Spanish regulations also issued in 2007 (Royal Decree 47/2007), in response to Directive 2002/91/EC.

From 2007-2012, energy certification in Spain was mandatory only for new buildings. In 2013 the requirement was extended to apply to the sale or rental of existing buildings (through Royal Decree 235/2013).

The Technical Code for Construction (Codigo Technico Edificación) was published in 2006. This document set out the rules and minimum requirements for new buildings. This included requirements for the envelope, the systems of production of cold and heat (heating system regulations), ventilation, etc.

As a supplement to the Technical Code for Construction 2006, a regulation (Royal Decree 1027/2007) on heating systems was published in 2007. It is known as Regulation of Thermal Installations in Buildings (RITE)[1], and it addresses more technical issues related to heating and cooling systems. It not only established production systems' energy efficiency requirements, but also established the obligation to carry out maintenance and schedule inspections of air conditioning (AC) systems in buildings in Spain.

Since all laws and regulations, namely the Technical Code for Construction and RITE, must be updated every five years, there were several publications in 2013. In particular, Royal Decree 235/2013 set out the new procedure for building certification and the RITE (Royal Decree 1027/2007) was updated through Royal Decree 238/2013, with tightening of energy efficiency requirements, and the review of the scope of the maintenance system. The Technical Building Code was updated through the Order 1635/2013.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

The 2006 publication (Royal Decree 314/2006) of the minimum requirements of energy efficiency for the construction of new buildings was a milestone because until then requirements of energy efficiency in building construction had only been set by general rules.

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NATIONAL WEBSITES www.minetur.gob.es, www.fomento.gob.es, www.idae.es

[1] *RITE – Reglamento de Instalaciones Térmicas de los Edificios*

The Technical Code for Construction 2006 set out the requirements for heat transfer in new buildings, following an analysis of the climate conditions in the various regions of Spain (both for heating and cooling).These requirements therefore depend on several factors, e.g., the climatic zone and percentage of glazed area in the building envelope. The code also covers structural requirements and limitations to prevent moisture. Requirements are also applied to the production of heating and cooling systems and lighting, and to the use of Renewable Energy Sources (RES).

All these parameters have evolved in recent years, and the requirements have become more restrictive, in order to increase the energy efficiency of buildings. In 2013, these parameters were further updated following the completion of the cost-optimal study.

I.ii. Format of national transposition and implementation of existing regulations

The rules and regulations governing energy efficiency requirements in Spain are contained in the Technical Code for Construction, which was last updated by Order 1635/2013. This document contains all the information necessary to meet the minimum requirements for energy efficiency in new buildings, as well as energy rehabilitation of existing buildings.

These minimum requirements are related to all aspects of the thermal envelope of the building, systems of cold and heat production (supported by the specific and technical document RITE) and renewable energies, and they have been specifically calculated following the methodology and criteria established by the Energy Efficiency Directive (Directive 2012/27/EU - EED).

The methodology used for the preparation of these requirements included an analysis of the best solutions per type of construction in Spain, and simulated different scenarios of climates, types of construction and production systems using the LIDER/CALENER tool, the official tool created to simulate and evaluate energy efficiency in Spanish buildings. The tool results were then used to determine which limit values should be used in the normative documents Technical Code for Construction and RITE.

LIDER/CALENER is consistent with the established methodology and it is based on the European standards in force at the time of the creation of the programmes. It includes in its calculations the building envelope, thermal bridges, infiltrations, solar shading, thermal inertia, and hours of operation, as well as the technical characteristics of the heating and cooling systems.

The requirements are set in terms of both (non-renewable) primary energy consumption and CO_2 emissions. These values are calculated through the LIDER/CALENER tool and are based on the final energy consumption and the application of specific factors that are published officially by the Ministry of Industry.

Support guides, energy factors, support for the application of the regulations, as well as other documents of interest are published at the website of the Ministry of Industry, Energy and Tourism[2].

I.iii. Cost-optimal procedure for setting energy performance requirements

The cost-optimal calculations and comparison with current and future energy performance requirements in Spain were completed in 2013, in order to comply with the obligations established by Directive 2010/31/EU and Delegated Regulation 244/2012. The calculations were based on six reference buildings for existing buildings and ten reference buildings for new buildings, taking into account the existing building database and typical characteristics of buildings in Spain. The calculations also considered different orientations, six climatic zones and many individual measures defined for each subcategory of multiple building combinations, in order to find the cost-optimal values.

The exercise produced the cost-optimal primary energy consumption, which set the minimum requirements for the new Technical Building Code in 2013. The calculated cost-optimal weighted energy demands were met for all the climatic zones, except for the warmest one (α-zone, corresponding to the Canary Islands). In this region, the cost-optimal measures have not been implemented yet. The results for this case indicated that in five out of six buildings, the minimum requirement for energy demand for cooling (there is no heating demand in climatic zone α) is either less than 15 kWh/m^2.year, or lower than 15%

[2] www.minetur.gob.es/energia/desarrollo/EficienciaEnergetica/CertificacionEnergetica/Paginas/certificacion.aspx

of the outcome of the cost-optimal results. Thus, it is not justifiable to establish more demanding minimum energy performance requirements for existing buildings located in the warmest climatic zones. That fact is applied to several climatic zones based on the severity of the climate in summer.

Some conclusions for the new minimum requirements are as indicated in Tables 1 and 2.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

In Spain, the definition of Nearly Zero-Energy Building (NZEB) has not yet been established, although work was in progress at the end of 2014. The plan is to set out the NZEB values alongside the revision of the Technical Code for Construction, which will take place in 2016-2017 and will become compulsory in 2018.

Figures and statistics on existing NZEBs

Spain still does not have a definition of NZEB, therefore it cannot identify buildings that comply with these requirements.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Spain has developed and submitted a strategy for the energy efficient rehabilitation of the national building stock, which focuses on an analysis of the rehabilitation of the building sector in Europe and specifically in Spain[3].

Considering the barriers as well as opportunities for energy rehabilitation in Spain, the strategy has developed measures in order to achieve the final objectives of energy savings and reduced emissions, based on the following points:

> policy measures;
> administrative measures;
> measures of finance and operations;
> information and communication measures;
> measures to develop business strategies, specifically focusing on communities of building owners;
> specific measures to deal with energy poverty.

The goals set for Spain depend on certain scenarios and alternatives. In particular, the building sector has a global goal for the period from 2014-2020 that varies, depending on the forecast savings of final energy consumption for both residential and non-residential buildings, between 2.652 ktep and 7.087 ktep.

The Ministry of Finance and Public Administration is responsible for upholding the exemplary role of the public administration. The Spanish national institute for the diversification and saving of energy (IDAE) has prepared an inventory of the buildings that will be affected, the total number of which is 2,184 (as of June 2015). The strategy for the renovations takes into account the potential savings based on the measures recommended on the Energy Performance Certificate (EPC).

The Ministry also intends to amend the legislation of public sector contracts to apply Article 6 of the EED in such a way that the central administration only purchases products, services and buildings that have high energy efficiency. This would also depend on profitability, economic viability, sustainability in a broader sense, and technical considerations, as well as sufficient competition, ensuring the multiple options that consider the best technologies.

Table 1: Comparison of Thermal Transmittance (TT) of windows on existing buildings (W/m².K).*

Climatic zone	Optimal TT	Comparison with DB-HE** 2006		Comparison with DB-HE 2013	
		Required TT	Difference (%)	Required TT	Difference (%)
α3	4.33	5.7	31.6	5.7	31.6
A3	4.45	5.7	28.1	5.7	28.1
B4	4.45	5.7	28.1	4.2	-5.6
C2	4.45	4.4	-1.1	3.1	-30.3
D3	3.90	3.5	-10.3	2.7	-30.8
E1	3.90	3.1	-20.5	2.5	-35.9

*Optimal values are calculated as the average of optimal values of each selected building
**DB-HE: the basic document of the Technical Code for Construction

Table 2: Comparison of Thermal Transmittance (TT) of side walls on existing buildings (W/m².K).*

Climatic zone	Optimal TT	Comparison with DB-HE 2006		Comparison with DB-HE 2013	
		Required TT	Difference (%)	Required TT	Difference (%)
α3	1.47	1.22	-17	1.35	-8.2
A3	1.47	1.22	-17	1.25	-15
B4	1.47	1.07	-27.2	1	-32
C2	1.47	0.95	-35.4	0.75	-49
D3	1.47	0.86	-41.5	0.6	-59.2
E1	1.16	0.74	-36.2	0.55	-52.6

*Optimal values are calculated as the average of optimal values of each selected building

[3] ec.europa.eu/energy/sites/ener/files/documents/2014_article4_es_spain.pdf

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

In Spain the regulation of buildings' technical requirements is included in the regulation of thermal facilities as part of the Royal Decree 238/2013.

This regulation is applied to fixed installations (e.g., lighting), Heating, Ventilation and Air-Conditioning systems (HVAC), and production of Domestic Hot Water (DHW), and is designed to meet the requirements for thermal comfort and indoor air quality. The requirements apply:

- to new buildings or renovations of existing buildings;
- to elements of existing buildings that are undergoing renovation (only the relevant parts).

II.ii. Regulation of system performance, distinct from product or whole building performance

The regulation of energy efficiency of Technical Building Systems (TBS) in Spain sets requirements depending on the type of system. In the case of heat production, RITE regulates HVAC systems, as well as pumps, fans, etc.

As an example, the regulation of heat production systems is developed using an approach based on performance or objectives, laying out the requirements that must be met by the systems, but without imposing the use of a particular technical solution, or preventing the introduction of new technologies and concepts, in terms of design (Table 3).

In this sense, rather than regulate the overall system, the regulations set limits on energy performance and energy losses in distribution. In the latest update to this regulation (Royal Decree 238/2013), the following changes were made:

- increase in requirements for thermal insulation of pipes, equipment, accessories and ducts;
- global distribution losses are limited to 4% of the maximum carrying capacity of the pipework or ductwork used;
- development of two procedures (simplified or alternative procedure) for the calculation of the thickness of thermal insulation, according to the nominal thermal power of generation of cold or heat installed.

For fans, the Specific Fan Power (SPF) is regulated, according to the power absorbed by the motor divided by the transported fluid flow rate (Table 4).

Lighting is regulated in a specific section of the Technical Building Code. In this case, a minimum lighting efficiency is required and the maximum power installed is limited.

The efficiency indicator is called "VEEI"[4] and is a function of the power, the area, and the medium illuminance in the room. As an example, an office lighting system has to meet the requirements set in Table 5.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

In Spain any requirements concerning the energy efficiency of installations affect both new installations and parts that have been replaced during the renovation of existing systems.

Table 3: Minimum performance requirements for boilers according to Royal Decree 238/2013.

Boiler	Efficiency at rated output		Part load efficiency	
	Average water temperature (ºC)	Energy performance (%)	Average water temperature (ºC)	Energy performance (%)
Gas boilers	70	≥90 + 2 log Pn*	≥ 50	≥97 + log Pn*
Liquid fuel boilers	70	≥90 + 2 log Pn*	≥ 40	≥86 + 3 log Pn*

*Pn: rated power

Table 4: Specific Fan Power.

Category	Specific Fan Power W/(m³/s)
SFP 1	SFP ≤ 500
SFP 2	500 < SFP ≤ 750
SFP 3	750 < SFP ≤ 1,250
SFP 4	1,250 < SFP ≤ 2,000
SFP 5	SFP > 2,000

Table 5: Lighting efficiency indicator and maximum allowed installed power for office lighting systems.

	VEEI (minimum)	Pmax (W/m²)
Office lighting systems	3	12

[4] *VEEI = P * 100 /(S*Em) - Lighting efficiency indicator, where P is power installed (W), S is surface (m²) and Em is medium illuminance*

In the case of a facility or building that is being renovated over more than 25% of its floor area, the requirements shall apply under the following conditions:

> incorporation of new subsystems of climate control, or modification of existing ones;
> incorporation of new systems of DHW production, or modification of existing ones;
> replacement or expansion of the equipment generating heating or cooling;
> change of type of energy used and the incorporation of renewable energy;
> change in the use of the building.

In all these cases, the refurbished system must meet the requirements set in the RITE, both in terms of performance and maximum allowable losses. These requirements apply to both the entire system, and to each partial section.

In the case of a simple generator exchange, the system must still comply with the performance requirements, but it does not qualify as a refurbishment project.

II.iv. Provisions for installation, dimensioning, adjustment and control

The installation of thermal conditioning systems in Spanish buildings must include a technical report, which details all information concerning the dimensioning and control of the installation. The report must also include an analysis of the alternatives to the selected system (e.g., other technologies, connection to district heating and/or cooling, etc.).

This analysis applies only to large installations of more than 70 kW.

All new facilities must comply with the requirements of energy input from RES, according to the Technical Code for Construction. Among the requirements, the Code requires a study of the best alternatives to cover all the energy demand for buildings using RES, wherever technically and economically reasonable. In particular, for large installations that require more than 70 kW heating and/or cooling power installed and with a useful floor area over 1,000 m^2, the designers should consider the implementation of RES with special attention to the use of biomass, as well as heat pumps to provide for 100% of the building's heating needs.

The Spanish legislation also differentiates the scope of the analysis of dimensioning and control according to the power needs and the floor area of the building, including all the sizing, building management systems or controls, and the analysis of alternatives. For large systems there are additional requirements, including more complex control systems, maintenance, etc. The air quality system is controlled by sensors that measure CO_2 or Volatile Organic Compounds.

II.v. Encouragement of intelligent metering

Metering of consumption, especially those aspects related to energy, is included in Spanish legislation, which allows for flexibility in the use of different metering systems.

The Spanish government has taken action in two directions:

> On the one hand, regulations such as the Royal Decree 1110/2007 regulate and promote the introduction of smart metering in the residential market (for electricity consumption). This regulation calls for the replacement of the current analogue meters with intelligent or smart meters that can be integrated into a remote management and measurement system implemented by the electricity companies.
> On the other hand, promotion of the use of intelligent or smart meters has been undertaken in the form of publications, e.g., guides published by IDAE.

For measurement of thermal consumption, all buildings must have fuel counters, as well as energy counters in the heating and cooling networks. New houses belonging to a block and with centralised heating and AC systems must have individual counters for each house.

Spain is preparing the publication of a Royal Decree which will regulate thermal consumption metering according to the EED and accounting for thermal consumption in centralised heating systems, whereby identifying intelligent measurement systems as the ideal for this type of metering.

Figure 1: Spanish guides for smart consumption metering.

II.vi. Encouragement of active energy saving control (automation, control and monitoring)

In line with the development of consumption metering systems, work is also being done to promote the integration of intelligent metering systems. All national regulations (updated in 2013) allow for flexibility in the incorporation of this type of technologies.

The calculation methodology for energy certification accounts for the use of control systems for lighting in non-residential buildings. The certification methodology includes these requirements.

Additionally, the government has also published guides relating to these systems. Specifically, IDAE has produced a guide titled "How to save energy by installing automation systems in your home", which informs and promotes the installation of such energy saving equipment.

Also the “Practical Guide to Energy Efficient and Responsible Consumption”, published in 2007 by the IDAE, contains related information. The guide includes contact information of professionals and businesses that can implement these systems in houses, as well as an example of improved installations, which include AC, lighting and zoning controls, and can achieve savings of up to 17% on heating, and 80% on lighting.

Figure 2: Spanish guide for automation systems in residential buildings

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The mechanism established in Spain for the implementation of the EPC for buildings includes the establishment of a national (instead of a regional) obligation that describes which buildings must have the certificate, which are exempt, and where they need to be registered.

Once carried out by qualified experts, EPCs must be registered in the respective region, through its registration office, which in turn will undertake the necessary controls to ensure the required level of quality.

Regional registries feed their own databases, and periodically (every 6 months) send the information to the central administration, where all the information is being automatically centralised at the national level. All the information is used to generate statistics that are publicly available on the official web site of the Ministry of Industry, but the databases themselves are not public.

How flats are certified in apartment buildings

Certification can be either for a whole building, or for part of it. In the first case, if the heating and cooling systems are common, certification is directly applied for the entire building. In the case of individual installations, qualified experts can simplify the EPC using the characteristics of similar apartments in the same building.

Additionally, it is possible to certify only one apartment in a building. In this case, the features of the external envelope and the real areas will be used. For an individual apartment with its own AC system, the EPC is based on its specific characteristics. If the building has a centralised AC system, the EPC uses the characteristics of the centralised systems with a power in proportion to the overall area of the conditioned spaces.

Format and content of the EPC

EPCs in Spain contain information concerning the location of the building, information about the competent technician, building features as dimensions, transmittance, installed power, etc., partial and global energy indicators, and finally the values of indicators with proposed energy efficiency improvements.

EPC activity levels

Table 6 shows the number of EPCs by region, for both new and existing buildings.

Typical EPC costs

The cost of EPCs in Spain derives from the free market and is very variable. Because of the need to certify public buildings, the Ministry of Finance and Public Administration has recommended rates for the issue of EPCs (average values in Table 7). These fees are based on estimates of the work to be carried out and are representative for other non-residential buildings.

Assessor corps

The qualifications required for the certification of experts are laid out in the Royal Decree 235/2013. A degree in architecture or engineering is required in order to obtain the qualification to inspect both residential and non-residential buildings. Private entities can also be registered, provided that they have the necessary qualified workers. The requirements are explained in a simplified document available from the website of the Ministry of Industry, Energy and Tourism[5].

Although there is no specific exam or course, assessors must have the necessary knowledge of the procedures and methodology to produce EPCs.

Figure 3: Spanish EPC cover page and label.

Table 6: Number of EPCs issued in Spain (2014).

	Nº of EPCs for new buildings	% of EPCs for new buildings	Nº of EPCs for existing buildings	% of EPCs for existing buildings
ANDALUCIA	609	4.31%	88,308	13.68%
ARAGÓN	-	0.00%	32	0.00%
ASTURIAS	17	0.12%	3,993	0.62%
BALEARES	188	1.33%	18,017	2.79%
CANARIAS	181	1.28%	32,172	4.99%
CATALUÑA	5,530	39.11%	195,089	30.23%
C LEON	72	0.51%	27,700	4.29%
C MANCHA	17	0.12%	10,507	1.63%
EXTREMADURA	3,015	21.32%	1,072	0.17%
GALICIA	65	0.46%	399	0.06%
MURCIA	154	1.09%	16,233	2.52%
NAVARRA	747	5.28%	5,926	0.92%
PAIS VASCO	125	0.88%	17,085	2.65%
RIOJA	283	2.00%	5,388	0.83%
VALENCIA	2,951	20.87%	128,888	19.97%
MADRID	176	1.24%	91,368	14.16%
CANTABRIA	10	0.07%	3,182	0.49%
TOTAL	*14,140*	*100%*	*645,359*	*100%*

Table 7: Average price paid to obtain an EPC, published by the Ministry of Finance.

Floor area (m²)	Price (€)
0-80	184.34
80-150	222.69
150-250	339.61
250-500	633.22
500-800	929.29
800-1,200	1,264.50
1,200-3,000	1,596.81
3,000-5,000	2,286.95
5,000-8,000	2,665.84
8,000-10,000	3,056.70
over 10,000	3,233.4 + 0.2 €/m²

[5] www.minetur.gob.es/energia/desarrollo/EficienciaEnergetica/CertificacionEnergetica/Normativa/Documents/Respuestas_a_preguntas_frecuentes_CEE_18_11_13.pdf

Compliance levels by sector

In Spain, there is no centralised analysis of the EPC data by building type. This is because the information that is recorded and then entered into the certification database does not contain data concerning the type of building.

The database is currently being expanded to allow for some additional features. From 2015 onwards, it will be possible to begin to register and include more parameters of each certified building. Among these are: type of building, insulation levels, generation systems, energy performance characteristics of systems, etc.

Enforcement with building owners and real estate actor

The Royal Decree 235/2013 establishes the obligation for building owners to provide information on the buildings' energy efficiency before any sale or rental agreement is signed.

The role of the regions, as well as notaries, is to ensure compliance with the requirements. Spain has published penalties for non-compliance, through Law 8/2013 of 26 June 2013 on urban rehabilitation, regeneration and renewal. By the end of 2014, it had already brought-in more than 200 fines.

Quality Assurance (QA) of EPCs

The control system, the number of EPCs inspected, the percentage of inspections of EPCs, and the procedures are different for each region. As a minimum, a documentary control is undertaken for 100% of the records.

Control of EPCs is carried out first of all by taking into account the percentages of the different ratings (A, B, C, etc.) in the EPCs and in each autonomous community, and tracking advertising for the sale or rental of buildings.

According to the different regions, (autonomous communities CCAA), different control types are applied:

> visual control of 100% of the certificates: every EPC is visually checked to ensure that it is complete;

> detailed control of the EPC: analysis and review of the digital file with data for the energy rating calculation, on-site visit to the building, and, if applicable, recalculation and recertification;

> external control prior to the registration of the EPC. The developer must delegate technical control to an authorised agent who must verify the building data used to issue the certificate. It is also the work of these agents to fully verify the results contained in the EPC. To implement this option, the process requires that
  - the external agents produce a global quality control plan to cover the whole construction process;
  - at the end of construction, they make a detailed check of the EPC to ensure that it corresponds precisely to what has been built.

According to data available in July 2014, the quality control system has carried out control (over a total of 567,000 EPCs in Spain) as follows:

> 560,000 visual controls;

> 5,000 detailed controls;

> 2,000 external controls.

These figures indicate that 100% of the EPCs have been checked, and about 1% subjected to detailed quality control procedures. Additionally, there are two autonomous regions that, in addition to the EPC, require the presentation of a document of compliance from an accredited control entity that they use as quality control.

III.ii. Progress and current status on public and large buildings visited by the public

The certification and display of EPCs for public buildings and large buildings visited by the public is still under development at the end of 2014.

III.iii. Implementation of mandatory advertising requirement

The obligation to announce any sale or rental of buildings with an energy efficiency label has been regulated in Spain since 2013.

The entry into force of the obligation to publish the EPC coincided with the obligation to certify buildings for sale or rent. As a result, it is not possible to determine the effect of the obligation to publish the results on the number of EPCs in Spain.

The specific obligation to publish the results is linked to the type of advertising. For example, in the case of advertising in newspapers or magazines, it is not necessary to incorporate the complete EPC label, but to show only the information concerning the rating of the property in terms of CO_2 emissions and primary energy consumption, both numerically and with the letter that corresponds to the rating scale.

The reality in Spain is that in many cases the information displayed states 'under development', which implies that the EPC issue has been contracted but has not yet been completed.

III.iv. Information campaigns

In Spain, information campaigns for citizens, as well as for different agents involved, have been developed by IDAE, including a campaign of education and information, with activities in various fields including:

> presentations and workshops in the various regions and at professional associations;
> guides, manuals and explanatory documents on the requirements, mechanisms and obligations for the energy certification of buildings;
> online training courses, specifically for citizens, and other courses for managers and real estate agents.

These activities are complemented by additional dissemination activities in each of the regions (e.g., websites, workshops, media communication, etc.).

All these campaigns have been developed since 2012 and many of them are still on-going. Both documents and courses remain active and are updated when changes are introduced.

Figure 4:
Spanish education and information campaign.

Figure 5:
Online training.

III.v. Coverage of the national building stock

Analysis of the Spanish building stock indicates that there are approximately 19 million certifiable homes in Spain, counting primary homes, plus secondary housing that is used more than 4 months each year.

The regional distribution of certificates is shown in Table 8.

For existing buildings, the percentage of EPCs per region is indicated in Figure 7.

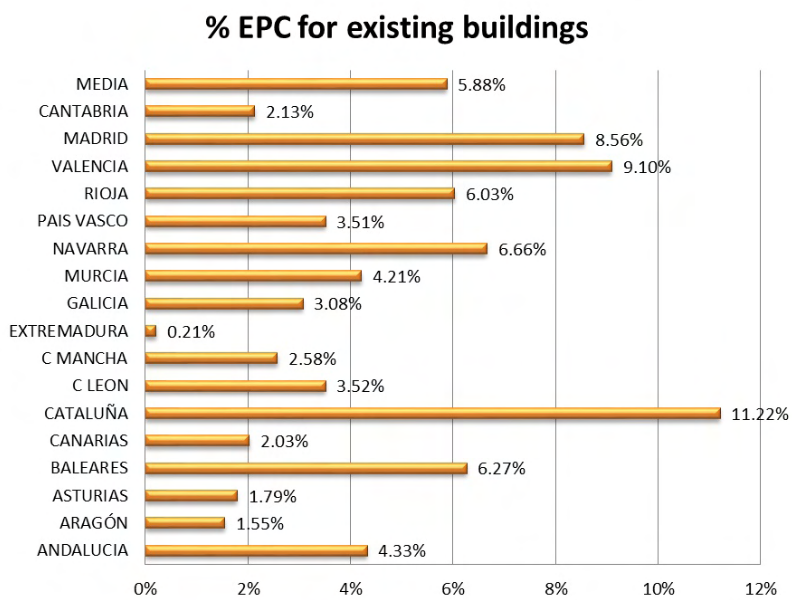
It is predicted that the number of EPCs will increase sharply in the coming years, until the market is regularised, since many buildings were already either for sale or rent before the Royal Decree 235/2013 entered into force, and so still do not have a valid EPC.

Figure 6:
'Information and frequently asked questions for energy certification of buildings' (April 2013).

Table 8.
EPC coverage per region (2014).

	Nº of EPCs for new buildings	Nº of EPCs for existing buildings	Total Nº of EPCs	Nº of buildings	%
ANDALUCIA	1,040	147,204	148,244	3,400,289	4.33%
ARAGÓN	33	8,863	8,896	573,089	1.55%
ASTURIAS	52	8,474	8,526	473,235	1.79%
BALEARES	268	28,464	28,732	453,984	6.27%
CANARIAS	150	16,900	17,050	832,859	2.03%
CATALUÑA	2,030	332,588	334,618	2,965,246	11.22%
C LEON	207	42,912	43,119	1,219,892	3.52%
C MANCHA	35	24,545	24,580	952,379	2.58%
EXTREMADURA	3,015	1,072	4,087	510,247	0.21%
GALICIA	150	38,413	38,563	1,248,866	3.08%
MURCIA	221	26,202	25,389	595,296	4.21%
NAVARRA	775	16,737	17,567	251,737	6.66%
PAIS VASCO	285	28,454	28,739	809,532	3.51%
RIOJA	59	8,847	8,906	146,675	6.03%
VALENCIA	4,578	201,586	206,164	2,215,777	9.10%
MADRID	239	197,332	197,571	2,305,472	8.56%
CANTABRIA	8	5,372	5,380	251,784	2.13%
TOTAL	*13,145*	*1,133,965*	*1,146,131*	*19,251,631*	*5.88%*

Figure 7:
EPC coverage for existing buildings per region.



IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

Spain has applied the inspection option in response to Articles 14 and 15 of the EPBD. This was initially done in 2007 (for Article 8 of Directive 2002/91/EC) and updated in 2013 by the Regulation of the Thermal Systems of Buildings (Royal Decree 238/2013).

This document contains the implementation of a schedule of inspections to verify the correct operation of the facilities and to produce a report with advice on ways to improve energy performance.

The responsibility to undertake the inspections lies with the regions.

IV.i. Progress and current status on heating systems

Overview, technical method and administration system

Heat generation systems that use boilers must be inspected in Spain if the power is over 20 kW, and then the inspection shall include:

> analysis and evaluation of performance;

> the official record of maintenance inspection;

> inspection of the solar power installation, if any, and inclusion of the evaluation of the minimum solar contribution to the production of DHW and solar heating.

It is also necessary to inspect the complete heat generation system, especially when the heating or cooling system is more than fifteen years old, and the inspection includes, at a minimum, the following:

> inspection of the entire system (not just the boiler);

> analysis of the official record of maintenance inspection;

> production of a report in order to advise the owner, proposing improvements or modifications to the installation, to improve its energy efficiency and consider incorporating solar energy.

In the latter case, the technical measures will be justified on the basis of their energy, environmental and economic profitability, supported by a cost-effectiveness calculation.

These inspections are carried out every 2-4 years, according to the region.

Figure 8. Madrid information campaign on inspections.

Arrangements for assurance, registration and promotion of competent persons

The responsibility for the registration of the inspectors lies with each region. The regions are in charge of ensuring the quality of the inspection and the registration of the inspection report. In the 10 years since the implementation of inspections, the regions have developed different systems and mechanisms to carry out this work.

Most regions use the existing infrastructure of inspections carried out by maintenance companies (e.g., industrial safety), which undertake general maintenance activities that can include this type of inspection.

Promotional activities

Different regions have launched information campaigns concerning inspections of buildings' heating systems.

Enforcement and penalties (activity level and statistics on penalties already levied)

There is currently no information available on enforcement and penalties.

Quality control of inspection reports

Every region performs an individual control of every registered inspection report.

Inspection activity figures

Inspections are carried out by competent technicians who, according to the heating systems' regulation, have passed a training test and hold a professional license that enables them to undertake such work.

The inspector must possess four qualifications, obtained through independent tests: installer of central heating and sanitary hot water systems, installer of AC systems, maintainer of heating and DHW systems, and maintainer of AC systems. If someone holds only one of these, there should be a supplementary training course, taught by an accredited entity.

Costs and benefits

The cost of inspection ranges between 50 € and 120 € depending on what type of installation is being inspected. The benefit to be gained of the inspection depends on what type of corrections are required, and on the type of installation.

IV.ii. Progress and current status on AC systems

There is an obligation to regularly inspect cool generators of rated thermal input greater than 12 kW, and the inspection includes:

> analysis and evaluation of performance;
> the official report of maintenance inspection;
> inspection of the solar power installation, if any, and inclusion of the assessment of the contribution of the solar cooling system.

3. A success story in EPBD implementation

One of the main success stories of the implementation of the EPBD in Spain has been the development and implementation of programmes aimed at energy savings in buildings. One of them is the "PAREER" programme[6], described below.

In 2013, work began on the development of a grant-financing scheme for building renovation in Spain. The programme concentrated on the areas that required substantial effort from the public administration in order to save energy, and focused on residential buildings, thus promoting the rehabilitation of the Spanish building stock.

This programme facilitates and promotes (since its implementation in 2013) the energy rehabilitation of buildings with energy-saving measures based on the EPBD calculation methodology and the application of cost-optimal criteria.

The main criterion for eligibility is the building's EPC, and application of the energy performance recommendations appearing on the certificate. It is necessary to demonstrate that, after the renovations, the EPC rating will increase at least one level.

The basic operation of the scheme, which is promoted by the Ministry of Industry, Energy and Tourism, and implemented by the Institute for the Diversification and Saving of Energy (IDAE), funds up to 90% of work and renovations on heating and air-conditioning (AC) systems and on the thermal envelope of the building, to reduce the energy demand. Between 20% and 30% of the support (only for the thermal envelope renovation costs) is under the form of a grant, in order to reduce the payback period of the investment. The rest must be reimbursed by the building owners within a maximum of 12 years.

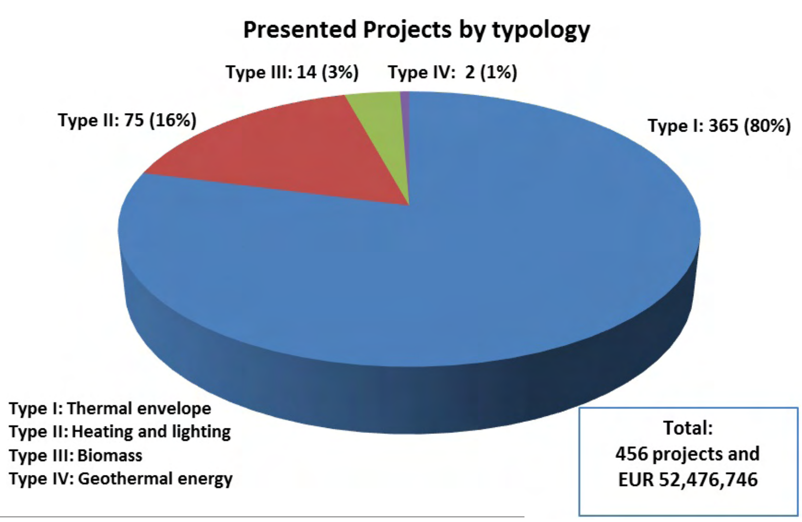
This programme is endowed with 125 M€ and currently holds over 450 records, with eligible costs above 50 M€ for the rehabilitation of such projects.

Activities included in this area are as follows:

> Type I: Thermal envelope
> Type II: Heating and lighting
> Type III: Biomass
> Type IV: Geothermal energy.

Figure 9: A successful energy rehabilitation programme for buildings in Spain.

Figure 10: Projects submitted under the PAREER Programme.



[6] www.idae.es/index.php/id.858/relmenu.409/mod.pags/mem.detalle

In all of these areas, the main criterion for eligibility is the implementation of the EPC recommendations, resulting on the improvement of at least one letter in the energy rating scale of the EPC.

This programme can be considered a success in the implementation of the EPBD, as it actively promotes progress towards high quality EPCs, the inclusion of specific measures for improvement laid out for each building, and the improvements are undertaken following the cost-optimal calculations done in accordance with the official methodology.

It also promotes energy rehabilitation for buildings that need it most, due to the need to improve the energy rating by at least one level to bring performance in line with cost-optimal.

Additionally, the programme creates a culture of cooperation between professionals in the building sector, citizens, and real estate agents, and improves the network of companies dedicated to improving energy efficiency, and forces them to apply objective criteria of energy efficiency to the work they carry out.

Finally the programme has brought social benefits as, in addition to improving the comfort and economy of families and reducing their energy bills, it also generates jobs, something needed in a country with much skilled labour in the construction and renovation of buildings.

4. Conclusions, future plans

The recent work on the development of regulations related to energy saving directives must be revised and updated in the near future.

Most of the actions derived from Directives 2002/91/EC and 2010/31/EU, have already been implemented. However, based on the experience acquired in the past twelve years (both nationally and from other Member States through the Concerted Action EPBD), there are still many areas for improvement.

In the coming years, Spain will address certain key actions for achieving the energy saving and emissions reducing goals by 2020, and lay the groundwork to secure the objectives by 2030.

First is the definition and implementation of Nearly Zero-Energy Buildings (NZEBs). This is still work in progress, because Spain will reach these standards through a gradual approach. The latest milestone is in 2016-2017, when the rules for constructing new buildings will be drafted and enforced. The contribution of Renewable Energy Sources (RES) to NZEBs has yet to be defined, in particular regarding the minimum values to be applied.

There will also be a review of the regulations for heating systems. This will include tighter requirements in terms of energy efficiency (for both the generator and the complete system) in order to encourage those systems that could achieve better performance and lower consumption. All types of solutions will be considered: individual generators, heating/cooling networks, cogeneration, integration of RES, etc. The regulations will also include additional requirements for maintenance, control and inspection.

Also worth mentioning is the hard work that remains in order to extend and improve the energy certification of buildings process, bringing the percentage of certified buildings to 100% as soon as possible, while still ensuring quality. This will require (in addition to improving the work of the regions) more publication, communication and awareness-raising campaigns, as well as training for citizens, estate agents, and building administrators, without forgetting the key role of technical certifiers.

At this point, it is also important to adapt the methodology for calculation, using the new rules that will better coordinate methodologies for all MSs in the coming years, through CEN standards that are being revised.

Implementation of the EPBD in Sweden

STATUS IN DECEMBER **2014**

1. Introduction

In order to implement the Energy Performance of Buildings Directive (EPBD), Sweden has altered existing, pre-EPBD regulations for energy performance in 2006, 2009, 2012 and 2015. In addition, a further revision is planned for 2016. Sweden has developed a Nearly Zero-Energy Buildings (NZEBs) action plan and is currently working towards establishing NZEB levels.

The original legislation regulating Energy Performance Certificates (EPCs), dating from 2006, has been amended with a view to comply with Directive 2010/31/EU. The system for the qualification of energy experts has changed its approach from accrediting companies, to accrediting experts and a new process of issuing certificates for buildings has been launched in 2014.

In response to Articles 14 and 15 of the Directive 2010/31/EU, Sweden has chosen the alternative approach, starting with mapping the target groups for inspections and directing all follow-up activities towards those groups. By the end of 2014, more than 1,200 companies and organisations have received advice on how to reduce energy use. Furthermore, systems have been developed and launched so as to follow up on the impact of the alternative measures. All the above information has also become part of the EPC advice.

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Swedish energy performance regulations are based on measured delivered energy, including energy performance requirements for heating, cooling, hot water and other general uses of the building (pumps, fans and lighting for all buildings), known in Sweden as "estate energy", divided by the area intended to be heated to more than 10 °C (A_{temp}).

According to the building regulations (BFS 2011:6), new buildings must be designed in such a way that energy use is limited by low heat losses, low cooling demands, efficient use of heating and cooling, and efficient use of electricity.

Buildings must be designed so as to ensure the following:

> building's specific energy use; for example, for climatic zone III (see Figure 1), where more than 80% of the Swedish population lives, the requirements are listed in Table 1 for residential buildings and in Table 2 for non-residential buildings;

> installed maximum electric power rating for heating (via electric resistance, electric boilers or heat pumps);

> average thermal transmittance (U_m) of the building envelope (A_{om}) displayed in Table 3.

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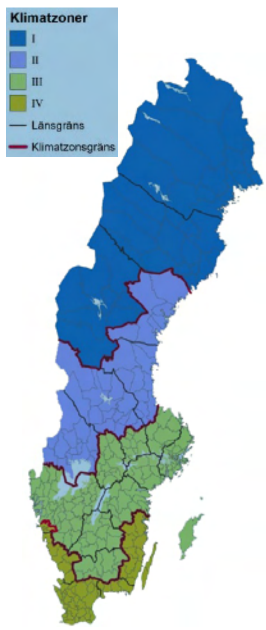

Figure 1: Climatic zones I-IV from north to south (länsgränser = county limits).

NATIONAL WEBSITES
www.boverket.se/sv/om-boverket/other-languages
www.energimyndigheten.se/en

Energy use requirements for new[6] residential buildings [kWh/m^2] A_{temp}	2006	2009	2012	2015: Single-family houses: 1-2 apartments	2015: Single-family houses: PE-ratio[5]	2015: Multi-family houses: >2 apartments	2015: Multi-family houses: >50% of the dwellings < 35m^2	2015: Multi-family houses: PE- ratio[5]	2016 - 2017	2021[4]
Electrically heated[1,2]	75[3]	55	55	55	90/55= 1.64	50	55	80/50= 1.60	Planned change due to re-evaluation in 2015	Due to cost-optimal at the time
Non-electrically heated	110	110	90	90		80	90	90/55= 1.64		

1. Electrically heated defined as installed power of more than 10 W/m^2.
2. Electrically heated have a maximum power limit that must not be exceeded.
3. Only for electrical panels in single-family houses.
4. 1 January 2021.
5. Primary Energy (PE)-ratio is the ratio between the value for non-electrically heated and electrically heated buildings.
6. When altered, aim at the above with regard to the size of the alteration and the possibility of the building. Recommended but not required target. Target is defined by the possibilities of the building. For example, no change on the cultural values should be made. Owners cannot alter the look of the window and due to this fact it may not be possible to reach the exact demand.

Table 1: Building code since 2006, residential buildings, electrically heated/ non-electrically heated buildings, climatic zone III.

Energy use requirements for new[8] non-residential (including public) buildings [kWh/m^2] A_{temp}	2006	2009	2012	2015	PE-ratio	2016-2017	2019[6]: Public buildings	2021[7]: Other non-residential buildings
Electrically heated[1,2]	100[3]	55[5]	55[5]	50[5]	70/50= 1.40	Planned change due to re-evaluation in 2015	Planned change due to cost-optimal at the time	
Non electrically heated		100[4]	80[4]	70[4]				

1. Electrically heated defined as installed power of more than 10 W/m^2
2. Electrically heated also demand maximum installed power.
   Addendum if the $q_{hygiene}$ is between 0.35 and 1.0.
3. Addendum if $q_{hygiene}$ is between 0.35 and 1.0 l/s. m^2. +110*(q-0.35) [kWh/m^2]
4. Addendum if $q_{hygiene}$ is between 0.35 and 1.0 l/s. m^2. +70*(q-0.35) [kWh/m^2]
5. Addendum if $q_{hygiene}$ is between 0.35 and 1.0 l/s.m^2. +45*(q-0.35) [kWh/m^2]
6. 1 January 2019.
7. 1 January 2021.
8. Existing buildings: When altered aim at the above with regard to the size of the alteration and the possibility of the building.

Table 2: Building code since 2006, non-residential buildings, electrically heated/non-electrically heated buildings, climatic zone III.

		2006	2008	2011	2015
Residential	Non-electrically heated	0.5	0.5	0.4	0.4
	Electrically heated		0.4		
Non-Residential	Non-electrically heated	0.7	0.7	0.6	0.6
	Electrically heated		0.6		
For buildings < 50 m^2					0.33
Airtightness buildings < 50 m^2					0.6 l/s.m^2

Table 3: Evolution of maximum average building U-value [W/m^2.K].

Moreover, at least one more revision of the EPBD is expected before 2021 to take into account the 5 year revision cycle stipulated in its mandate.

The requirements for non-residential buildings include an air exchange rate set between 0.35 and 1.0 l/s.m^2, while requirements also vary depending on the heating source (electrical and non-electrical), as well as the climatic zone.

The overall U-values must not exceed 0.4 W/m^2.K for residential buildings and 0.6 W/m^2.K for non-residential buildings.

In general, there are no quantitative requirements for other building elements or systems. For example the building code states the following:

> Airtightness must be sufficient so that the requirements for specific energy use and installed electric power rating for heating are met. For buildings with a floor area less than 50 m^2 there is a requirement of 0.6 l/s.m^2 with regard to airtightness.

> Installations must be designed so as to provide adequate efficiency during normal operation.

> Building services requiring electrical energy, e.g., ventilation, fixed lighting fittings, electrical heaters, pumps and

motors, must be designed to ensure that the power requirement limit is met and energy is used efficiently.

> The need for cooling must be minimised through design and technical measures.
> The building must have a control and regulation system in order to maintain both optimal energy efficiency and thermal comfort.
> Heating Ventilation and Air-Conditioning (HVAC) systems must be fitted with automatic regulation equipment so as to ensure that the supply of heating and cooling is regulated based on power demand and in relation to both outdoor and indoor climate and the intended use of the building.
> According to regulations, a building's energy use shall be monitored by a method of measurement. This method shall ensure that the energy use of the building can be read in order to enable calculation of the building's energy use for the desired year.

The responsibility for compliance lies with the developer. The compliance check is based on measured values and takes place during the second year of operation. There is no requirement to measure single parameters as long as the measured value complies with the building code. For example, if the measured energy is within the specified limits, there is no reason for measuring airtightness or how it is regulated. Compliance controls are supervised by the Municipality Building Board.

Moreover, legislation provides for the compulsory ventilation check where a certified assessor checks the ventilation system before a building can be used, and thereafter every two years with regard to schools, and every three years regarding offices.

Furthermore, primary energy factors, PE-ratio, are addressed by different requirements, one for electrical heated and another for all non-electrical heated buildings.

Over the years, the regulations have evolved towards lower energy use requirements. Both the building code and the handbook entitled "*Energy management according to the building code*" (Figure 2) include general advice and guidelines. The methodology consists of adding up the measured values for energy used for heating, Domestic Hot Water (DHW), cooling and estate energy, divided by the heated[1] area.

I.ii. Format of national transposition and implementation of existing regulations

Swedish regulations regarding the required qualities of buildings are outlined in different legislation acts, the most significant ones being the "*Planning and building act*" and the "*Environmental code*". The regulations connected to the "*Environmental code*" indicate how a building should operate, e.g., thermal comfort, ventilation rates, etc. The regulations related to the "*Planning and building act*" set out the role of the building in achieving these qualities. EPCs are regulated by a separate legislative system.

When it comes to energy use, Sweden normally does not put restrictions on the selection of calculation programme/standards, with a recommendation, however, for CEN standards to be applied for the calculation of U-values.

The building compliance system comprises the developer and its representative, the certified person responsible for inspections and verification, and the local municipal building council. Boverket, the National Board of Housing, Building and Planning, has the responsibility to check if an EPC has been issued for a specific building. Boverket performs its role by cross-checking the national cadastre of the building stock with the EPC register. Boverket contacts owners who have not yet declared their buildings on a weekly basis. If non-compliance persists, Boverket may impose a fine against the owner. By the end of 2014, two demands/warnings have been sent to two building owners. In one case, the EPC was issued, in the other case, as no EPC was issued, the case was sent to the Court, which was about to impose a fine.

The EPC register also provides the opportunity to monitor the compliance level of new buildings. An analysis of the register has found that the compliance rate is not satisfactory. As a result, Boverket is working on ways to cooperate with the local building boards of municipalities to improve the compliance ratio, both for the energy use and for the EPCs. The main problem is the time it takes before the new buildings are registered into the system.

Figure 2: Handbook "Energy management according to the building code".

[1] A_{temp}, *area intended to be heated to at least 10 ºC.*

I.iii. Cost-optimal procedure for setting energy performance requirements

Boverket is continuously monitoring the results of the cost-optimal calculation requirements. It also examines the possible effect of a further tightening of requirements on the cost-optimal calculations for the three categories- according to the latest revision-, i.e., single-family houses, multi-family houses and non-residential buildings. Whenever there are favourable economic conditions, the regulations are tightened.

The latest revision of the building requirements (following cost-optimal calculations) was held in 2012, with follow up revisions planned for 2015 and 2016. The next revision of the NZEB levels is scheduled for 2018/2020.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

Up until now, the national plan has set 2015 as the landmark evaluation year regarding the progression towards NZEBs. This will also be followed by pilot projects demonstrating how to build low energy buildings while meeting all requirements of the building code. Until summer 2015, certain pilot projects will be evaluated as to the extent they managed to fulfil all the requirements of the building code, as well as to the point that they can still be considered low energy buildings. In parallel, ways for the best formulation of requirements stated in the building code will also be examined. The results of these last two exercises are to be reported to the government by mid June 2015. The government will then submit the results to the Commission.

As a result, no final definition of NZEB was available in Sweden at the end of 2014.

Nonetheless, the level of the NZEB requirements cannot be set lower than the requirements of 2014 until the end of 2015.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Sweden's strategy for energy efficiency renovation is based on the building code and the EPC regulation, which so far have contributed to the efficiency improvement of building energy use by 11% during the period 1995 - 2011. If policy instruments are extended until 2050, the total energy purchased per m^2 is predicted to decrease by 22-30% by 2050. The new EPCs have an important role to play in this strategy, as they will support a functioning market for energy efficiency. A 50% reduction of energy use by 2050 (1995) requires that the extent of renovations must increase and that other measures relating to operational electricity, household and building electricity will also be taken. A particular aspect of the action plan is to provide sufficient information to the building owners of the now fifty year old "*million dwellings programme*", so that every time a building renovation takes place, energy efficiency is also taken into consideration. The "*million dwellings programme*" was a state initiated programme, developed between 1965 and 1975 and set to build 1 million dwellings in Sweden. As a consequence, the houses built during this period represent a significant part of the Swedish building stock and are particularly relevant, since due to age many of them are in need of refurbishment.

Sweden has chosen to follow the alternative approach under Article 5 of the EED. In Sweden, the two agencies that own 95% of the state-owned buildings are to implement the whole 3% target. The expected savings by 2020 will be 21 GWh and the reference floor area is 1,678,000 m^2. In addition, the EPC register has been used to form the alternative approach, while the database has been used to separate targets for energy savings.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

Sweden uses measured values for compliance control of regulation requirements. Thus, the developers themselves can choose the areas where they will focus their efforts. As a result, there are no qualitative figures on the specific parts of the system (e.g., boiler efficiency). As long as a total value is measured lower than the requirements, the building is regarded as compliant. When a building is renovated or refurbished, it is the altered part of the building that should comply with the regulations for new buildings. Requirements are set in relation to the "size of the alteration" and "the technical possibilities for changes in the building".

Sweden has also endorsed a general advice on the Specific Fan Power (SFP) factor of the ventilation system in new buildings, and in renovated and refurbished buildings, either for the ventilation system as a whole, or for a specific part of the system.

When a building component or function is altered, it is required that the altered part should fulfil the requirements so that the system as a whole, will be compliant with regulation requirements. The same control system applies also to installation, dimensioning and adjustment.

There is a market driven encouragement for using smart meters in buildings, mainly supported by Energy Service Companies' (ESCOs) competition on the best smart meter, prompting consumers to use the one which is energy wise the most efficient. However, there are no specific requirements on smart metering.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTs

III.i. Progress and current status on sale or rental of buildings

The Energy Performance Certificate system is run by Boverket which is responsible for supervision and control, as well as management of the national EPC database.

EPCs are issued by certified assessors. The organisations that carry out the certification of experts are accredited by the Swedish Board for Accreditation and Conformity Assessment (SWEDAC). The certifying bodies are under SWEDAC´s supervision and have the right to revoke a license if the expert has shown incompetence, or has issued an incorrect or false EPC.

Sweden has used accredited companies up until January 2014. The company issuing EPCs had to be accredited by SWEDAC, and have at least one certified energy expert in a managerial position. This system changed on 1 January 2014. The accredited companies have been replaced by a system, which requires that all assessors have to be certified (individual responsibility). Sweden applies mutual recognition vis-à-vis assessors from other EU countries and so far Finnish, Danish and British assessors are also working in the system.

Since 2007, experts register the EPCs directly in the national database.

Through the website of Boverket, all EPCs are accessible and searchable by address. The information that can be obtained online is the ID-number of the EPC, the date of issuance, the energy performance rating (given as a single value of specific energy in kWh/m^2.year and energy class), and finally, whether radon measurements and compulsory ventilation controls have been executed. Building owners and real estate agents can order the full version of the EPCs from the website. There is also a GIS application under way that would enable people to look for certified buildings via this app.

EPCs are valid for 10 years. Moreover, certification following a major renovation is not mandatory, but is normally performed because of the owners' wish to update the value of the new reduced consumption relative to the reference benchmark.

EPCs are issued only at building level and thus there are no EPCs for individual apartments.

Format and content of the EPC

Boverket changed the EPC format in January 2014 by introducing classes A-G (Figure 3). The intervals for the classes are described as percentages of the minimum requirements for new buildings (Table 4). The higher limit of the Class C represents the minimum energy performance for a new building.

The average cost of an EPC is about 1,000 €. There may be variations depending on the type, size and complexity of the building (increasing costs for increasing complexity).

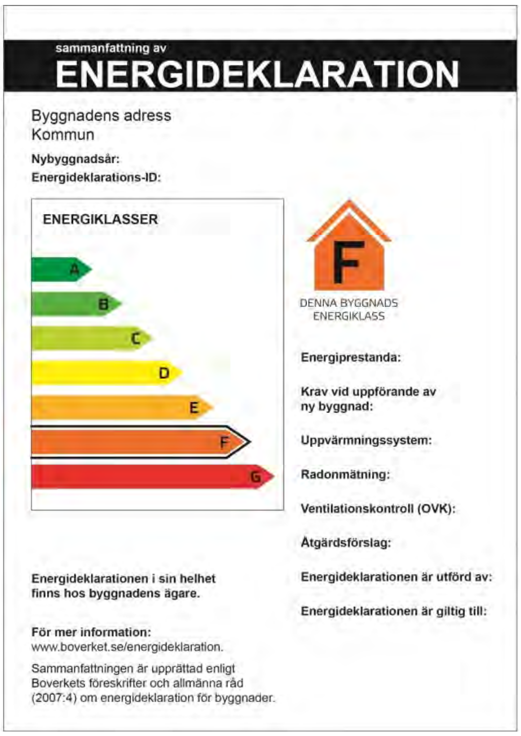

Figure 3: EPC format.

Class	Range [percentage of requirements for new buildings]
A	≤ 50%
B	> 50 - ≤ 75%
C	> 75 - ≤ 100%
D	> 100 - ≤ 135%
E	> 135 - ≤ 180%
F	> 180 - ≤ 235%
G	> 235%

Table 4: EPC classes.

Assessor corps

There are minimum requirements set out for qualified experts. Required qualifications include education and professional experience of at least five years, whereof at least two years in connection to energy use in buildings and indoor-environment. Education requirements entail university education, e.g., Master of Science or Degree in Architecture, which must be relevant to the energy systems or building, or other related technical education. Certifying bodies, accredited by SWEDAC, evaluate the qualifications of the applicants. Following evaluation of the education and experience requirements, there is also a mandatory exam for a qualified applicant to become a certified assessor (energy expert). Moreover, certified assessors have to take the exam every five years in order to renew their licence.

The CEX 2007:5 regulations, which define competence levels for qualified experts, are issued by Boverket.

There are two distinct levels of assessors. The lower level addresses simple buildings, e.g., single-family houses and smaller multi-family houses. The higher level is for more complex buildings (e.g., buildings with air-conditioning), public buildings, as well as all buildings with cultural value. Both levels have the same requirement for education and experience, but there are differences in the mandatory exam. For example, in the exam for the higher level, candidates must prove their knowledge on the interconnection of systems for heating, cooling and ventilation in a building, as well as on pertinent regulations.

Compliance levels by sector

There are certain buildings which are required to have a valid EPC in all cases. This category includes buildings for rental and also larger public buildings. There are indications that the compliance rate in this group is about 75%. This estimation is grounded on the comparison between property information managed by the public authority *"Swedish National Land Survey"* and information available in the EPC database. The system has been partly inactive, but this could generate a positive impact on the market, which will become more stable when all buildings have to renew their certificates after 10 years. Therefore, the demand for experts will be more stable throughout the years.

As far as other buildings are concerned, an EPC is required only in certain conditions. This second category includes buildings for sale and new buildings. Regarding the former, the most common trend is the sale of single-family buildings. In this case the compliance rate recorded is high, i.e., a certificate is available in 90-95% of the buildings sold.

Enforcement with building owners and real estate actors

The building owner is responsible for fulfilling the obligations set in the regulations. The fulfilment of these requirements is monitored by Boverket since July 2014. According to these requirements, if an EPC has been issued, the energy performance (energy class) has to be displayed in relevant advertisements and the EPC has to be showed to the buyer or tenant before purchase and to be handed over to the new owner or tenant after the deal is completed.

The Swedish Estate Agents Inspectorate (FMI) is the central authority assigned to supervise estate agents, while also providing information on code of practice. FMI includes a Disciplinary Board comprising members appointed by the Government.

Quality Assurance (QA) of EPCs

Swedish regulations separate buildings into two groups, i.e., buildings which are required to have a valid EPC in all cases and buildings that only need to have an EPC in certain conditions. Both categories include residential and non-residential buildings (and larger public buildings). For that reason, there is no distinction between sold and rented buildings, neither between public and large buildings. Instead there is a distinction between buildings required to have an EPC in all cases and those which only need an EPC when they are for sale.

Up until now, control mechanisms have focused on the first category. Since 2014 Boverket has the possibility to order an EPC to be issued combined also, if necessary, with a penalty. Until the end of August 2014, around 13,000 buildings were subject to these controls. There has been no need so far for a fine to be imposed.

With regard to the second group, Boverket has been performing checks only when prompted by consumers' complaints. This is to be attributed to the regulations, which provide for the buyers the opportunity to have an EPC issued at the cost of the seller within 6 months from the transaction.

Moreover, certifying bodies have thus far not revoked the licence of any qualified expert.

The number of EPCs issued in 2014 was about 50,000. Validity checks are performed on every EPC automatically when the expert is actually issuing the EPC. In addition, input data are controlled by software in diverse (automated) ways, for example by climate-correction and validation of administrative information on the building through other national databases. There are also programmed warnings and error messages when input data are out of a certain range. Furthermore, the calculation of energy performance is controlled by software as well. Finally, the National Board is responsible for validity checks.

III.ii. Progress and current status on public and large buildings visited by the public

The original regulation included public buildings of more than 1,000 m^2, which has been changed, however, in accordance with Directive 2010/31/EU. As the regulation on certification covered all types of buildings, the development described above for sold and rented buildings also applies to public and large buildings, including assessors, quality control, etc.

The total number of EPCs for non-residential buildings is about 55,000, including also public buildings, while the number of new buildings is about 1,200.

III.iii. Implementation of mandatory advertising requirement

Energy performance indicators in advertisements are mandatory since July 2012 under the Law 2006:985 with changes to 2012:397 on energy certification of buildings. In January 2014, energy labels for classes A-G were introduced in the regulations. Building owners with EPCs with this symbol are required to show the EPC class in their advertisements. The EPC class makes the information easily accessible for the buyer or potential tenant, and is expected to raise the interest on energy consumption. Boverket supervises the fulfilment of mandatory requirements and may order corrections if these are not met. During autumn 2014, Boverket inspected the compliance of the use of the energy performance indicator with the mandatory advertising requirement. The findings were the following: in 43% of the advertisements, neither the new energy performance indicator[2] nor the old energy performance level indicators[3] were displayed, while 38% of advertisements included the energy performance level indicator. Additionally, in 19% of the advertisements both the energy performance indicator and the EP-level indicator were presented and in 1% only the energy performance indicator was publicised.

Certificates from the early days of the certification era did not require an energy performance indicator energy label but only a numerical energy performance level indicator. Boverket has introduced a service which makes it possible for building owners to acquire an energy class according to the new system for buildings with older EPCs. This option is on a voluntary basis and free of charge.

III.iv. Information campaigns

When Directive 2010/31/EU was incorporated in Swedish regulations, an information campaign was organised addressing estate agents. At the beginning of 2013 Boverket made the EPCs available for building owners and real estate agents through electronic channels to facilitate their work. A manual has also been produced with regard to advertisement displaying the energy class. In the future it will be possible to import energy labels from the national database into systems used for advertising.

In autumn 2014, the said information campaign targeted mostly the parties involved in transactions, namely buyers, sellers and real estate agents. The main focus was on buyers and information on how to use the EPCs. The campaign also focused on consumers' rights and sellers' obligations. Relevant information was made available through digital channels.

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[2] *Energy performance indicator for the A-G scale.*

[3] *Energy performance level indicator with a numerical value.*

III.v. Coverage of the national building stock

The total amount of EPCs at the end of December 2014 was 535,260 (Figure 4) with the number of EPCs for new buildings reaching about 6,250 in total. The respective numbers by building type are presented in Table 5.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

For heating and air-conditioning (AC) systems, Sweden has chosen alternative measures in response to Articles 14 and 15 of the EPBD.

IV.i. Report on equivalence

Sweden already has several control and information programmes where professionals carry out inspections of heating and AC systems. These energy advisors, inspectors, chimney sweepers and service engineers provide building owners with qualified advice on how to reduce energy use. In addition to fulfilling EPBD Articles 14 and 15, the following steps have been taken:

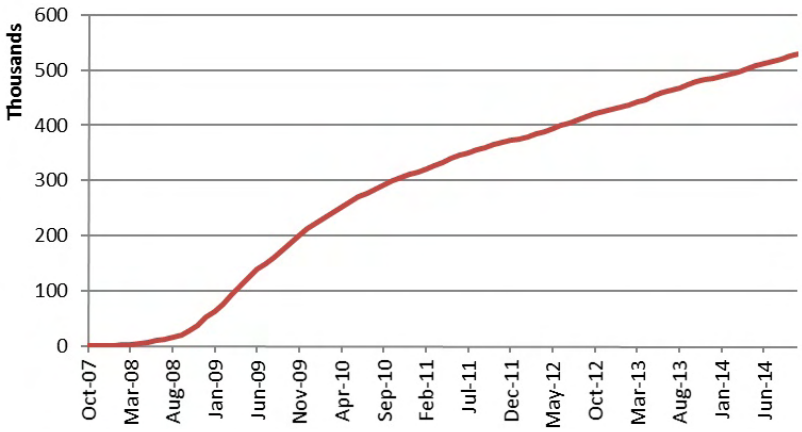
> Municipal energy advisors provide advice on how to reduce the total energy use and the effect on climate through other measures, such as transition to renewable energy sources.

> Advisors meet with numerous building owners who own systems that do not fall under the scope of Articles 14 and 15 of the EPBD, e.g., private home owners with a small oil boiler, or large and inefficient district heating systems. These groups represent a 10 times greater energy use compared to the focus groups of Articles 14 and 15, and meeting with them results in a combined increased reduction in energy use.

> Building owners receive free advice, which encourages them to spend money on energy-saving measures rather than inspections.

For estimations, see Tables 6 and 7.

Figure 4: Accumulated number of EPCs. Grand total in December 2014: 535,260 EPCs.



IV.ii. Progress and current status on heating systems

So far, related activities have focused on four areas;

> identifying and giving advice to owners of relevant systems via the EPCs and also obtaining contacts through energy and climate advisers and professionals such as chimney sweepers and other persons who are in contact with property owners and managers;

> ensuring the quality of advice given, by educating municipal energy advisors and producing written information for the internet, brochures and small leaflets;

> building networks with other organisations that contribute through trained professionals in their respective fields—four such examples are the National Association of inspectors of ventilation systems, chimney sweepers, F-gas inspectors and the Swedish Association of Local Authorities and Regions;

Table 5: Estimated amount of EPCs issued and percentage of building stock certified.

	§4[1] new buildings in 2014	§5.1 rented	§5.2 public	§6[2] when sold	Total number of EPCs	Total number of buildings	Percentage of Total [%]	Percentage in compliance with the law
Single-family houses	3,760	56,025[3]	-	281,560[4]	341,345	2,099,500	16.3	70.3
Multi-family houses	1,340	143,025	-	-	144,365	176,800	81.2	81.2
Non-residential buildings[5]	1,150	3,500	44,900	-	49,500	54,980	90.0	90.0
Total number of EPCs	6,250	202,550	44,900	281,560	535,260	2,331,280	23.0	71.3

1. Paragraphs refer to the Swedish law (2006:985) on energy certification of buildings, etc.
2. Multi-family houses, other rented houses and public buildings are registered under §5 as they are required to have an EPC in all cases.
3. 56,025 EPCs issued represent 31% of 180,000 rented houses in 6 years (2009-2014).
4. 281,560 EPCs issued represent 94% of 300,000 transactions in 6 years (2009-2014).
5. EPC required only in case of rented or public building.

> introducing follow-up activities to ensure the impact of alternative measures, e.g., counsellors (energy and climate advisers) following up on interventions after 2-3 years, counting the web clicks on requests for information and follow-up on contacts via the energy certification system.

These activities have been designed in cooperation with representatives from existing programmes and have resulted in the outreach of building owners at three different levels: via energy advisors, via other trained professionals and through the dissemination of written information (Figure 5).

Impact and equivalence assessment

According to the EU framework for comparing alternative measures with inspections, Sweden has chosen to use the top-down method to describe the impact, due to the lack of data at system level. There is information available on the national use of energy for heating, for different types of fuel, and in different types of buildings. However, there is no data available on the size (power) of the heating systems, their age, technical condition, replacement rate, etc. Therefore, approximations derived from the data in EPC protocols have been used to provide information on the average energy savings for a large heating system.

The impacts of alternative measures have thus been estimated based on reports submitted by energy advisors. As the follow-up system is newly launched the available database is rather small. However, assessments on future impact will become more precise over time.

The baseline of energy reduction in heating systems is approximately 1% per year. This number has considerable variations between individual years, mainly due to variations in winter temperatures. The effects below represent results on top of the 1% baseline.

Due to the inherent delay, until qualified advice results in a lower national energy use, it is not possible to detect any measurable impacts for the years 2013 and 2014. The full potential is to be reached over a period of 1-5 years thereafter with a reduction of 45 GWh in total.

As advice is offered through programmes already in place, there are no additional costs directly linked to addressing outreach efforts towards owners of large heating systems. However, the Energy Agency provides support to assure the quality of advice, as well as follow-up activities with a view to ensure the impact of the alternative measures by way of:

> project management;

> information material tailored for owners of large heating systems;

> education of municipal energy advisors;

> ready-to-use material for press and other trained professionals that come in contact with owners of large heating systems;

> follow-up two years after on-site inspection.

The total cost of the measures for heating systems in 2013 and 2014 is estimated at around 470,000 €.

The greatest benefit of the chosen measures is a better adaptation of implementation to the intentions of Article 14. The majority of Swedish buildings are heated by electricity (including heat pumps) or district heating, which in Sweden naturally have a low impact on climate. By educating and supporting existing professionals and concentrating on existing activities knowledge is spread to a wider range. The Swedish approach gives more building owners the opportunity to receive advice than if only inspections took place.

Figure 5: Information brochures for energy efficient heating and cooling systems.

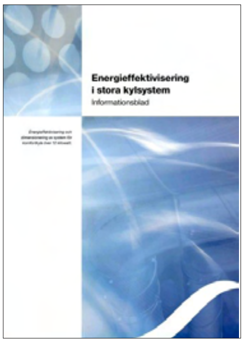


Table 6: Effects of alternative measures for heating systems in the years 2013 - 2016.

Year / Source of advice	Measured results		Estimations of final energy savings [MWh]		
	2013	**2014**	**2015**	**2016**	**After 2016**
On-site inspections by municipal energy advisors	0	0	3,500	3,500	7,000
On-site inspections by other skilled professionals	0	0	7,000	7,000	14,000
Written information (web sites, brochures, leaflets, etc.)	0	0	700	700	1,400
Total	0	0	11,200	11,200	22,400

Table 7: Effects of alternative measures for air-conditioning systems in the years 2013-2016.

Year / Source of advice	Measured results		Estimation of final energy savings [MWh]		
	2013	**2014**	**2015**	**2016**	**After 2016**
On-site inspections by municipal energy advisors	0	0	1,060	1,060	2,120
On-site inspections by other skilled professionals	0	0	6,625	6,625	13,250
Written information (web sites, brochures, leaflets, etc.)	0	0	212	212	424
Total	0	0	7,900	7,900	15,800

IV.iii. Progress and current status on AC systems

Detailing of activities to improve energy performance of air-conditioning systems

Activities to improve energy performance of AC systems overlap with those concerning the heating systems. For this, target group networks with other organisations have been established, e.g., service engineers working with cooling systems. Similarly, within the system of compulsory ventilation checks, assessors are obliged to give advice on how to reduce the energy use in the ventilation system. As a result, there are collateral benefits with regard to certain AC system owners, who are provided also with advice on energy reduction.

Impact and equivalence assessment

Sweden has chosen the top-down method also with regard to the AC systems. However, cooling systems are almost always powered by electricity and it is hard to separate this form of electricity from the electricity being used for other purposes. Due to this lack of data, an assessment on the number of AC systems has to be made. In the EPC protocols, one third of the buildings with a large heating system also have a large (> 12 kW) cooling system. Based on the assumption that the ratio is 1:3 for all buildings, a similar assessment to the one produced for heating systems can be made.

Due to the inherent delay, until qualified advice results in a lower national energy use, it is not possible to detect any measurable impacts for the years 2013 and 2014. The full potential is to be reached over a period of 1-5 years thereafter, with a reduction of 32 GWh in total.

Costs and benefits

Advice to owners of these systems is provided through the same programmes as for heating systems and consequently the benefits overlap as well. The costs are linked to the same support activities and are therefore divided between heating systems and AC systems in proportion to the size of the target group.

The total cost of the measures for AC systems is estimated at 155,000 €.

The Swedish climate is generally favourable for decreasing the need for cooling. The key in order to make AC systems more efficient is to control heating and cooling together, i.e., to ensure that the building is neither over-heated nor over-cooled. The main benefit of the chosen alternative measures is that the energy advisor shares advice on both aspects. One benefit is to point out what the building code suggests, namely avoiding simultaneous heating and cooling.

3. Conclusions, future plans

The work towards NZEBs has commenced and there will be an assessment completed at the end of 2015. As a result, the level of energy requirements in buildings will be further lowered.

The information campaign following the last amendment of the EPC has already produced and will give further results regarding the lower use of energy in the future. Sweden will continue to provide advice on the fulfilment of the requirements of Articles 14 and 15. It is estimated that the number of in-place inspections by municipal energy advisors will double in 2015 and continue growing thereafter. In 2015, a range of other professionals must also be engaged to reach an even greater number of building owners and companies. In 2016, the first follow-up of the outcome will take place two years after the inspections made in 2014. This will provide concrete data on the actual impact of the different advice systems.

Implementation of the EPBD in the United Kingdom England

STATUS IN DECEMBER **2014**

1. Introduction

This report provides information about the implementation of the Energy Performance of Buildings Directive (EPBD) in England. It updates the previous United Kingdom (UK) reports published in 2010 and 2012. The implementation of the EPBD in the other three UK jurisdictions (Wales, Scotland and Northern Ireland) is addressed in separate reports.

The implementation of the EPBD in England is the responsibility of the Department for Communities and Local Government (DCLG) and is achieved through:

> *the Building Regulations 2010* (SI** 2010/2214) as amended[1];*

> *the Building (Approved Inspectors etc.) Regulations 2010* (SI 2010/2214 and 2010/2215) as amended[2]; and*

> *the Energy Performance of Buildings (England and Wales) Regulations* (SI 2012/3118) as amended[3].*

This report introduces the most recent requirements. It also addresses certification and inspection systems including quality control mechanisms, the training of Qualified Experts (Energy Assessors), information campaigns, incentives and subsidies. For more details please visit the referenced websites or contact the responsible institutions.

(*) This is the main Regulation. Subsequent amendments must also be considered, they include:

> *the Building Regulations etc. (Amendment) (No.2) Regulations 2013 (SI 2013/1959)[4];*

> *the Building (Amendment) Regulations 2013 (SI 2013/1105)[5];*

> *the Building Regulations etc. (Amendment) 2013 (SI 2013/181)[6];*

> *the Building Regulations etc. (Amendment) 2012 (SI 2012/3119)[7];*

> *the Building (Amendment) Regulations 2012 (SI 2012/718)[8];*

> *the Building (Amendment) Regulations 2011 (SI 2011/1515)[9].*

Regulations are available at www.legislation.gov.uk.

(**) SI = Statutory Instrument.

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www.gov.uk/government/organisations/department-for-communities-and-local-government

[1] *www.legislation.gov.uk/uksi/2010/2214/contents/made*
[2] *www.legislation.gov.uk/uksi/2010/2214/contents/made and www.legislation.gov.uk/uksi/2010/2215/contents/made*
[3] *www.legislation.gov.uk/uksi/2012/3118/contents/made*
[4] *www.legislation.gov.uk/uksi/2013/1959/contents/made*
[5] *www.legislation.gov.uk/uksi/2013/1105/contents/made*
[6] *www.legislation.gov.uk/uksi/2013/181/contents/made*
[7] *www.legislation.gov.uk/uksi/2012/3119/contents/made*
[8] *www.legislation.gov.uk/uksi/2012/718/contents/made*
[9] *www.legislation.gov.uk/uksi/2011/1515/contents/made*

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Figures 1 and 2 show the simplified historical Building Regulations improvements in England for new residential and new non-residential buildings. Energy requirements are not measured as energy (primary or final), but as net CO_2 emissions (kg_{CO_2}/m^2.year). Each building (new or renovated) must have emissions below those of a reference building, which is the exact same building but with standard levels of insulation, systems efficiency, etc. Each type of energy (e.g., gas, electricity) has a different carbon intensity expressed as kg_{CO_2}/kWh which reflects the amount of CO_2 emitted to deliver 1 kWh of energy to the building. Table 1 is extracted from the Government's Standard Assessment Procedure (SAP) 2012. It illustrates the various carbon emission factors for different types of fuel.

The graphs in Figures 1 and 2 are based on the 2006 Building Regulations (the reference year), historical improvements for 2010 and 2013, and Government announcements on the trajectory to zero carbon buildings which were made before/during 2014, including the 2016 and 2019 zero carbon targets. Following the 2015 elections, the Government announced in *"Fixing the foundations: Creating a more prosperous nation, HM Treasury, July 2015"* that it will not be following the previous Government's zero carbon policies. It is unclear how CO_2 emission targets may change in the future.

The new 2013 Building Regulations set energy performance requirements for new and existing buildings (residential and non-residential buildings) and came into effect in April 2014. The new regulations were strengthened to deliver improved CO_2 savings over the previous 2010 Building Regulations of:

> 6% across the new residential building mix;

> 9% across the new non-residential building mix.

Minor changes to the requirements for existing residential and non-residential buildings were also introduced in 2013.

Further changes to the Building Regulations will be required to achieve Government's zero carbon commitment for new residential units (single-family houses and apartments) by 2016 and for non-residential buildings by 2019. The current Building Regulations do not specifically address public authority buildings.

Although there are no specific legal requirements for public buildings, many public bodies require that their buildings achieve minimum ratings under environmental certification systems such as BREEAM, i.e., the Building Research Establishment Environmental Assessment Method. For example, the Department for Environment, Food and Rural Affairs (DEFRA), through the Government Buying Standards, requires all buildings on the Government Estate to achieve:

> a minimum BREEAM rating of 'Excellent' for new buildings;

> a minimum BREEAM rating of 'Very Good' for all major refurbishments.

Figure 1: Residential Building Regulations improvements (historical and anticipated) for new buildings in England.

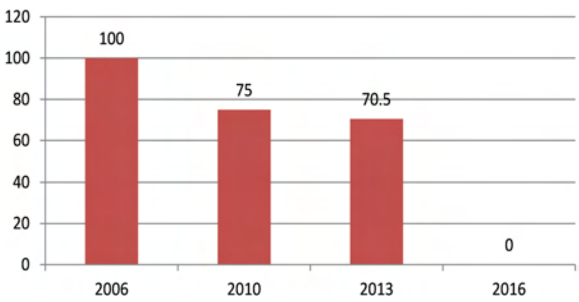


Figure 2: Non-residential Building Regulations improvements (historical and anticipated) for new buildings in England.

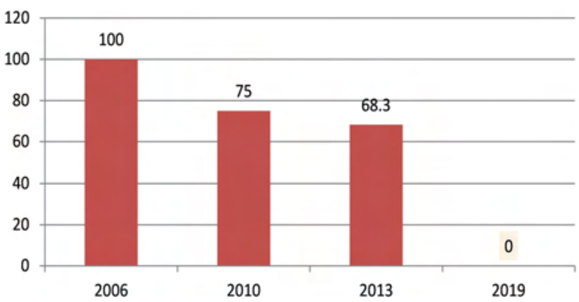


Table 1: Carbon emission factors, extracted from Table 12 of the SAP 2012.

Fuel	Standing charge, £ (a)	Unit price p/kWh	Emissions kg CO_2 per kWh (b)
Gas:			
mains gas	120	3.48	0.216
bulk LPG	70	7.60	0.241
bottled LPG		10.30	0.241
LPG subject to Special Condition 18 (c)	120	3.48	0.241
biogas (including anaerobic digestion)	70	7.60	0.098
Oil:			
heating oil		5.44	0.298
biodiesel from any biomass source (d)		7.64	0.123
biodiesel from vegetable oil only (e)		7.64	0.083
appliances able to use mineral oil or biodiesel		5.44	0.298
B30K (f)		6.10	0.245
bioethanol from any biomass source		47.0	0.140
Solid fuel: (g)			
house coal		3.67	0.394
anthracite		3.64	0.394
manufactured smokeless fuel		4.61	0.433
wood logs		4.23	0.019
wood pellets (in bags for secondary heating)		5.81	0.039
wood pellets (bulk supply for main heating)		5.26	0.039
wood chips		3.07	0.016
dual fuel appliance (mineral and wood)		3.99	0.226
Electricity: (a)			
standard tariff	54	13.19	0.519

I.ii. Format of national transposition and implementation of existing regulations

Part L of the Building Regulations addresses *"Conservation of Fuel and Power"* and transposes some of the requirements of the EPBD. To support the implementation of the Building Regulations in England, a series of *"Approved Documents"* (ADs) have been published. These documents describe *"reasonable provisions"* to comply with the Building Regulations. ADs provide a route to comply with Building Regulations, which is adopted for most projects.

The four ADs supporting the implementation of Part L of the Building Regulations are:

> AD L1A and AD L1B for new and existing residential buildings respectively;

> AD L2A for new non-residential buildings; and

> AD L2B for existing non-residential buildings[10].

The ADs include references to best practice guides such as Eurocodes (EN). An elemental approach is available for existing buildings, and five criteria are set for new residential and non-residential buildings:

1. Achieve a Target CO_2 Emission Rate and, for residential buildings only, a Target Fabric Energy Efficiency rate, which reflects the space heating and cooling requirements only, and is expressed as the amount of energy demand in units of kWh/m^2 of floor area per year.
2. Meet limits on design flexibility (including minimum fabric standards and building services efficiencies).
3. Limit the effects of heat gains in summer including the effect of shading devices and comfort assessment.
4. Ensure that the building performance is consistent with design calculations (with a particular focus on air permeability, commissioning of building services and, for residential units only, thermal bridges).
5. Provide for energy-efficient operation of the building.

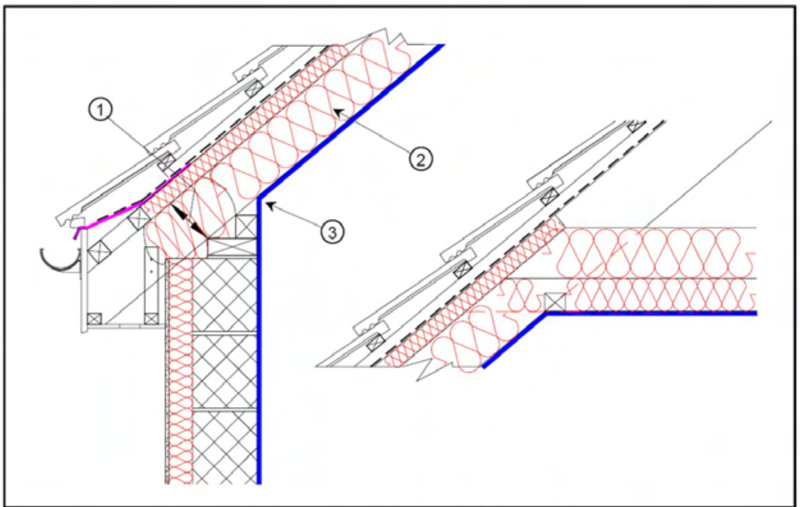
Note that criteria 1 to 4 above address thermal comfort. Internal air quality is addressed under Part F of the Building Regulations: *"Ventilation"*.

Compliance, particularly with the first three criteria, is assessed using the National Calculation Methodology (NCM). For residential units, the NCM is the Standard Assessment Procedure (SAP). An updated version (SAP 2012) was released in 2013 and encoded in privately-owned software tools. For non-residential buildings, the NCM Modelling Guide was updated in 2013 and is encoded in both a Government-approved software tool (SBEM) and alternative privately-owned software tools. Both NCMs use an Asset Rating approach, i.e., predicted energy consumption based on standard conditions. For more details visit www.ncm.bre.co.uk.

These software tools are also used to produce Energy Performance Certificates (EPCs) on construction, sale and rent. A separate procedure has been set to produce EPCs for display: the Operational Rating Calculation (ORCalc).

To support construction quality, the Government produced Approved Construction Details (ACDs). The ACDs focus on improving thermal bridging and airtightness, and help constructors to demonstrate that reasonable provisions for thermal bridging have been undertaken. These ACDs are particularly suitable for residential style buildings. ACDs are available at www.planningportal.gov.uk. Figure 3 gives an example. Alternative construction details can be used. Airtightness testing is required for most

Figure 3: Illustration from ACD for pitched roof. Extracted from ACDs for masonry external wall insulation.



[10] *The Approved Documents (ADs) are available at www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/approved#ApprovedDocumentL2A:ConservationoffuelandpowerNewbuildingsotherthanhouses*

> *Conservation of fuel and power in new dwellings, Approved Document L1A, HM Government, 2013 edition – for use in England*

> *Conservation of fuel and power in new buildings other than dwellings, Approved Document L2A, HM Government, 2013 edition – for use in England*

> *Amendments to the following Approved Documents, HM Government, November 2013*

- *Approved Document L1B: Conservation of fuel and power in existing dwellings (2010 edition)*
- *Approved Document L2B: Conservation of fuel and power in existing buildings other than dwellings (2010 edition)*

new residential and non-residential buildings. Some new buildings may be exempted from airtightness testing under particular circumstances, e.g., where less than two residential units are involved and the residential unit type has already passed airtightness testing within the previous 12 months and where a permeability of 15 $(m^3/h)/m^2$ at 50 Pa has been used in the building energy modelling.

Building Regulations outputs are submitted to local Building Control Bodies (BCBs) for checking. Statistics on compliance, enforcement and penalties are not kept at national/ England level. *"Competent Persons"*, who have been assessed as "competent" and are registered with a Government-approved Competent Person Scheme, are allowed to self-certify that their work complies with Building Regulations as an alternative to a submission to BCBs. More information on *"Competent Persons"* can be found at www.competentperson.co.uk.

I.iii. Cost-optimal procedure for setting energy performance requirements

A UK-wide cost-optimal report was published in May 2013. The report compares Building Regulations in each of the four UK jurisdictions to the calculated cost-optimal levels. In England, Building Regulations 2010 were used as the 2013 update was not yet finalised at the time of the cost-optimal study.

Residential buildings:

For new residential buildings, the reference building types considered sufficiently representative of developments in the UK were: semi-detached (single-family house) and mid-floor apartment. For existing buildings, the same two reference buildings types were adopted and modelled with two different wall constructions (uninsulated cavity wall and uninsulated solid wall), representing two common construction types within the UK. For new buildings, potential measures were compiled and grouped into packages which represent three different components of a building design: fabric, heating and photovoltaics. One hundred and twenty (120) alternatives were considered for each reference building. For existing buildings, each measure was assessed individually. The values for all measures were selected to give a spread of primary energy and lifecycle costs. Primary energy was calculated for each package/measure using the new/existing building software tool used for Building Regulations compliance assessments. Costs were calculated for each model to allow cost-optimal curves to be drawn and the cost-optimal levels to be defined. Cost-optimal levels were then compared to current Building Regulation requirements in the four UK jurisdictions. Outcomes from these comparisons are summarised in Tables 2 and 3.

> *New residential buildings* – The results show that the current standards were on average 16 to 23% more energy efficient than the cost-optimal level.
> *Existing residential buildings* – In all cases, the current standards meet or improve upon cost-optimal levels.

Non-residential buildings:

For new non-residential buildings, seven reference buildings were selected: office (natural ventilation and air-conditioning - AC), education, hotel/restaurant, retail, distribution warehouse, and hospital/ healthcare. These were deemed representative of the significant majority of the UK non-residential building stock. An appropriate construction type (cavity wall or steel frames) was selected for each reference building. For existing buildings, two reference buildings were considered for each of the seven non-residential building types: a low and a high energy efficiency buildings based on benchmark data of the actual building stock. A similar approach was adopted for measures and packages as for residential buildings (new and existing). For new buildings, packages represent four different components of a building: fabric, services, heating and photovoltaics, so that selecting one package from each component forms a complete building design. A total of 225 packages were considered for each reference building. For existing buildings, common renovation and replacement

Table 2: New residential units. Comparison table between current requirements and cost-optimal, England and Northern Ireland.

Reference building	Cost-optimal level (kWh/m^2.year)	Current requirements (kWh/m^2.year)	Gap (%)
Semi-detached	141	117	+16% better than cost-optimal
Mid-floor apartment	116	99	

Table 3: Existing residential units. Comparison table between current requirements and cost-optimal for England, Wales and Northern Ireland.

Reference building (averages)	Cost-optimal level	Current requirements	Gap
Cavity walls	U=0.55 W/m^2.K	U=0.55 W/m^2.K	Cost-optimal
Solid walls	U=0.4 W/m^2.K	U=0.30 W/m^2.K	+25% better than cost-optimal
Windows	U=1.6 W/m^2.K	U=1.6 W/m^2.K	Cost-optimal
Roof	U=0.20 W/m^2.K	U=0.18 W/m^2.K	Cost-optimal
Heating	88% (gas boiler)	88% (gas boiler)	Cost-optimal

measures which can have significant impact on energy use were selected. As for residential buildings (new and existing), primary energy was calculated using the Building Regulation compliance assessment software. Costs were calculated for each model to allow cost-optimal curves to be drawn and the cost-optimal levels to be defined. Cost-optimal levels were then compared to current Building Regulation requirements in the four UK jurisdictions. Outcomes from these comparisons are summarised in Tables 4 and 5.

> *New non-residential buildings* – In four building sectors, the reference standards were more energy efficient than the cost-optimal levels: air-conditioned office, naturally ventilated office, secondary school, and hospital. Reference standards in three building sectors were below cost-optimal levels (air-conditioned hotel, distribution warehouse, air-conditioned retail warehouse). On average across all sectors, standards were 4 to 7% lower than cost-optimal levels.
> *Existing non-residential buildings* – On average across all building sectors, the current standards were below cost-optimal levels for walls, floors, windows, lighting, chiller, and Air Handling Unit (AHU). The standards met or improved upon cost-optimal levels for roof and heating.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The UK national plan titled *"Increasing the number of Nearly Zero-Energy Buildings"* covers all four jurisdictions: England, Wales, Northern Ireland and Scotland. The plan was submitted to the European Commission and it confirms the UK's legally binding commitment (under the Climate Change Act 2008) to a reduction in greenhouse gas emissions of at least 34% by 2020 and 80% by 2050. To meet these targets, the emissions footprint of buildings will need to be almost zero, which will mainly be achieved through:

> reducing demand for energy in buildings, for example through heat efficiency improvements, lighting and appliances efficiency improvements, and behaviour change;
> decarbonising heating and cooling supply, for example through building- and network-level technologies.

The UK is committed to successive improvements in new-build energy standards through changes to the Building Regulations in England and their equivalents in the Devolved Administrations (Wales, Scotland and Northern Ireland), see Figures 1 and 2.

England has a target for all new homes to be zero-carbon from 2016, and an ambition for all new non-residential buildings in England to be zero-carbon from 2019 (2018 for new public sector buildings).

At the end of 2014, the UK is working on a definition for zero-carbon residential units. The definition includes three core requirements which must all be simultaneously met for a home to qualify as zero-carbon:

1. The performance of the envelope must, at a minimum, comply with the defined standard known as the Fabric Energy Efficiency Standard (FEES).
2. Any CO_2 emissions that remain after consideration of heating, cooling, fixed lighting and ventilation, must be less than or equal to the Carbon Compliance limit established for zero carbon homes.
3. Any remaining CO_2 emissions, from regulated energy sources (after requirements 1 and 2 have been met), must be reduced to zero.

Requirement 3 may be met by either deliberately 'overperforming' on requirements 1 and 2, so that there are no remaining emissions, or by investing in "Allowable Solutions" which allow carbon

Table 4: New non-residential buildings. Comparison table between current requirements and cost-optimal, England, Wales and Northern Ireland.

Reference building	Cost-optimal Level (kWh/m².year)	Current requirements (kWh/m².year)	Gap (%)
Office (AC)	163	155	-4% worse than cost-optimal
Office (NV)	89	87	
Secondary School	143	132	
Hospital	279	246	
Hotel (AC)	419	487	
Distribution Warehouse	131	136	
Retail Warehouse (AC)	193	232	
Average	202	211	

Table 5: Existing non-residential buildings. Comparison table between current requirements and cost-optimal for England, Wales and Northern Ireland.

Reference building (averages)	Cost-optimal level	Current requirements	Gap
Cavity walls	U=0.30 W/m².K	U=0.55 W/m².K	-83% worse than cost-optimal
Other walls	U=0.20 W/m².K	U=0.30 W/m².K	-50% worse than cost-optimal
Roof	U=0.24 W/m².K	U=0.18 W/m².K	+25% better than cost-optimal
Heating	84% (gas boiler)	E, W, NI: 84%	Cost-optimal
Floor	U=0.22 W/m².K	U=0.25 W/m².K	-14% worse than cost-optimal
Windows	U=1.64 W/m².K	U=1.8 W/m².K	-10% worse than cost-optimal
Lighting	61 l.m/W	55 l.m/W	-10% worse than cost-optimal
Chiller	3.9	3.5	-10% worse than cost-optimal

emissions that cannot be cost-effectively off-set on-site to be tackled though nearby or remote measures. The specific framework under which Allowable Solutions will operate has not been defined yet.

It is expected that a similar definition may be adopted for non-residential buildings[11].

The UK considers that its approach for zero-carbon buildings will meet the EPBD definition of Nearly Zero-Energy Buildings (NZEBs) as:

> although a range of low- and zero-carbon technologies will count towards meeting its zero-carbon standard, in practice the policy is expected to drive high levels of on-site renewables;

> this is expected to encourage the development of heat networks which could eventually be connected to renewable heat sources;

> low carbon technologies not classed as renewable still have a significant role to play in meeting the aims of the directive;

> the Building Regulation standards for zero-carbon buildings will take into account all the energy uses covered by Annex I of the EPBD. This will be delivered through an energy efficiency standard covering space heating and cooling. The remaining energy demand for fixed services will be covered by broader carbon emissions standards set in the regulations.

Figure 4: Illustration of zero-carbon definition for new residential units. Extract from www.zerocarbonhub.org.

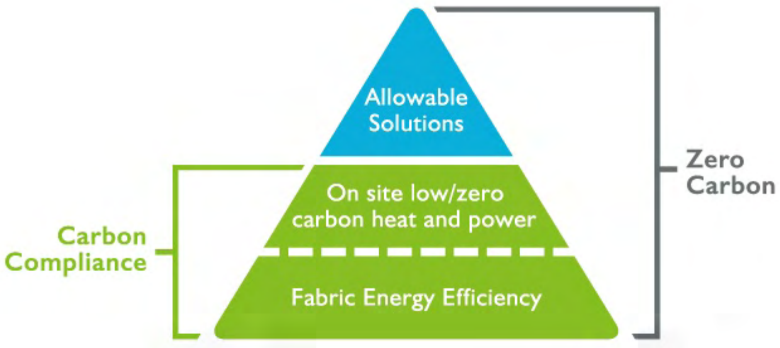
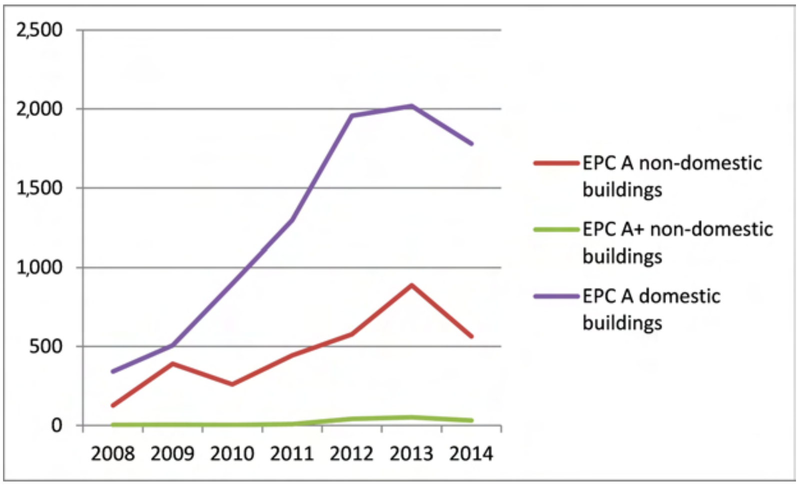


Figure 5: Historical records with an Energy Performance Certificate label of Class A and A+ (new residential and non-residential buildings in England).



NZEB statistics are not maintained in England. Figure 5 shows historical records with an Energy Performance Certificate label of Class A and A+ (non-residential buildings only) for new buildings. The graph shows a steady increase from 2008 to 2013 and a notable drop in 2014. Note that new building construction rates will also affect these data.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

Responsibility for the transposition of the EPBD in the UK is shared between the Governments of each jurisdiction: the Department for Communities and Local Government in England, the Welsh Assembly Government in Wales, the Department of Finance and Personnel in Northern Ireland, and the Local Government and Communities Directorate in Scotland. In some instances, transposition is identical across two or more jurisdictions.

The UK Department of Energy and Climate Change (DECC) is responsible for the transposition of the Energy Efficiency Directive (EED). The EED will mostly be implemented on a UK-wide basis. In a number of areas, where the Devolved Administrations in Northern Ireland, Wales and Scotland have responsibility for implementation, they have opted to pursue a UK-wide approach, though in some areas implementation will still be undertaken by the Devolved Administrations.

The UK National Energy Efficiency Action Plan (NEEAP) was published in April 2014. It includes a Building Renovation Strategy in compliance with Article 4 of the EED. The strategy references existing measures such as the Green Deal and Energy Company Obligation which are helping households to insulate their homes, the UK Green Investment Bank that is connecting private finance with demand for energy efficiency measures, Salix and RE:FIT that finance modernisation of the public sector's buildings. Forthcoming measures include the introduction of smart meters in households and small businesses to provide consumers with near real-time information on their energy use,

[11] *Further information is available at www.zerocarbonhub.org/zero-carbon-policy/zero-carbon-policy*

and the roll out of the residential Renewable Heat Incentive which will help stimulate a transformation in the way homes are heated.

The UK decided to implement the alternative approach allowed for by Article 5(6) and notified the Commission of the alternative measures that will be adopted to achieve an equivalent improvement in the energy performance of the buildings within the Central Government estate, which includes Central Government buildings in England, and buildings for UK-wide Government departments and in the Devolved Administrations. The NEEAP confirms that the main policies and measures used to meet the target are the Greening Government Commitments (GGC) for Central Government in England, and separate initiatives in Scotland, Wales and Northern Ireland. The measures include behavioural change, facilities management, estate management, installing energy efficient Information Technology (IT) hardware, and installing energy efficient technology. The GGC run from 2010 to 2015 and target a 25% greenhouse gases reduction over a 2009/10 baseline. The GGC are expected to deliver 516.6 GWh savings by 2020, well above the 163.6 GWh UK target for equivalence.

The NEEAP includes further details of other initiatives for all UK jurisdictions[12].

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The *"Domestic and Non-domestic Building Services Compliance Guides"* are referenced in the Approved Documents (see section I.ii above) and set out recommended minimum energy efficiency standards for components of building services systems, including:

> space heating;
> Domestic Hot Water (DHW);
> mechanical ventilation;
> comfort cooling;
> internal and external lighting;
> low carbon generation of heat by heat pumps, solar thermal panels, and Combined Heat and Power (CHP)/ micro CHP systems.

A summary of recommended minimum energy efficiency standards for residential buildings is included below as an example of the content of the Building Services Compliance Guides. The guides are available at www.planningportal.gov.uk.

The Approved Documents, which support the Building Regulations, include detailed specifications for the "reference building" from which the Target CO_2 Emission Rate is derived to assess compliance. These "reference building" specifications provide useful benchmarks for the actual building design. Note that standards higher than the recommended minimum standards (Table 6) will need to be achieved if new buildings are to meet the Building Regulations.

II.ii. Regulation of system performance, distinct from product or whole building performance

The commissioning of Technical Building Systems (TBS) is specifically addressed in the Approved Documents to help ensure the actual building performance is as consistent as possible with the design intentions. The Approved Documents reference the *"Domestic and Non-domestic Building Services Compliance Guides"*, as well as additional industry guidance. Typically the guides recommend following manufacturer's instructions for commissioning and explaining to users how to operate the system efficiently. The guides include additional information such as the qualifications/ accreditation required for the person commissioning a particular system.

The non-residential Approved Document references "Soft Landings" as a voluntary approach. Soft Landings aim to address the performance gap between design intentions and operational outcomes. It

Table 6: Selected examples of recommended minimum energy efficiency standards. "Domestic Building Services Compliance Guide", HM Government, 2013 edition – for use in England.

Building Services Type	Recommended minimum energy efficiency standard
Gas-fired wet central heating: condensing boiler	Seasonal efficiency (SEDBUK 2009): 88%
Solid fuel heating: independent boiler – wood/pellets/chips	75% nominal load 70% part load
Oil-fired wet central heating: condensing regular boiler	Seasonal efficiency (SEDBUK 2009): 88%
Heat pump – electrically driven (not air to air): space heating	For new buildings: coefficient of performance (COP) 2.5 at rating conditions in EN 14511
Heat pump – electrically driven (not air to air): Domestic Hot Water (DHW)	For new buildings: coefficient of performance (COP) 2.0 at rating conditions in EN 14511
Mechanical ventilation: continuous supply and extract with heat recovery	Specific fan power (SFP - W/(l/s): 1.5
Heat recovery: balanced mechanical ventilation systems	Dry heat recovery efficiency: 70%
Fixed lighting: internal light fittings	Lighting efficacy: 45 lamp lumens per circuit-watt
Comfort cooling: water-cooled air-conditioners working in cooling mode	Energy efficiency ratio (EER): 2.5

[12] www.gov.uk/government/uploads/system/uploads/attachment_data/file/307993/uk_national_energy_efficiency_action_plan.pdf

provides a step-by-step process for clients and their project teams to follow in order to avoid typical pitfalls and deliver a better-performing product[13]. The Government adopted the Soft Landings approach and, in 2012, announced that by 2016 all centrally-funded projects should be delivered in accordance with Government Soft Landings[14].

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

The Building Regulations are supported by Approved Documents and *"Domestic and Non-domestic Building Services Compliance Guides"* which include recommended minimum energy efficiency standards for new and replacement of existing building systems. For example, the recommended minimum energy efficiency standards for "gas-fired wet central heating condensing boilers" vary from 88% to 90%.

Under certain circumstances (typically where the liveable building area is extended), additional energy efficiency measures (named "consequential improvements") must be undertaken as set out in the Approved Documents. These requirements only apply to large, existing residential and non-residential buildings (i.e., greater than 1,000 m^2) and can include improvements to the performance of the building services.

II.iv. Provisions for installation, dimensioning, adjustment and control

The *"Domestic and Non-domestic Building Services Compliance Guides"* cover the design, installation, control and commissioning of technical building systems, and provide the minimum efficiencies required for each technical building system. The sizing of the systems is a separate process carried out by the design engineer in accordance with industry best practice.

II.v. Encouragement of intelligent metering

Metering requirements are included in the Approved Documents for new and existing non-residential buildings. The overall aim is to enable occupiers to meter at least 90% of the estimated annual energy consumption and to assign energy to the various end uses, e.g., heating, lighting, etc. The Approved Documents reference industry best practice for the installation of meters. Automatic meter reading and data collection must be provided in new non-residential buildings greater than 1,000 m^2.

There are no metering provisions for new and existing residential units in the Approved Documents. Instead, the Government aims for all homes to have smart meters by 2020. Energy suppliers will be responsible for replacing over 53 million gas and electricity meters in the UK. Most householders will have smart meters installed by their energy company between 2015 and 2020, although some energy companies are starting to install smart meters now.

II.vi. Encouragement of active energy-saving control (automation, control and monitoring)

Provisions for the effective control of TBS (for new and existing residential and non-residential buildings) are included in the *"Domestic and Non-Domestic Building Services Compliance Guides"*, in the Approved Documents, and in the Building Regulations. The National Calculation Methodology (NCM) also provides additional benefits for more effective controls, for both residential and non-residential buildings.

In addition, the Approved Document for new non-residential buildings includes benefits for installing automatic monitoring (with out-of-range alarms) of the building's energy performance and power factor correction equipment. For example, the calculated Building Emission Rate (BER) may be reduced where certain management features are provided, thus helping the new building to meet the maximum Target Emission Rate (TER). For "automatic monitoring and targeting with alarms for out of range values" the BER may be reduced by 5%.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The overarching systems in place are identical across all building sectors. The Government has licensed Accreditation Schemes. Under these licenses,

[13] *More information at www.bsria.co.uk/services/design/soft-landings*
[14] *www.bimtaskgroup.org/gsl-department-guidance-documents*

Accreditation Schemes are permitted to accredit suitably qualified/ trained Energy Assessors for the production of regulatory outputs for compliance with the Energy Performance of Buildings Regulations. Licenses are under regular review and may be revoked. In December 2014, ten Accreditation Schemes were licensed to operate.

Accredited Energy Assessors must use Government-approved software tools to produce regulatory outputs such as EPCs, display EPCs, recommendations reports, AC inspection reports, etc.

Regulatory outputs are recorded on a register (which covers England and Wales), and individual outputs may be retrieved from the register by members of the public (see details below).

How flats are certified in apartment buildings

- *New residential units:* an individual EPC must be produced for each apartment in the same building, e.g., each apartment in an apartment block gets its own EPC. However, some Building Regulations requirements, such as the Target CO_2 Emission Rate and the Target Fabric Energy Efficiency Rate may be calculated for the entire building rather than for each residential unit.
- *Existing residential units:* certification for individual apartments/units may be based on the assessment of another representative apartment/unit in the same block. The accredited Energy Assessor will need to visit a sample of the apartments/units to verify that they are indeed representative. Supporting evidence is required to demonstrate the apartment/unit is representative. Individual EPCs for each apartment/ unit may also be done.

Format and content of the EPC

- *Residential:* The EPC provides an asset rating (i.e., a calculated energy rating) of the current and potential energy efficiency of the building on a scale from A to G (Figure 6), with A being the most efficient and G the least efficient. The current rating is based on the characteristics of the building itself, its services, a standardised occupancy profile and the building's energy consumption cost. The potential rating shows the effect of undertaking the recommendations included in the EPC. The average EPC rating for a residential unit in England and Wales is class D, rating 60. Typically the lowest rating for a new building would be class C.

  In 2012, the format of the residential EPC was revised based on consumer research. The first page of a residential EPC is shown in Figure 7. The revised residential EPC is shorter, uses plain English and has an improved design and layout. Its primary focus is on the potential costs and savings of different energy efficiency measures, rather than CO_2 emissions.

  The residential EPC also contains an environmental impact rating, which is a measure of a house's impact on the environment in terms of carbon dioxide (CO_2) emissions. The EPC includes a list of cost-effective recommendations specific to the residential unit to improve the energy ratings, and indicates the potential energy efficiency and environmental impact ratings if all cost-effective measures were installed. This is applicable to both new and existing buildings. For new buildings, the current and potential ratings may be identical where all cost-effective measures have been implemented.
- *Non-residential:* Energy performance is shown as a single CO_2-based asset rating against an A to G scale (Figure 8). The non-residential EPC (for both new and

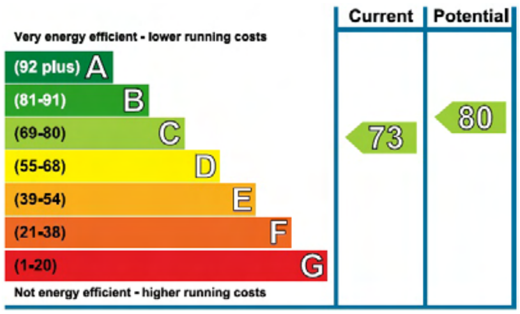
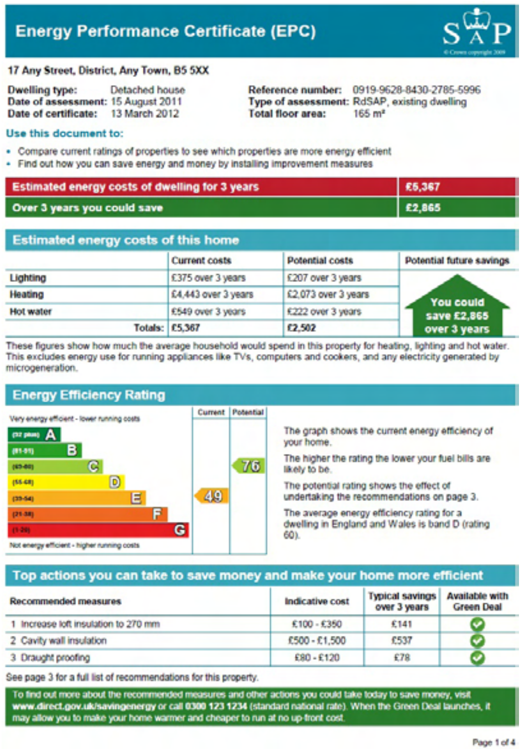


Figure 6: Residential EPC classes, asset ratings, and examples of current and potential ratings.



Energy Performance Certificate (EPC)

17 Any Street, District, Any Town, B5 5XX

Dwelling type: Detached house
Date of assessment: 15 August 2011
Date of certificate: 13 March 2012
Reference number: 0919-9628-8430-2785-5996
Type of assessment: RdSAP, existing dwelling
Total floor area: 165 m²

Use this document to:
- Compare current ratings of properties to see which properties are more energy efficient
- Find out how you can save energy and money by installing improvement measures

Estimated energy costs of dwelling for 3 years	£5,367
Over 3 years you could save	£2,865

Estimated energy costs of this home

	Current costs	Potential costs	Potential future savings
Lighting	£375 over 3 years	£207 over 3 years	You could save £2,865 over 3 years
Heating	£4,443 over 3 years	£2,073 over 3 years	
Hot water	£549 over 3 years	£222 over 3 years	
Totals:	£5,367	£2,502	

These figures show how much the average household would spend in this property for heating, lighting and hot water. This excludes energy use for running appliances like TVs, computers and cookers, and any electricity generated by microgeneration.

Energy Efficiency Rating

The graph shows the current energy efficiency of your home.

The higher the rating the lower your fuel bills are likely to be.

The potential rating shows the effect of undertaking the recommendations on page 3.

The average energy efficiency rating for a dwelling in England and Wales is band D (rating 60).

Top actions you can take to save money and make your home more efficient

Recommended measures	Indicative cost	Typical savings over 3 years	Available with Green Deal
1 Increase loft insulation to 270 mm	£100 - £350	£141	✓
2 Cavity wall insulation	£500 - £1,500	£537	✓
3 Draught proofing	£80 - £120	£78	✓

See page 3 for a full list of recommendations for this property.

To find out more about the recommended measures and other actions you could take today to save money, visit **www.direct.gov.uk/savingenergy** or call **0300 123 1234** (standard national rate). When the Green Deal launches, it may allow you to make your home warmer and cheaper to run at no up-front cost.

Page 1 of 4

Figure 7: First page of a residential EPC.

existing buildings) includes two benchmarks: the energy rating if the property were newly-built, and the energy rating if it were typical of the existing stock (Figure 9). A shortlist of standard cost-effective recommendations (for both new and existing buildings) is generated by the software. Appropriate recommendations are selected by the assessor for inclusion in the accompanying Recommendations Report and are categorised as:

- short term - payback less than three years;
- medium term - payback between three and seven years;
- long term - payback more than seven years.

Other recommendations may also be provided, based on the Energy Assessor's knowledge.

EPC activity levels

Asset rating based EPCs are produced for buildings on construction, sale and rent.

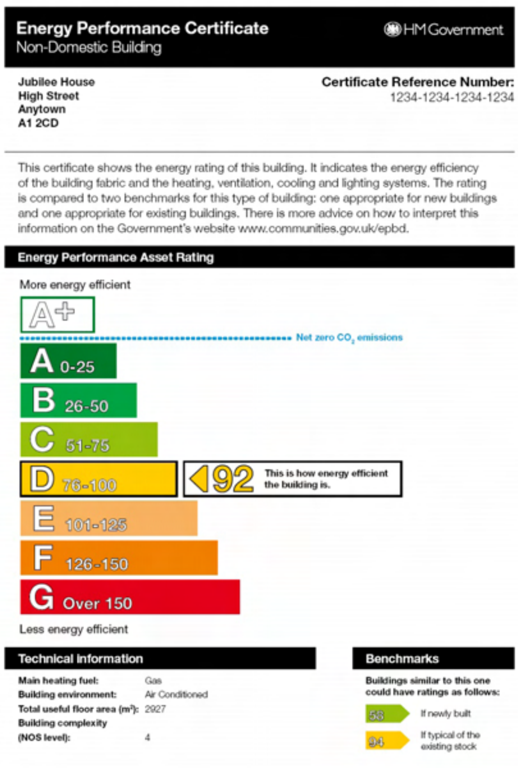


Figure 8: First page of a non-residential EPC.

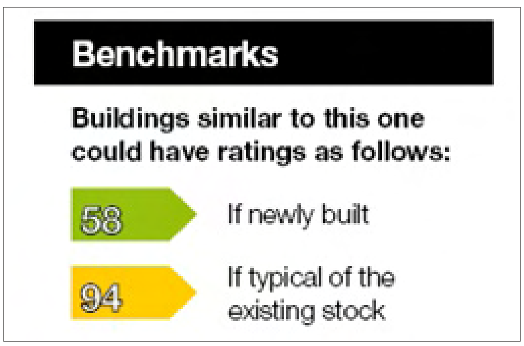


Figure 9: Non-residential EPC benchmarks.

Operational rating (i.e., measured energy rating) based certificates (Display Energy Certificates – DECs) are produced and displayed in large public buildings (see details in section III.ii). Both residential and non-residential EPCs are valid for 10 years. All EPCs become legally valid after they have been recorded on the register which covers England and Wales. The register contains nearly 13 million EPCs (including cancelled, "not for issue" and multiple EPCs on a single property) and this number is growing by over 1 million per year. In 2013 alone, over 2 million residential and over 79,000 non-residential EPCs were recorded on the register. These represent a valuable source of information about the energy efficiency of buildings as they cover an increasingly larger proportion of the ca. 27 million homes in the UK (more information on the coverage of EPCs in section III.v).

Most EPCs recorded on the national register are freely accessible to the public through an address search (unless the building owner opts out). All EPCs on the register are freely accessible through a unique reference number search. EPCs record statistics are also available on the register, and in July 2014 the Government released "experimental official statistics" on EPC activity levels in England and Wales[15]. Record data from 2008 to July 2014 is included in Tables 7 and 8, Figures 10 and 11.

Selected organisations have access to limited data in bulk. These limitations are designed to protect consumers and there is a charge for this service. Allowing access to this data has a number of benefits, including: supporting the implementation of other Government energy efficiency programmes (e.g., the Green Deal) and facilitating research and analysis which can inform Government policy.

References: Residential register (England and Wales) www.epcregister.com; Non-residential register (England and Wales for certificates and AC inspection reports) www.ndepcregister.com.

Typical EPC costs

The cost of certificates varies greatly. Indicative starting costs, i.e., lowest market costs (based on internet search in July 2014) are:

> for residential buildings: from 35 £ to 60 £ (ca. 44 € to 75 €);

> for non-residential buildings: from 129 £ to 150 £ (ca. 162 € to 188 €).

[15] *www.gov.uk/government/collections/energy-performance-of-buildings-certificates*

The above costs include the registration fee payable each time an EPC is recorded on the register. The fee for registering a residential EPC reduced from 1.67 £ to 1.30 £ (ca. 2.12 € to 1.65 €) and from 11.81 £ to 9.73 £ (ca. 15 € to 12.36 €) for a non-residential EPC record (effective from April 2014).

Assessor corps

National Occupational Standards (NOS) specify the qualifications and skills which Energy Assessors should meet to be accredited to produce regulatory outputs. Different types of accreditations are available to would be Energy Assessors, depending on the building type (residential or non-residential), the complexity of the building and software to be used, and the type of regulatory outputs to be produced (EPC, DEC, AC report, etc.). The different types of accreditations are shown in Table 9. Accreditation Schemes must ensure that accredited assessors satisfy the appropriate NOS requirements. This is typically done through training and examination, or by demonstrating suitable prior experience. The level of training/ examination also varies between Accreditation Schemes. As an example, the NOS for the Production of ORs, DECs, and Advisory Reports includes four units:

1. Unit 1 [Chapter 1] Work in a safe, effective and professional manner
   - Element 1.1 Contribute to the maintenance of health, safety and security at work
   - Element 1.2 Develop and maintain effective working relationships
   - Element 1.3 Conduct energy assessments in a professional and ethical manner
2. Unit 2 [Chapter 2] Prepare for energy assessments of non-dwellings to produce Energy Performance Certificates (EPCs), Operational Ratings (ORs), Display Energy Certificates (DECs) and Advisory Reports (ARs)
   - Element 2.1 Agree and confirm instructions to undertake energy assessments
   - Element 2.2 Investigate relevant matters relating to the property and energy usage
3. Unit 3 [Chapter 3] Determine Operational Ratings and issue Display Energy Certificates for non-dwellings
   - Element 3.1 Determine Operational Ratings for non-dwellings
   - Element 3.2 Issue Display Energy Certificates
4. Unit 4 [Chapter 4] Produce Advisory Reports
   - Element 4.1 Obtain information, produce and issue Advisory Reports

Domestic EPC lodgements by band										
	Total EPCs	A	B	C	D	E	F	G	not recorded
Total	10,524,551	8,800	905,377	2,929,889	4,082,265	1,913,539	533,638	150,656	387
Percentage	100%	0%	9%	28%	39%	18%	5%	1%	0%

Table 7: Residential EPCs, 2008 to July 2014, England.

Non-domestic EPC lodgements by band										
	Total EPCs	A+	A	B	C	D	E	F	G	not recorded
Total	487,715	147	3,253	36,830	133,007	144,384	80,540	40,697	48,755	102
Percentage	100%	0%	1%	8%	27%	30%	17%	8%	10%	0%

Table 8: Non-residential EPCs, 2008 to July 2014, England.

Figure 10: Residential EPCs, 2008 to July 2014, England. Percentages by EPC band ("not recorded" = faulty EPC, e.g., cancelled/withdrawn EPC).

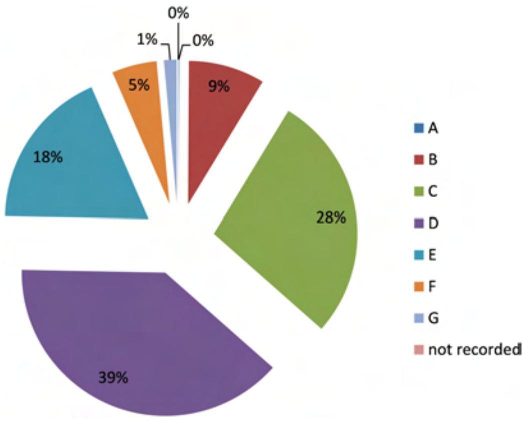


Figure 11: Non-residential EPCs, 2008 to July 2014, England. Percentages by EPC band.

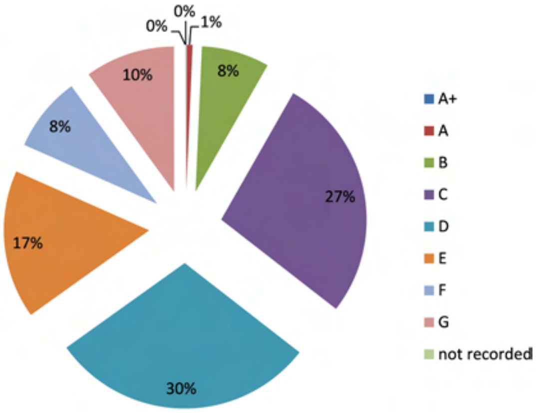


Table 9 shows the number of registrations for Energy Assessors notified to the Energy Performance of Buildings Register by Accreditation Schemes in England and Wales as of 12 August 2014. These numbers may change on a daily basis, and may include duplicates as an Energy Assessor may be a member of more than one Accreditation Scheme. AC inspectors are accredited experts allowed to carry out inspections of AC systems (see section IV), but are part of the same registry.

The same NOS apply across England and Wales, therefore accredited Energy Assessors can operate in both jurisdictions.

Minimum Continuous Professional Development (CPD) requirements are also specified. For example, non-residential level 5 assessors must complete 7.5 hours CPD per year. If the CPD requirement is not met, penalties include temporary expulsion from the Accreditation Scheme, which prevents the Energy Assessor from producing EPCs.

Compliance levels by sector

The Government does not monitor compliance levels. Compliance is verified at Local Authority level and Local Authorities do not have a requirement to publish compliance assessment outcomes, nor is there a central national body which records compliance.

Enforcement with building owners and real estate actors

Local Authorities Trading Standard Officers (TSOs) have the powers to require the "relevant person" (for example the seller, the prospective landlord or the constructor) to produce copies of the EPC for inspection and to take copies if necessary. In 2012, these powers were extended to include persons acting on behalf of the "relevant person" for example Estate or Letting Agents.

Table 9: Energy Assessor types and numbers notified to the England and Wales register

Assessor types	Assessor numbers
Domestic EPCs (existing buildings) RdSAP	43,885
Domestic EPCs (new buildings) SAP	2,517
Non-domestic EPCs (level 3)	7,071
Non-domestic EPCs (level 4)	4,555
Non-domestic EPCs (level 5)	568
Display Energy Certificate (DEC)	2,545
AC inspection (level 3, simple)	1,537
AC inspection (level 4, complex)	1,265
Total Assessors	***63,943***

Notes
RdSAP: Reduced Standard Assessment Procedure
SAP: Standard Assessment Procedure
EPC: Energy Performance Certificate
DEC: Display Energy Certificate
AC: Air-Conditioning
EPC level 3: simple non-domestic buildings
EPC level 4: medium complexity non-domestic buildings
EPC level 5: complex non-domestic buildings
AC level 3: simple packaged AC
AC level 4: complex central AC

Penalties for non-compliance with the regulatory requirements vary depending on the type of building:

> for residential properties, the penalty is 200 £ (ca. 250 €);

> for non-residential properties, the penalty is a sum equivalent to 12.5% of the rateable value of the building, subject to a minimum of 500 £ (ca. 625 €) and a maximum of 5,000 £ (ca. 6,250 €).

No information is collected by the Government about the number of penalty notices issued by Local Authorities for non-compliance with the Energy Performance of Buildings Regulations.

Quality Assurance (QA) of EPCs

The Government introduced Scheme Operating Requirements (SORs) in 2010 to ensure that all Accreditation Schemes achieve a common set of minimum quality standards. These requirements were updated in 2012 to strengthen the existing procedures, and to ensure a high quality of regulatory outputs. The example below shows the content of the DEC SOR:

1. Ensure that members of the scheme are "fit and proper" persons to undertake energy assessments and that they operate within a code of conduct [...] which is actively enforced by the scheme.
2. Ensure that members of the scheme are qualified to undertake energy assessments.
3. Ensure that members of the scheme have in force suitable indemnity cover.
4. Ensure that members of the scheme use operational procedures that ensure consistency and accuracy of energy assessments.
5. Maintain active quality assurance procedures that are calculated to ensure so far as is reasonably practical that the other provisions listed here are delivered.
6. Facilitate the resolution of complaints against members of the scheme.
7. Implement disciplinary procedures in a proportionate and reasonable manner.
8. Establish and maintain a register of members.
9. Ensure financial probity, financial stability and operational resilience of the scheme.
10. Allow [Government] to monitor the scheme periodically to ensure that it continues to comply with the terms of its approval and delivers compliance with the legislation.
11. Maintain suitable administrative and operational systems that are applied in

a consistent, fair and open way that is compliant with all relevant legislation.
12. Meet other requirements that [Government] has specified from time to time, and in line with the "Approval Letter".

Appendix 5 of the DEC SOR describes the Accreditation Scheme quality assurance requirements. The headings and selected examples are provided below:

> Section 1: Introduction
> Section 2: Accuracy of DECs, Advisory Report, and the audit methodology. For example, random sampling should demonstrate no more than 10%/month of DEC or Advisory Report to be defective. Defective certificate examples include: floor area and energy calculations not within 2.5% of quality assurance assessment, based on evidence submitted by the energy assessor, not a site visit.
> Section 3: Evidence supporting DECs and Advisory Reports.
> Section 4: Methods of sampling of scheme members' DECs and Advisory Reports. For example:
  • Random sampling: at least 2% of DEC or Advisory Report recorded through the Accreditation Scheme.
  • Minimum checks: for each member, at least 1 check in each calendar semester, and at least 1% of all records must be checked.
  • New members: at least 5% of records in first six months are checked.
> Section 5: Requirements on Quality Assurance Assessors (QAAs).
> Section 6: Provisions for replacing defective certificates/Advisory Reports.
> Section 7: Scheduling of DEC audits and the replacement of defective DECs and Advisory Reports.
> Section 8: Monthly reporting to DCLG of the results of schemes' member QA.
> Section 9: The avoidance of conflicts of interest.
> Section 10: Participation in cross scheme moderation activities.
> Section 11: Requirements for disciplinary measures. For example:
  • Where there is evidence that the energy assessor failed to visit the building, the assessor shall be suspended pending investigation. Assessors shall be subject to increased auditing frequency (10% of records for first six months) following reinstatement after a suspension.
  • Where there is evidence that the Energy Assessor has continued to fail to identify the different benchmarks, the assessors shall be revoked.
> Section 12: Handling the outsourcing of QA.
> Section 13: Dealing with uncertainty.

The SORs mandate Accreditation Schemes to undertake Quality Assurance (QA) of the outputs produced by their accredited Energy Assessors. The Government also carries out QA audits of the quality systems implemented by Accreditation Schemes and compliance with the SORs. These provisions ensure that a statistically significant percentage of certificates is checked by independent experts for QA purposes.

In the most severe instances (for example following multiple failures to remedy a defective QA system) the Government may suspend or revoke an Accreditation Scheme's license to operate. To date, the Government has made very limited use of these powers. The number of EPCs controlled is recorded by the Government but it is not currently published. Similarly, Accreditation Schemes may revoke an Energy Assessor's license to operate.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

Different approaches have been adopted depending on the type of building occupier and the building's floor area (Table 10). DECs are issued and displayed in buildings larger than 500 m² that are occupied by a public authority and frequently visited by the public. This threshold will fall to 250 m² in 2015. EPCs are displayed in commercial premises larger than 500 m² that are frequently visited by the public, and where an EPC has previously been issued.

Details of the EPC approach for non-residential buildings are provided in section III. EPCs are based on predicted energy consumption, while DECs are based on an OR approach, i.e., measured energy consumption which is normalised to allow cross sector comparison. As indicated in Table 10, yearly DEC are only required for public authority buildings with a floor area greater than 1,000 m².

Table 10: Energy performance display requirements.

Occupier	Floor area	Requirements	Validity
Public authority*	Greater than 500 m²	Produce and display a DEC	10 years
		Produce an Advisory Report	10 years
	Greater than 1,000 m²	Produce and display a DEC	1 year
		Produce an Advisory Report	7 years
Commercial premises*	Greater than 500 m²	If an EPC has been produced (for construction, sale or rent), the EPC must be displayed**	10 years

* The building must be frequently visited by the public.
** EPCs (produced for construction, sale or rent) must be accompanied by a Recommendations Report.

Format and content of the EPC

DECs show the energy performance of a building based on the actual energy consumption for the previous year in the form of an OR (Figure 12). If available, the building's performance over the previous three years may also be shown to illustrate the performance trend. The OR is a numerical indicator of a building's CO_2 emissions on a scale of A to G, with A being the best performance. An EPC rating may also be included on the DEC, if an EPC is available for the building.

The building's performance is compared to a benchmark. For each building category, the benchmark is set at the median performance for all buildings in each benchmark category. Benchmarks have been reviewed periodically to ensure they are adequate. Buildings which have zero CO_2 emissions over the year achieve an OR of zero. Buildings which perform at the benchmark level achieve an OR of 100 at the D to E boundary. Buildings which emit twice as much CO_2 as the benchmark achieve an OR of 200. Buildings which are net energy generators are given an OR of zero. The approved benchmarks are set out in the Technical Memorandum 46 (TM 46) Energy Benchmarks published by the Chartered Institution of Building Services Engineers (CIBSE)[16].

DECs are accompanied by an Advisory Report, which includes cost-effective recommendations and has a maximum validity of seven or 10 years (Table 10).

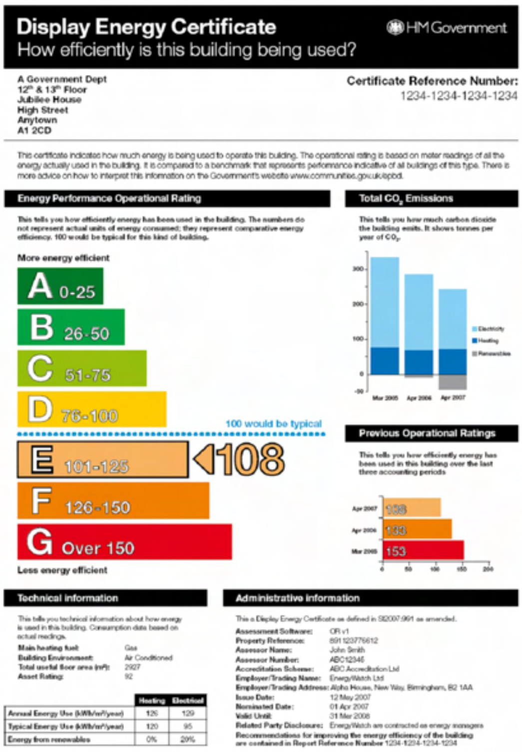


Figure 12: Display Energy Certificate (DEC).

Recommendations are categorised by payback in the same way as in Recommendations Reports which accompany non-residential EPCs (see section III for details).

In 2011, CIBSE undertook a review of 45,000 DECs recorded between 2008 and 2010 in England and Wales. The review concluded that overall the benchmarking system worked well, with a good correlation between ORs and benchmarks in 94% of the DECs analysed. In 2013, CIBSE reviewed 73,000 DECs recorded between 2008 and mid-2012. Selected key findings included:

> The benchmark values are generous in 12 out of 14 benchmark categories.

> Revisions to the benchmarks would be justified in many categories.

> In many benchmark categories there is higher electricity use and lower fossil thermal energy use than the benchmark values. [...] The two opposite effects tend to cancel each other in the overall operational ratings.

DEC record data from 2008 to July 2014 is included in Table 11 and Figure 13.

The cost of DECs varies greatly. Indicative starting costs, i.e., the lowest market costs (based on internet search in July 2014) range from 80 £ to 175 £ (ca. 100 € to 220 €). These costs include the registration fee payable each time a DEC is recorded on the non-residential register. Registration fees for a DEC are the same as for a non-residential EPC, i.e., 9.73 £ (ca. 12.36 €).

Assessor corps

As for EPCs (section III.i.), qualification and training requirements are detailed in the NOS which specifically addresses DECs. There are no mandatory CPD requirements set at the national level. Accreditation Schemes may, at their own discretion, implement requirements that exceed NOS.

Quality Assurance (QA) of EPCs

The administration processes (Energy Assessors accreditation, QA, etc.) and enforcement powers for DECs are identical to those implemented for EPCs (see details in section III.i.). As DECs are displayed in buildings, this adds an informal layer of control, for example where informed members of the public may enquire about a DEC not being displayed.

Penalties

Occupiers of buildings qualifying under the regulations who fail to:

[16] *www.cibse.org/knowledge/cibse-tm/tm46-energy-benchmarks*

> possess or control a valid Advisory Report may be subject to a 1,000 £ (ca. 1,250 €) penalty;
> display a valid DEC may be subject to a 500 £ (ca. 625 €) penalty.

III.iii. Implementation of mandatory advertising requirement

From 2012, an EPC must be commissioned before the property is marketed. Sellers and landlords are ultimately responsible for commissioning an EPC. Estate or Letting Agents (acting on behalf of sellers or landlords) must be satisfied that an EPC is available or has been commissioned before the property is marketed.

From January 2013, for buildings on sale or rent that have a valid EPC, the Asset Rating of the building expressed in the EPC must be stated in any advertisement of the sale or rental in commercial media.

The enforcement and penalty regimes are as described for EPCs in section III.i.

III.iv. Information campaigns

Publicity campaigns were run in 2008 and 2009 to introduce a range of initiatives, including AC inspections. At present, the Government does not intend to run a publicity campaign about regulatory requirements which building owners should be aware of.

Other Government initiatives to improve the energy efficiency of buildings have benefited from publicity campaigns such as the launch of the Green Deal in 2013, or the Energy Suppliers campaigns under The Energy Company Obligation (ECO) which implements Article 7 of the EED.

III.v. Coverage of the national building stock

The UK NEEAP gives a statistical overview of the main features of the building stock in the whole UK. The UK's building stock, including England, varies widely both in age and type. The data presented in Figures 14 and 15 is taken from a national register of EPCs. EPCs are only required under specific circumstances so this is not fully representative of all building types.

The UK has 27 million homes across a wide range of housing types, including a significant proportion of older buildings. Of these, 22.1 million homes are located in England. Figure 14 shows the distribution of about 10.5 million residential EPCs in England (Table 7). Buildings with no EPCs are not represented in Figure 14.

There are over 1.8 million non-residential premises in the UK, which are responsible for around 17% of the total UK energy consumption. Figure 15 shows the distribution of about 0.5 million non-residential EPCs in the UK (Table 8). Buildings with no EPCs are not represented in Figure 15.

The number of EPCs recorded in 2013, for new and existing buildings in England totalled 1,874,030 residential EPCs, 75,114 non-residential EPCs, and 35,473 DECs.

	DEC lodgements by band								
	Total	A	B	C	D	E	F	G	not recorded
Total	185,625	1,155	8,555	35,101	63,132	42,440	16,941	18,296	5
Percentage	100%	1%	5%	19%	34%	23%	9%	10%	0%

Table 11: Display Energy Certificates (DECs), 2008 to July 2014, England.

Figure 13: Display Energy Certificates (DECs), 2008 to July 2014, England. Percentages by DEC band ("not recorded" = faulty EPC, e.g., cancelled/withdrawn EPC).

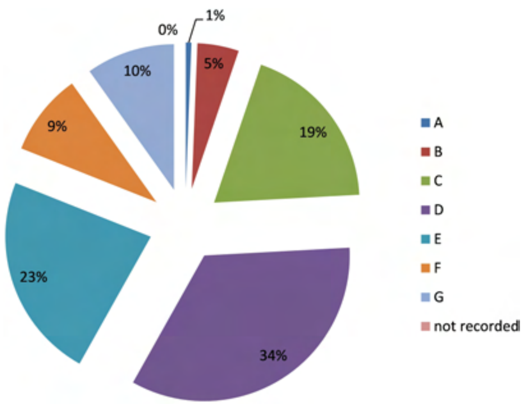
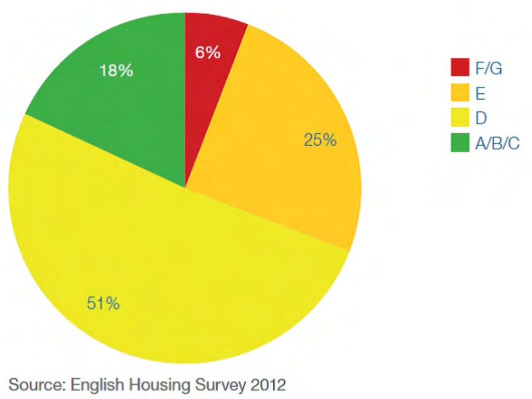


Figure 14: Energy efficiency rating of English housing stock, 2012 (extracted from the UK NEEAP).



IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

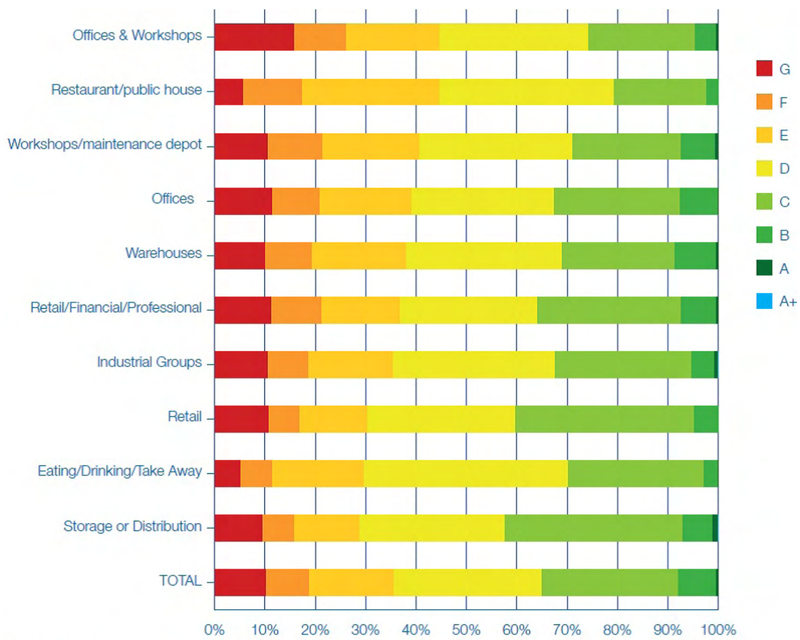
The UK (England, Wales, Scotland and Northern Ireland) adopted alternative measures for heating systems and inspections for AC systems.

A UK-wide scheme is being implemented to transpose the requirements of EED Article 8: the Energy Savings Opportunity Scheme (ESOS). ESOS allows compliance with EED Article 8 by complying with the EPBD DEC. The inspection of AC systems, and the alternative measures adopted for heating systems are not recognised by ESOS, i.e., they do not directly contribute to the transposition of EED Article 8. However, AC inspections would likely be considered when undertaking ESOS audits.

The UK (England, Wales, Northern Ireland and Scotland) decided to pursue the option to provide advice on boilers/ heating systems, rather than implement an inspection regime. This is in continuation of the extensive programme of information, grant schemes and regulation which the UK has implemented historically. Equivalence reports were issued to the Commission in 2007, 2010 and 2013. The fourth report is being prepared and the information below is based on the 2013 report.

The 2013 report found that the UK's alternative measures will produce a primary energy saving of 4.27 TWh during 2013 - 2015. In comparison, a boiler inspection regime would produce a saving of 1.14 TWh, thus justifying the UK's preferred approach.

Figure 15: Distribution of EPC ratings by building sector 2008 – 2013 (extracted from the UK NEEAP).



Source: Energy Performance Certificate data

IV.i. Progress and current status on heating systems

Detailing of activities to improve energy performance of heating systems

The alternative measures identified in the 2013 report are:

(1) The carbon emissions reduction target (early replacement of band G boilers).
(2) The community energy saving programme (energy suppliers/ generators to deliver energy saving to residential consumers in low income areas).
(3) Fuel poverty programmes in the UK (to improve identification and targeting of existing help to fuel poor customers).
(4) The energy company obligation – affordable warmth obligation (to obligate larger energy suppliers to deliver energy efficiency measures to residential premises).
(5) Green deal non-residential heating measures (to finance energy efficiency measures).
(6) Advice programmes and guidance encouraging boiler inspections leading to adjustments, installation of improved controls and early boiler replacements.

Building Regulations requirements for heating systems – particularly the need to install condensing boilers – have not been included as an alternative measure, although the specific performance requirements are integral to all of the above alternative measures.

Impact and equivalence assessment

The data sources for the energy savings of each alternative measure are detailed in the 2013 report. The key source documents included the updated edition of the UK's NEEAP, the final reports on the carbon emissions reduction target, the community energy saving programme, and the final impact assessment of the green deal. The exception to this is measure (6) (advice programmes) which was assessed using the boiler stock model updated from the previous equivalence reports. The impact of the alternative measures is detailed in Table 12.

The boiler stock model for the UK was updated to estimate the primary energy saving that would result from a hypothetical boiler inspection regime that extended the existing boiler inspection and servicing activity and also met the requirements. The savings are summarised in Table 13.

IV.ii. Progress and current status on AC systems

Overview, technical method and administration system

The inspections of AC equipment was phased in between 2009 (for systems > 250 kW) and 2011 (for systems > 12 kW). Installations must be inspected by an accredited Energy Assessor every five years, which is the validity of an inspection report.

From 2012, all new AC inspection reports must be registered on the national EPC register for England and Wales. This replaces the previous voluntary registration approach, and allows reports to be assessed for QA. As with EPCs, most reports registered on the national EPC register are freely accessible to the public through an address search. All reports on the register are freely accessible through a unique reference number search.

Arrangements for assurance, registration and promotion of competent persons

The approved approach to undertake AC inspections is set out in the Technical Memorandum 44 (TM 44) Inspection of Air-conditioning Systems published by the Chartered Institution of Building Services Engineers (CIBSE). CIBSE is one of the main professional institutions for building services engineers.

National Occupational Standards (NOS) and Scheme Operating Requirements (SOR) have been established for AC inspections. NOS set the minimum competencies and skills which Energy Assessors must demonstrate to become accredited (see NOS example in section III.i.). Two levels of accreditation are available to assessors: “Level 3” for simple packaged cooling systems, and “Level 4” for complex, centralised systems. Some of the NOS requirements to become an AC Energy Assessor are identical as the requirements for producing EPCs. Specific AC requirements are also included in the AC NOS. SORs define the minimum requirements for Accreditation Schemes offering AC inspections. SORs address the QA of AC inspection reports (see SOR example in section III.i.).

Promotional activities

To date, the Government has not run promotional activities specifically focused on the inspection of AC systems. Publicity campaigns were run in 2008 and 2009 to introduce a range of initiatives, including AC inspections.

Enforcement and penalties

Local Authorities Trading Standard Officers (TSOs) are responsible for ensuring that owners of AC systems (over 12 kW) are in possession of a valid inspection report.

The penalty for failing to ensure that an accredited Energy Assessor inspects an AC system every five years, or for failing to possess a valid inspection report is 300 £ (ca. 375 €).

No information is collected by the Government about the number of penalty notices issued by Local Authorities for non-compliance with the requirements of the Energy Performance of Buildings Regulations.

Quality control of inspection reports

AC inspection SORs are defined for Accreditation Schemes. The SORs (see example in section III.i.) set the minimum regime of QA which includes:

> ensuring that members of the Accreditation Scheme use operational procedures that ensure consistency and accuracy of energy assessments, including the statutory registration of AC inspection reports in the non-residential EPC register;

> maintaining active QA procedures to ensure the SORs quality objectives are delivered.

Inspection activity figures

More than 8,000 AC reports were recorded on the England and Wales national register in the 12 months ending July 2014, and in excess of 22,000 reports have been recorded in total.

Table 12: Primary energy savings attributable to alternative measures, UK 2013 Equivalence Report.

Alternative measure	Primary energy savings (2013-2015) (TWh)
The carbon emissions reduction target	2.41
The community energy saving programme	0.40
UK fuel poverty programmes	0.68
Energy company obligation – affordable warmth obligation	0.65
Green deal – non-residential heating measures	0.13
Advice programmes	0.003
Total	4.27

Table 13: Primary energy savings attributable to boiler inspection regime, UK 2013 Equivalence Report.

Sector	Measure	Primary energy savings (2013-2015) (TWh)
Residential	Boiler adjustment	0.11
	Implementation of controls guidance	0.21
	Early boiler replacement	0.25
	Total	0.57
Non-residential	Boiler adjustment	0.53
	Early boiler replacement	0.05
	Total	0.57
Total		1.14

Impact assessment, costs and benefits

The Impact Assessment estimated a cost (Net Present Value – NPV) for AC systems inspection in England and Wales of about 149 million £ (ca. 189 M€). The impact assessment lists as benefits the improved performance, reduced operating costs, added stimulus for improvements, and estimated NPV energy benefits of ca. 213 million £ (ca. 270 M€). Therefore, the net benefit was estimated to be 64 million £ (ca. 81 M€), with the CO_2 savings in the year 2020 estimated at 0.08 million tonnes.

3. A success story in EPBD implementation

Although not required by the EPBD, an EPC register was established in 2008, at the same time as the EPBD requirements were first implemented in England and Wales. It is a legal requirement to enter the EPBD document (certificate and/or report) on the register before giving it to the person who requested it. All documents recorded on the register are retained for at least 20 years.

Figure 16: Trend in median OR, based on performance of first DEC. Extracted from "Special Feature, What is the impact of DECs?" *DECC, June 2013.*

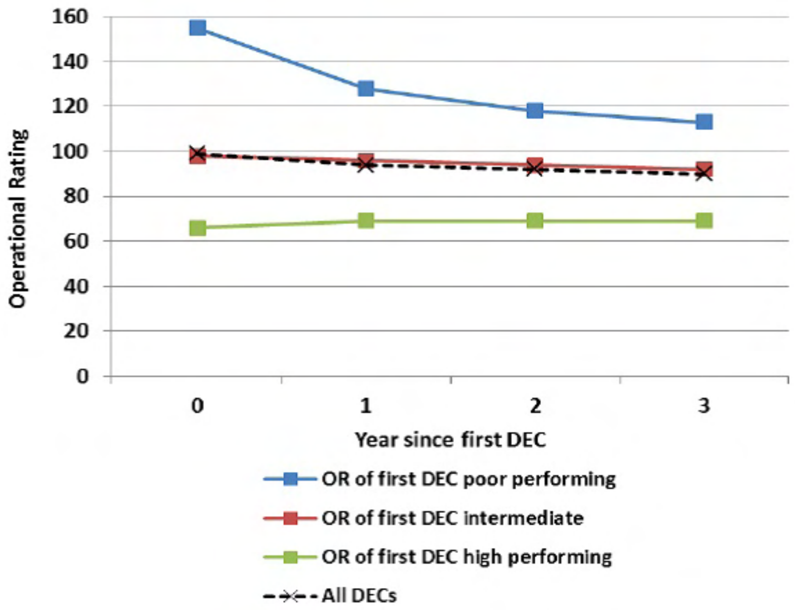
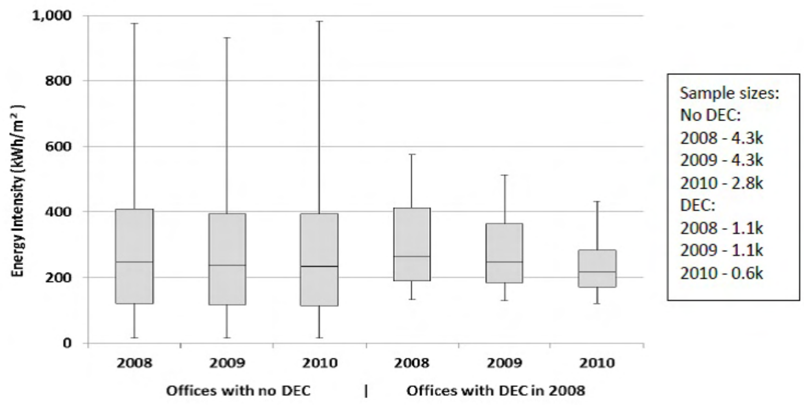


Figure 17: Comparing private sector offices (offices with no DEC) to public sector offices with a DEC (offices with DEC in 2008). Extracted from "Special Feature, What is the impact of DECs?" *DECC, June 2013.*



This register allows historic certificates/reports to be retrieved, QA of any certificate/report recorded, and dissemination of certificates to prospective buyers and tenants. The register also supports enforcement activities, reduces fraudulent issue of certificates/reports, and allows statistical analysis to inform policy making and improve understanding of the building stock.

For example, Display Energy Certificate (DEC) records for England and Wales were analysed and a report published in June 2013. This analysis suggests that overall Operational Ratings (ORs) (Figure 16) and energy consumption have fallen for public sector buildings with DECs. Comparing private sector offices to public sector offices with DECs provides tentative evidence to suggest that DECs have had a slight impact on the energy performance of a property (Figure 17).

The total EPC records data is provided in section III.i and includes 10.5 million residential EPCs, 0.5 million non-residential EPCs and nearly 200,000 DECs.

4. Conclusions, future plans

The UK is divided into four jurisdictions: England, Wales, Scotland and Northern Ireland. In some instances the mix of approaches transposing the requirements of the Energy Performance of Buildings Directive (EPBD) differs between jurisdictions. In other cases similar approaches were adopted by two or more jurisdictions.

Overall, the new (2013) Building Regulations in England will improve the performance of new residential units by 6% and non-residential buildings by 9% over the previous (2010) standards.

The transposition of the EPBD and associated benefits have been and continue to be reviewed by each UK jurisdiction as part of their respective programmes to achieve national energy efficiency objectives and carbon emissions reduction.

In some instances, these reviews validated the current implementation approach. In other cases, the reviews resulted in changes, for example the 2012 updates of the residential Energy Performance Certificate (EPC) adopted in England, Wales and Scotland. Changes have and will continue to be made to the implementation instruments where deemed appropriate.

Implementation of the EPBD in the United Kingdom Wales

STATUS IN DECEMBER **2014**

1. Introduction

This report provides information about the implementation of the Energy Performance of Buildings Directive (Directives 2002/91/EC and 2010/31/EU - EPBD) in Wales. It updates the previous UK-wide reports published in 2010 and 2012. The implementation of the EPBD in the other three UK jurisdictions (England, Scotland and Northern Ireland) is addressed in separate reports.

From 31 December 2011, Wales became responsible for its own Building Regulations. Prior to this date, EPBD requirements were implemented across England and Wales with no distinction. Therefore, the implementation of the EPBD in Wales is today shared between the Welsh Government (WG) responsible for Building Regulations and Approved Inspectors, and the UK Department for Communities and Local Government (DCLG) responsible for the Energy Performance of Buildings in England and Wales. Implementation is achieved through amendments to the England and Wales Regulations (see England report for details). These amendments include:

> *the Building (Amendment) (Wales) Regulations 2014 SI* 2014/110 (W. 10);*

> *the Building (Amendment) (Wales) Regulations 2014 SI* 2013/747 (W. 89).*

This report introduces the most recent requirements that are specific to Wales. Requirements that are common to both England and Wales have not been repeated in this report. For details, please refer to the England report.

(*) SI = Statutory Instrument.

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2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

Figures 1 and 2 show the simplified historical Building Regulations improvements in Wales for new residential and new non-residential buildings. The graphs are based on 2006 Building Regulations (the reference year), historical improvements for 2010 and 2014, and Government announcements on the 2016 review and 2020 zero carbon target.

Note: the 2006 and 2010 Building Regulations applied across England and Wales, while the 2014 Regulations apply to Wales only following the devolution of new powers and functions to Wales in 2011.

NATIONAL WEBSITE
www.wales.gov.uk/topics/planning/buildingregs/?lang=en

Figure 1:
Residential Building Regulations improvements (historical and anticipated) for new buildings in Wales.

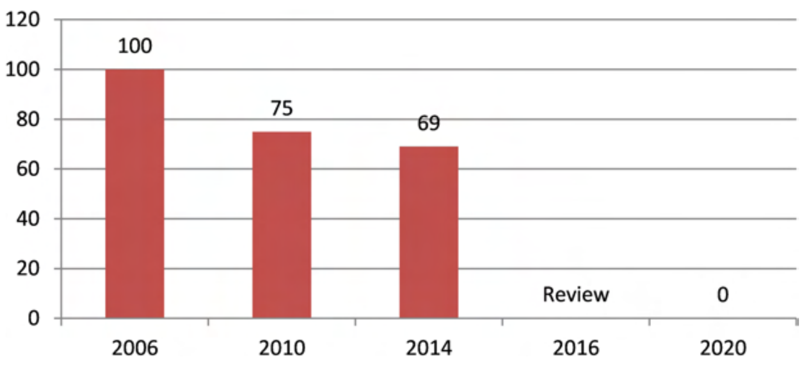


Figure 2:
Non-residential Building Regulations improvements (historical and anticipated) for new buildings in Wales.

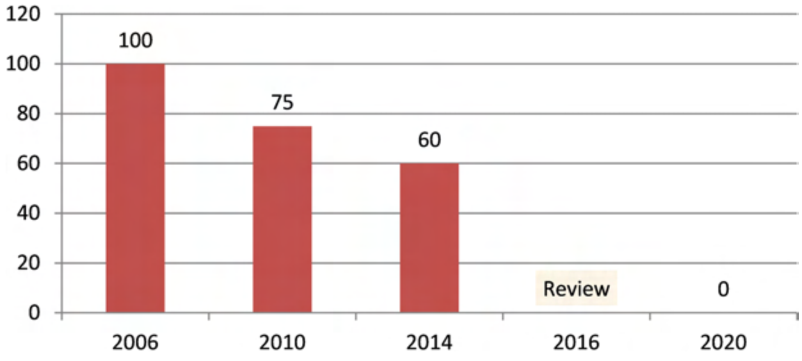
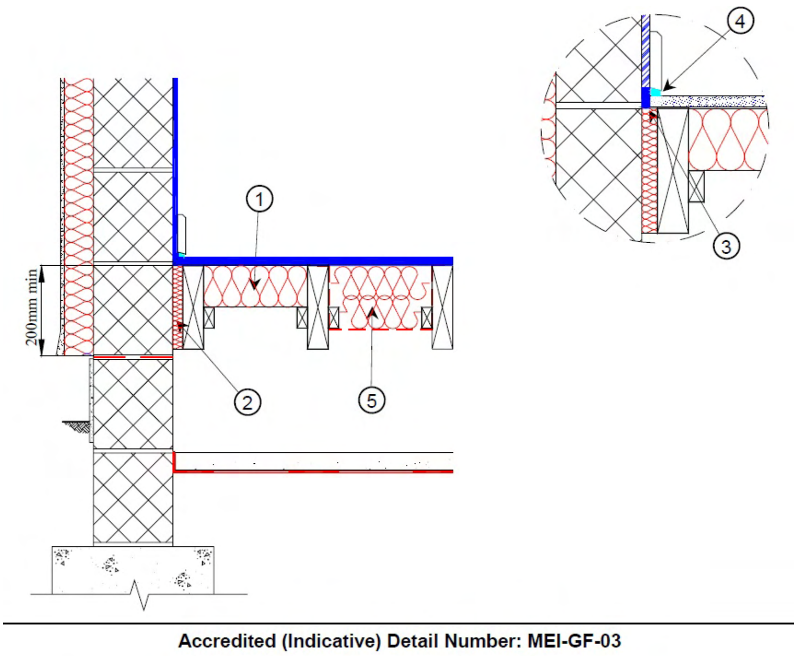


Figure 3:
Illustration from ACD for timber suspended ground floor. Extracted from ACDs for masonry external wall insulation.



The new 2014 amendments to the Building Regulations set energy performance requirements for new and existing buildings (residential and non-residential buildings) and came into effect in July 2014. The new Regulations were strengthened to deliver improved CO_2 savings over the previous 2010 Regulations of:

> 8% across the new residential building mix;

> 20% across the new non-residential building mix.

Changes to the requirements for existing residential and non-residential buildings were also introduced in 2014.

Further changes to the Building Regulations will be required to achieve the Government's zero carbon commitment for all new buildings by 2020. As shown in Figures 1 and 2, a review of the Building Regulations' energy performance requirements ("Part L") for new and existing buildings is scheduled for 2016.

I.ii. Format of national transposition and implementation of existing regulations

Wales adopted a similar approach to England, i.e., four "Approved Documents" which provide a route to comply with Building Regulations. An elemental approach is available for existing buildings, and five criteria are set for new residential units and non-residential buildings:

1. Ensure that the calculated Building CO_2 Emission Rate is no greater than the target and, for non-residential buildings only, that the Building Primary Energy Consumption is not greater than the target.
2. Meet limits on design flexibility (including minimum fabric standards and building services efficiencies).
3. Ensure appropriate passive control measures to limit the effects of summer heat gains, including the effect of shading devices and comfort assessment.
4. Ensure the "as built" building performance (including fabric and fixed building services) is consistent with design calculations.
5. Provide information for energy-efficient operation of the building.

As for England, these requirements are included in the National Calculation Methodology (NCM) and compliance is demonstrated by using Government-approved software tools. For more details see the England report and visit www.ncm.bre.co.uk. The Welsh Approved Documents (ADs) also allow the use of Accredited Construction Details (ACDs) to demonstrate compliance, and Wales adopted the English ACDs available at www.planningportal.gov.uk. Figure 3 gives an example. The compliance checking process is also similar to England, using Building Control Bodies (BCBs) and "Competent Persons". See England report for details.

I.iii. Cost-optimal procedure for setting energy performance requirements

A UK-wide cost-optimal report, which addresses Wales, was published in May 2013. Please refer to the England report for details.

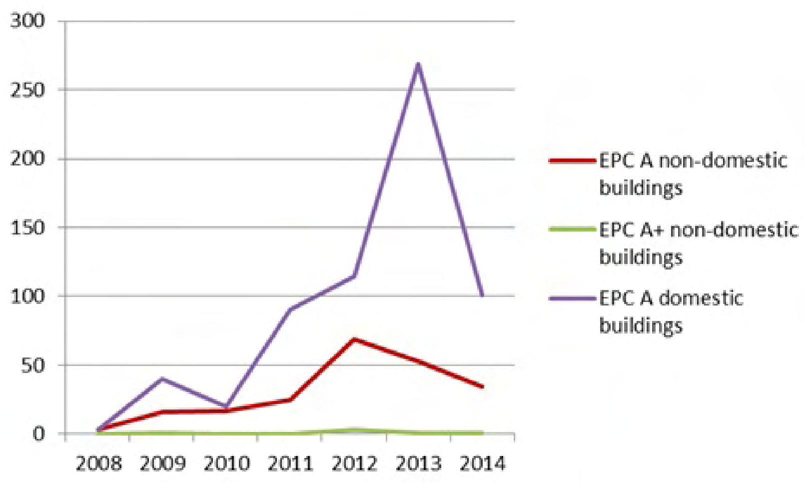
I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The UK national plan titled "Increasing the number of Nearly Zero-Energy Buildings" covers all four jurisdictions: England, Wales, Northern Ireland and Scotland. Please refer to the England report for details.

Nearly Zero Energy Buildings (NZEBs) statistics are not maintained in Wales. Figure 4 shows historical records of Energy Performance Certificates (EPCs) A and A+ (non-residential buildings only) for new buildings. The graph shows a steady increase from 2008 to 2012/2013 and a notable drop in 2013/2014. Note that new building construction rates will also affect these data.

Figure 4:
Historical EPC A/A+ records for new residential and non-residential buildings in Wales.



I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The Department of Energy & Climate Change (DECC) is responsible for the transposition of the Energy Efficiency Directive (EED) which will mostly be implemented on a UK-wide basis. In a number of areas, where the Devolved Administrations in Northern Ireland, Wales and Scotland have responsibility for implementation, they have opted to pursue a UK-wide approach (see England report for details). In some areas, implementation will be undertaken by the Devolved Administrations. The UK National Energy Efficiency Action Plan (NEEAP) was published in April 2014. It includes a Building Renovation Strategy in compliance with Article 4 of the EED. The Welsh policies and programmes to deliver this strategy include:

> the National Energy Efficiency and Savings Plan (2011);
> the Fuel Poverty Strategy (2010);
> "Nest", a fuel poverty programme that provides energy efficiency advice and income maximisation advice, alongside installation of 'whole house' measures, for qualifying properties;
> "Arbed" a whole house retrofit programme;
> the availability of an additional funding to leverage investment from the Energy Company Obligation (ECO);
> Building Regulations updates which include consequential improvements for all existing residential and non-residential buildings when extension or renovation work is undertaken.

Table 1: Residential EPCs, 2008 to July 2014, Wales.

	Domestic EPC lodgements by band									
	Total EPCs	A	B	C	D	E	F	G	not recorded
Total	612,473	637	38,345	152,507	235,544	128,162	41,681	15,575	22
Percentage	100%	0%	6%	25%	38%	21%	7%	3%	0%

Table 2: Non-residential EPCs, 2008 to July 2014, Wales.

	Non-domestic EPC lodgements by band									
	Total EPCs	A+	A	B	C	D	E	F	G	not recorded
Total	24,136	6	217	2,052	6,811	7,085	3,908	1,876	2,179	2
Percentage	100%	0%	1%	9%	28%	29%	16%	8%	9%	0%

Figure 5: Residential EPCs, 2008 to July 2014, Wales. Percentages by EPC band ("not recorded" = faulty EPC, e.g., cancelled/withdrawn EPC).

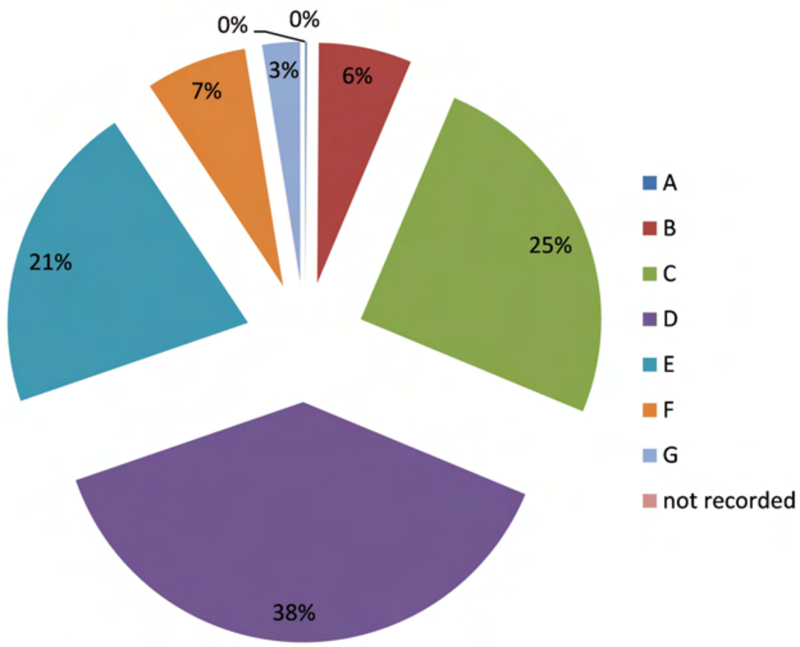
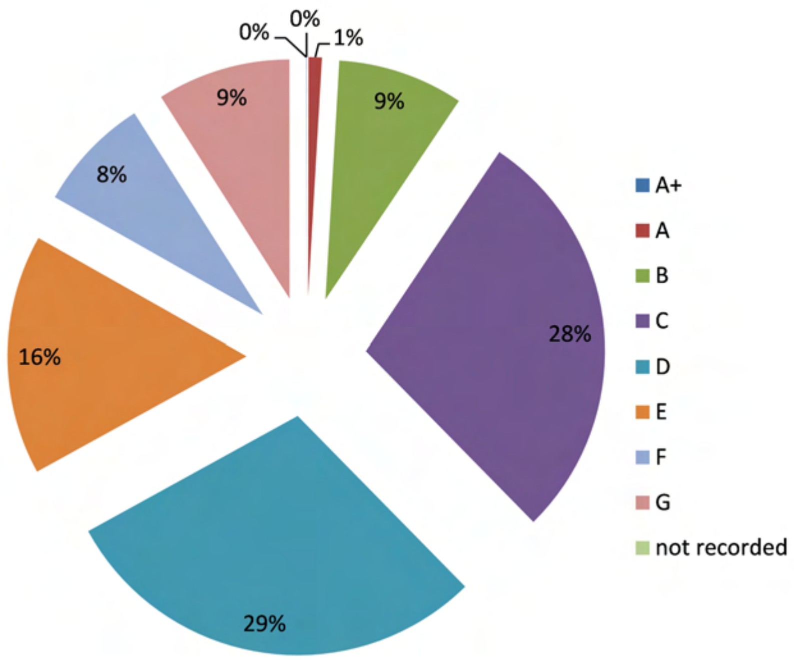


Figure 6: Non-residential EPCs, 2008 to July 2014, Wales. Percentages by EPC band.



The UK decided to implement the alternative approach allowed for by Article 5(6) and notified the Commission of the alternative measures that will be adopted to achieve an equivalent improvement in the energy performance of the buildings within the Central Government estate, which includes Central Government buildings in England, and buildings for UK-wide Government departments and in the Devolved Administrations. Alternative measures include behavioural change, facilities management, estate management, installing energy efficient Information Technology (IT) hardware, and installing energy efficient technology. The Welsh Government's Climate Change Strategy aims to cut emissions from the Welsh Government administrative estate by at least 30% in 2019/2020 from a 2010/2011 baseline. The Welsh Government estimates that the Strategy will save 3.4 GWh of energy which will contribute towards the UK equivalence target of 163.6 GWh savings.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

Wales adopted the same approach as England, where the Domestic and Non-domestic Building Services Compliance Guides set out recommended minimum energy efficiency standards. See England report for details.

The commissioning of technical building systems is also addressed in the Approved Documents and the Building Services Compliance Guides. They require commissioning to be done in accordance with relevant industry guidance for example CIBSE Commissioning Code M: Commissioning management (for non-residential buildings).

	DEC lodgements by band								
	Total	A	B	C	D	E	F	G	not recorded
Total	11,558	116	828	3,252	3,938	1,956	695	765	8
Percentage	100%	1%	7%	28%	34%	17%	6%	7%	0%

Table 3: Display Energy Certificates (DECs), 2008 to July 2014, Wales.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

Wales adopted the same approach as England. The Energy Performance Regulations apply to both England and Wales. See England report for details.

Tables 1-2 and Figures 5-6 provide Wales-specific data.

III.i. Progress and current status on public and large buildings visited by the public

Wales adopted the same approach as England. See England report for details.

Display Energy Certificates (DECs) data from 2008 to July 2014 is included in Table 3 and Figure 7.

III.ii. Implementation of mandatory advertising requirement

Wales adopted the same approach as England. See England report for details.

III.iii. Information campaigns

Wales adopted the same approach as England. See England report for details.

III.iv. Coverage of the national building stock

The UK National Energy Efficiency Action Plan (NEEAP) gives a statistical overview of the main features of the building stock in the UK. See England report for details.

The number of EPCs recorded in 2013, for new and existing buildings in Wales totalled 612,473 residential EPCs, 24,136 non-residential EPCs and 11,558 DECs.

Wales has about 1.3 million homes across a wide range of housing types, including a significant proportion of older buildings. Figure 8 shows the distribution of about 0.6 million residential EPCs in Wales (Table 1). Buildings with no EPCs are not represented in Figure 8.

There are over 1.8 million non-residential premises in the UK, which are responsible for around 17% of total UK energy consumption. Specific data for the energy efficiency rating by building type in Wales is not available.

Figure 7: Display Energy Certificates (DECs), 2008 to July 2014, Wales. Percentages by DEC band.

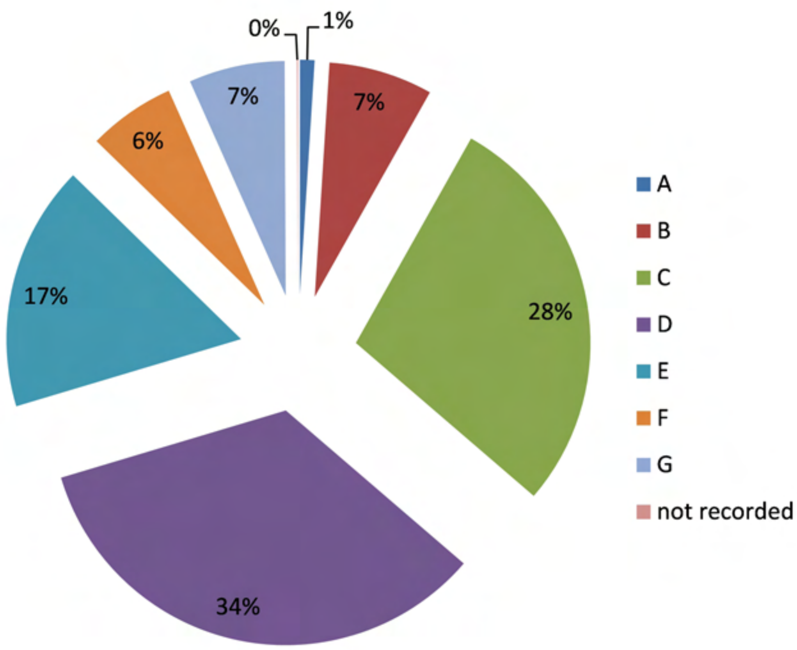
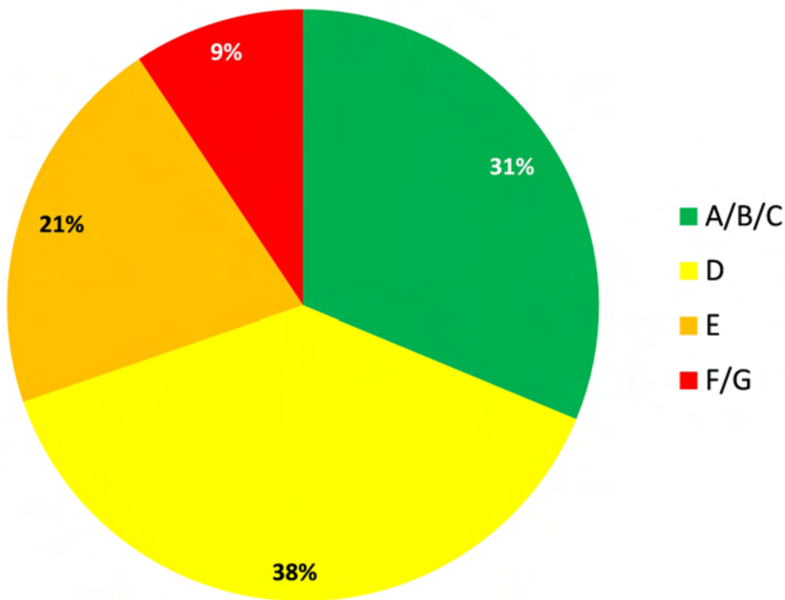


Figure 8: Distribution of residential EPCs in Wales, 2008 to 2014.



IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

The UK (England, Wales, Scotland and Northern Ireland) adopted alternative measures for heating systems and inspections for Air-Conditioning (AC) systems. Wales-specific programmes include “Nest” and “Arbed” which aim to address fuel poverty. Nest also provides access to advice and support. Please refer to the England report for further details.

3. Conclusions, future plans

The UK is divided into four jurisdictions. Historically, England and Wales shared the same Building Regulations. In 2011, Wales became responsible for its own Building Regulations, and the new Welsh Regulations came into force in 2014.

Overall the new Building Regulations in Wales will improve new residential units performance by 8% and non-residential buildings by 20% over the previous standards, a significant difference compared to England (where the improvements were between 6 and 9%). A Primary Energy Consumption target for new non-residential buildings and improved minimum fabric standards for new residential units have been introduced with an emphasis on reducing energy demand. A review of the energy performance requirements within the Building Regulations is scheduled for 2016, and it will consider the next step in the Welsh commitment to Nearly Zero-Energy Buildings (NZEBs) by 2018/ 2020. Regulations for the Energy Performance of Buildings cover both England and Wales.

Implementation of the EPBD in the United Kingdom Northern Ireland

STATUS IN DECEMBER **2014**

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1. Introduction

This report provides information about the implementation of the Energy Performance of Buildings Directive (Directives 2002/91/EC and 2010/31/EU - EPBD) in Northern Ireland. It updates the previous UK-wide reports published in 2010 and 2012. The implementation of the EPBD in the other three UK jurisdictions (England, Wales and Scotland) is addressed in separate reports. Northern Ireland (NI) has the smallest population of all UK jurisdictions, approximately 1.83 million (2.8% of the UK total population)[1].

Unlike Wales, Northern Ireland has had control of its own Building Regulations for many years. The first Regulations date back to 1972 and, prior to that, buildings were controlled through by-laws and local Acts. The implementation of the EPBD in Northern Ireland is the responsibility of the Department of Finance and Personnel Northern Ireland (DFPNI) and is achieved through:

- *the Building Regulations* (Northern Ireland) 2012 (SR** 2012 No. 192);*
- *the Building (Prescribed Fees) Regulations* (Northern Ireland) 1997 (SR 1997 No. 482);*
- *the Energy Performance of Buildings (Certificates and Inspections) Regulations* (Northern Ireland) 2008 (SR 2008 No. 170).*

DFPNI relies heavily on the research and development from other UK jurisdictions (principally England) in the development of Regulations and technical guidance.

This report introduces the most recent requirements. It also addresses certification and inspection systems including quality control mechanisms, the training of Qualified Experts (Energy Assessors), information campaigns, incentives and subsidies. For more details please visit the referenced websites or contact the responsible institutions.

(*) This is the main Regulation. Subsequent amendments must also be considered, they include: The Building (Amendment) Regulations (Northern Ireland) (SR 2012 No. 375 and SR 2014 No. 44) and the Energy Performance of Buildings (Certificates and Inspections) (Amendment) Regulations (Northern Ireland) (SR 2008 No. 241, SR 2009 No. 369, SR 2013 No. 12 and SR 2014 No. 43).

(**) SR = Statutory Rule.

NATIONAL WEBSITES

www.dfpni.gov.uk/articles/building-regulations-northern-ireland
www.dfpni.gov.uk/articles/energy-performance-buildings-northern-ireland

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[1] *http://ons.gov.uk/ons/taxonomy/index.html?nscl=Population#tab-data-tables*

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

DFPNI relies heavily on the research and development from other UK jurisdictions (principally England) in the development of Regulations and technical guidance. As such, the Northern Ireland Government implements the construction requirements of the EPBD through a phased roll-out of amendments to Part F (not Part L as in England) "Conservation of Fuel and Power" of its current Building Regulations which came into force on 31 October 2012. These amendments follow the standards of England's Building Regulations (Part L Conservation of Fuel and Power) and associated guidance. Amendments to the Building Regulations were introduced on 24 February 2014 to comply with the obligations of Articles 4, 6, 7 and 9 of Directive 2010/31/EU. Certification requirements are addressed in parallel legislation, the Energy Performance of Buildings (Certificates and Inspections) Regulations (Northern Ireland) 2008 (as amended).

Figure 1: Residential Building Regulations improvements (historical and anticipated) for new buildings in Northern Ireland.

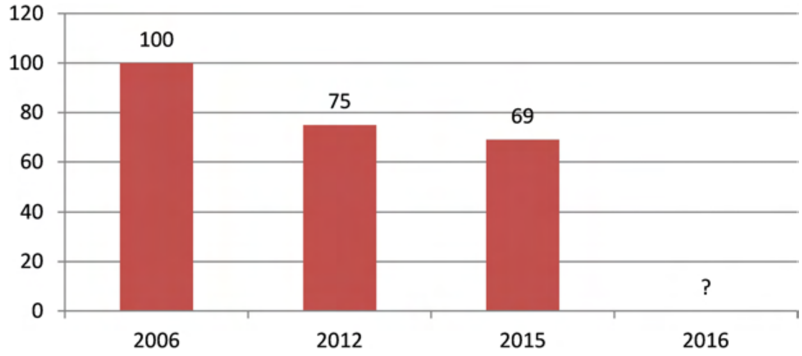


Figure 2: Non-residential Building Regulations improvements (historical and anticipated) for new buildings in Northern Ireland.

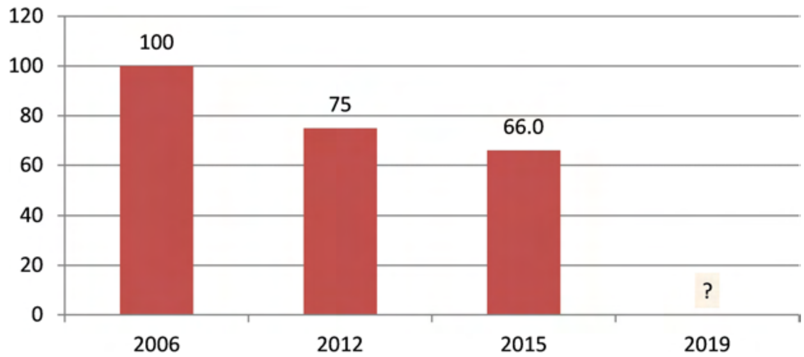
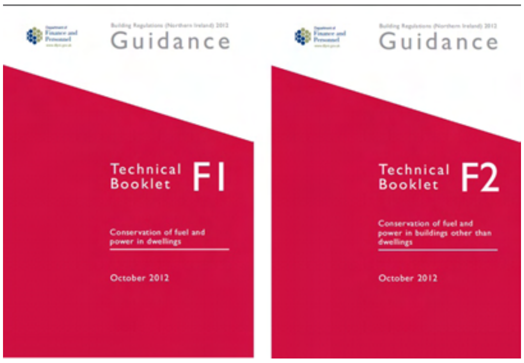


Figure 3: Technical Booklets F1 & F2, Conservation of fuel and power in dwellings & buildings other than dwellings, Northern Ireland, October 2012[2].



The Northern Ireland Government plans to amend the Part F technical standards in November 2015 to at least match the latest standards in England. The Minister for the DFPNI has committed to follow moves in England towards a Zero Carbon Homes standard post 2016 as shown in Figures 1 and 2. Details on how this will be achieved are still not available.

Further, more rapid, changes to the Building Regulations will be required to meet the EPBD requirements for Nearly Zero-Energy Buildings (NZEBs) for new Government buildings from 31 December 2018, for all new buildings by 31 December 2020, and to follow England's drive to zero carbon housing for 2016. To this end, DFPNI is re-formatting technical guidance to mirror the English Part L of the Building Regulations and has assigned resources to aid communication with regulators in other jurisdictions to more quickly implement subsequent amendments in the run up to 2018.

I.ii. Format of national transposition and implementation of existing regulations

Technical Booklets F1 (new and existing residential buildings) and F2 (new and existing non-residential buildings) (Figure 3) support the implementation of the Building Regulations for the more common building situations. The booklets include references to best practice guides such as Eurocodes (EN). An elemental approach is available for existing buildings, and five criteria are set for new residential units (single-family homes and apartments) and non-residential buildings:

1. Ensure that the calculated Building CO_2 Emission Rate does not exceed the Target Emission Rate.
2. Meet minimum acceptable standards (including minimum fabric, air permeability, and building services efficiencies standards).

[2] www.dfpni.gov.uk/articles/building-regulations-technical-booklets

3. Limiting the effects of solar gains in summer. This includes references to industry best practice such as CIBSE TM37 "Design for improved solar shading control"[3].
4. Ensuring the quality of construction and commissioning (building envelope, air permeability, commissioning fixed building services and, in non-residential buildings, air leakage testing of ductwork).
5. Provide instructions for the energy-efficient operation and maintenance of the building.

Note that Internal Air Quality (IAQ) is addressed under Technical Booklet K, Ventilation[4].

The National Calculation Methodology (NCM) implements these criteria. For residential units, the NCM is the Standard Assessment Procedure (SAP). For buildings other than residential, the NCM is the Simplified Building Energy Model (SBEM). Both NCMs use an Asset Rating approach, i.e., predicted energy consumption based on standard conditions. The NCMs currently used in Northern Ireland are SAP 2009 and SBEM V4.1e. These will be updated to the current standards applicable in England (i.e., SAP 2012 and SBEM V5.2) as part of the next planned amendment by DFPNI in November 2015.

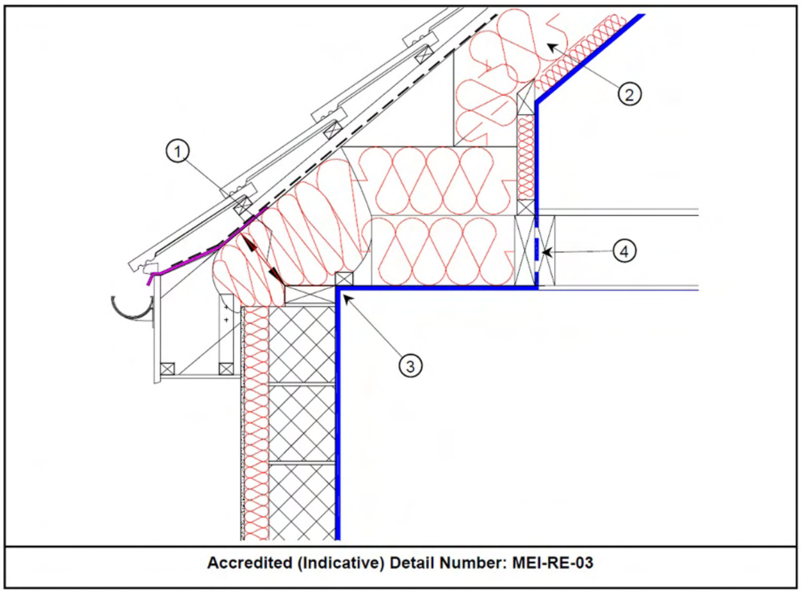
Compliance with the NCM and the compliance criteria is demonstrated by using UK Government-approved software tools to model the building. The UK Government has developed software tools which are freely available. Other proprietary software packages and interfaces (e.g., Dynamic Simulation Models – DSMs) may be used for more complex buildings, providing they have been approved. These tools are also used to produce Energy Performance Certificates (EPCs) on construction, sale and rent. A separate procedure has been set to produce Energy Performance Certificates (EPCs) for display: the Operational Rating Calculation (ORCalc).

The Technical Booklets allow the use of Accredited Construction Details (ACDs) to demonstrate compliance. Northern Ireland adopted the English ACDs[5]. Figure 4 gives an example. Airtightness testing is required for most residential and non-residential developments. Some developments may be exempted from airtightness testing under particular circumstances. For example, small non-residential developments (less than 500 m^2) may choose to avoid air pressure testing by assuming a permeability of 15 $(m^3/h)/m^2$ at 50 Pa when calculating the building emissions.

In Northern Ireland, all Building Regulations applications and outputs are submitted to local District Councils for checking and enforcement within their council boundaries. Building control officers carry out site inspections to ensure that works comply with Building Regulations and have the powers to serve contravention notices.

Building Regulations applications are audited at the Local Government Group level under the Local Government (Employment of Group Building Control Staff) Order (NI) 1994. Audits are both quantitative and qualitative. Qualitative reviews include sampling of residential and non-residential applications, which are audited by Group Officers and report findings to Council Managers. Reviews may include site inspections and plans assessments. Reviews findings inform future training priorities for Building Control staff. Quantitative reviews and statistics relating to agreed Key Performance Indicators are reported by each Group Chief.

Figure 4: Illustration from ACD for pitched roof. Extracted from ACDs for masonry external wall insulation.



[3] www.cibse.org/Knowledge/CIBSE-TM-(1)/TM37-Design-for-Improved-Solar-Shading-Control
[4] www.dfpni.gov.uk/publications/technical-booklet-k
[5] www.planningportal.gov.uk

I.iii. Cost-optimal procedure for setting energy performance requirements

A UK-wide cost-optimal report was published in May 2013. Please refer to the England report for details.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The UK national plan titled "Increasing the number of Nearly Zero Energy Buildings" covers all four jurisdictions: England, Wales, Northern Ireland and Scotland. Please refer to the England report for details.

NZEB statistics are not maintained in Northern Ireland.

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The UK Department of Energy & Climate Change (DECC) is responsible for the transposition of the Energy Efficiency Directive (EED) which will mostly be implemented on a UK-wide basis. In a number of areas, where the Devolved Administrations in Northern Ireland, Wales and Scotland have responsibility for implementation, they have opted to pursue a UK-wide approach, though in some areas implementation will be undertaken by the Devolved Administrations.

The UK National Energy Efficiency Action Plan (NEEAP) was published in April 2014. It includes a Building Renovation Strategy in compliance with Article 4 of the EED. Northern Ireland's policies and programmes to deliver this strategy include:

> the Northern Ireland's Strategic Energy Framework (2010);
> the Warm Homes and Affordable Warmth Schemes support fuel-poor private households to make energy efficiency improvements;
> the Northern Ireland Sustainable Energy Programme (NISEP) provides grants for energy efficiency and renewable energy schemes for residential and non-residential buildings;
> the Northern Ireland Renewable Heat Incentive (RHI) supports non-residential renewable heat generators. A Northern Ireland residential RHI is due to be launched by the end of 2014. A Renewable Heat Premium Payment is also available for the residential market;
> the Household Efficiency and Thermal improvement Programme (HEaT) (a Green Deal-style mechanism for energy efficiency improvements) is currently being developed;
> Northern Ireland is examining the possibility of an energy efficiency supplier obligation from 2016.

The UK decided to implement the alternative approach allowed for by Article 5(6) and notified the Commission of the alternative measures that will be adopted to achieve an equivalent improvement in the energy performance of the buildings within the Central Government estate, which includes Central Government buildings in England, and buildings for UK-wide Government departments and in the Devolved Administrations. Alternative measures include behavioural change, facilities management, estate management, installing energy efficient Information Technology (IT) hardware, and installing energy efficient technology. In Northern Ireland, an Energy Efficiency Plan for the Government Office Estate, covering the period 2011/2014, targeted a 10% energy savings against the 2010/2011 baseline. The Plan focused on three areas: reduction in the footprint of the estate, capital investments in energy efficiency, and behavioural change in staff occupying buildings. A new three year Plan is being developed for the period 2014/2017.

The NEEAP[6] includes further details of other initiatives for all UK jurisdictions.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The 2010 UK Domestic and Non-domestic Building Services Compliance Guides apply in Northern Ireland. Please see details in the England report.

Northern Ireland intends to adopt the 2013 version of the UK Domestic and Non-domestic Building Services Compliance

[6] www.gov.uk/government/uploads/system/uploads/attachment_data/file/307993/uk_national_energy_efficiency_action_plan.pdf

Guides as part of its 2015 Building Regulations amendments. This includes requirements for boilers, heat pumps, Air-Conditioning (AC) units, Domestic Hot Water (DHW), heat recovery, specific fan power, etc.

II.ii. Regulation of system performance, distinct from product or whole building performance

An approach similar to England was adopted and is described in the Technical Booklets. See England report for details. The local District Council (the enforcement authority) must be notified on completion of commissioning so that a Building Regulations Completion Certificate may be issued.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

An approach similar to England was adopted and is described in the Technical Booklets. See England report for details. Under certain circumstances (i.e., for large buildings greater than 1,000 m^2, where the habitable area is extended, or where fixed building services are installed for the first time, or their capacity is increased), additional energy efficiency measures (named “consequential improvements”) must be undertaken as set out in the Technical Booklets for residential and non-residential buildings.

II.v. Provisions for installation, dimensioning, adjustment and control

An approach similar to England was adopted and is described in the Technical Booklets. See England report for details.

II.vi. Encouragement of intelligent metering

For both residential and non-residential buildings, an approach similar to England was adopted and is described in the Technical Booklets. See England report for details.

Technical Booklet F2 (non-residential buildings) references industry best practice for the installation of meters, i.e., CIBSE TM 39 Building Energy Metering.

In July 2012, the Northern Ireland Minister for Enterprise, Trade and Industry confirmed that smart metering for homes would be taken forward in Northern Ireland. Most householders will have smart meters installed by their energy company between 2015 and 2020, although some energy companies started to install smart meters already in 2014.

II.vii. Encouragement of active energy-saving control (automation, control and monitoring)

An approach similar to England was adopted. Provisions for effective control of TBS are included in the Building Regulations and in the Technical Booklets for new and existing residential units and non-residential buildings.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The overarching systems in place are identical across all building sectors and, in most instances, mirror or adopted the England and Wales provisions. Northern Ireland approved the same Accreditation Schemes, as those licensed in England and Wales, to accredit Energy Assessors for the production of outputs under the Energy Performance of Buildings Regulations in Northern Ireland, such as EPCs and Recommendations Reports. Please see details in the England report.

Regulatory outputs (e.g., EPCs, Recommendations Reports) produced by accredited assessors are recorded on the Northern Ireland registers. Individual outputs may be retrieved from the register by members of the public using the building’s address, postcode, or the outputs’ unique reference number. Selected organisations have access to limited data in bulk, and anyone with an EPC can opt-out of having their data publicly available. The Northern Ireland residential buildings register is accessible via www.epbniregister.com and the Northern Ireland non-residential buildings register (EPC and AC inspection reports) at www.epbniregisternd.com.

How flats are certified in apartment buildings

The Northern Ireland approach is similar to England (i.e., an EPC must be produced for each residential unit (single-family home or apartment). Please see England report for further details.

Format and content of the EPC

> *Residential:* The EPC provides an asset rating (i.e., a calculated energy rating) of the current and potential energy efficiency of the building on a scale from A to G (see Figure 5). A is very efficient and G is the least efficient. This asset rating is based on the characteristics of the building itself, its services, a standardised occupancy profile and the building's estimated energy consumption cost. At the end of 2014, the average EPC rating for a residential unit in Northern Ireland is band D rating 60.

Figure 5: Residential EPC bands, asset ratings, and examples of current and potential ratings.

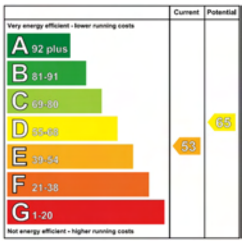


Figure 6: First page of a residential EPC.

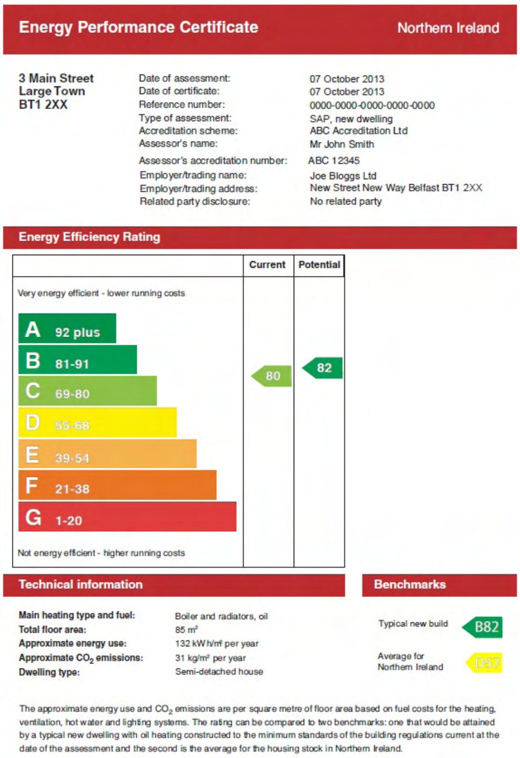


Figure 7: Residential EPC, environmental impact rating.

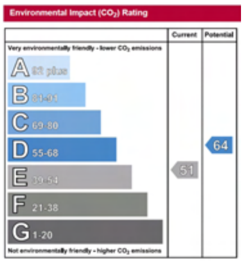
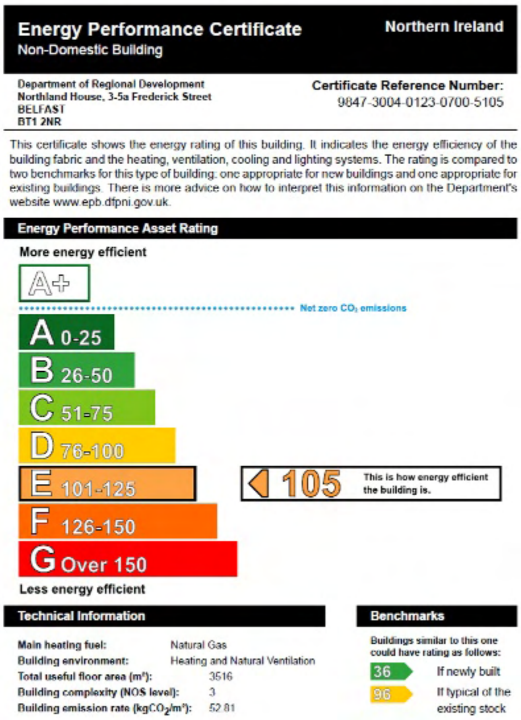


Figure 8: First page of non-residential EPC.



The first page of the EPC for new residential units is shown in Figure 6. The EPC for existing residential units is very similar, although it excludes the "Typical new Build" benchmark. The residential EPC also contains an environmental impact rating (Figure 7), which is a measure of the impact of the residential unit on the environment in terms of carbon dioxide (CO_2) emissions. The EPC includes a list of cost-effective recommendations specific to the residential unit to improve the energy ratings, and indicates the potential energy efficiency and environmental impact ratings if all cost-effective measures were installed.

> *Non-residential:* The EPC for non-residential buildings is identical to England and Wales except for the reference to Northern Ireland (Figure 8).

EPC activity levels

As in England and Wales, asset rating based EPCs are produced for buildings on construction, sale and rent, and operational rating (i.e., measured energy rating) based certificates (Display Energy Certificates - DECs) are produced and displayed in large public buildings (see details in section II.). Both residential and non-residential EPCs are valid for 10 years. All EPCs become legally valid after they have been recorded on the national register.

Most EPCs recorded on the Northern Ireland register are freely accessible to members of the public through an address search (unless the building owner opts out), or through a unique reference number search. Historical data to August 2014 is included in Tables 1 and 2, Figures 9 and 10.

Typical EPC costs

The cost of certificates varies greatly. Indicative starting costs, i.e., lowest market costs (based on internet search in July 2014) are:

> for residential buildings: ca. 50 £ (ca. 63 €) ;

> for non-residential buildings: ca. 200 £ (ca. 252 €).

The above costs include the registration fee payable each time an EPC is recorded on the Northern Ireland register. These fees are aligned on England and Wales registration fees.

	Domestic EPC lodgements by band							
	Total EPCs	A	B	C	D	E	F	G
Total	317,916	254	19,488	71,913	132,507	64,314	24,670	4,737
Percentage	100%	0.1%	6.1%	22.6%	41.7%	20.2%	7.8%	1.5%

Table 1: Residential EPCs to August 2014, Northern Ireland.

	Non-domestic EPC lodgements by band							
	Total EPCs	A	B	C	D	E	F	G
Total	8,964	55	878	2,683	2,230	1,242	770	1,106
Percentage	100%	0.6%	9.8%	29.9%	24.9%	13.9%	8.6%	12.3%

Table 2: Non-residential EPCs to August 2014, Northern Ireland.

Assessor corps

The England and Wales National Occupational Standards (NOS) were adopted in Northern Ireland (see England report for details). Table 3 details energy assessor types and numbers notified to the Northern Ireland registers as of 31 August 2014. Assessors accredited to operate in England and Wales are also accredited to operate in Northern Ireland.

Minimum Continuous Professional Development (CPD) requirements are also specified. Typically assessors must demonstrate attendance at 10 to 20 hours of CPD per year. If the CPD requirement is not met, penalties include temporary expulsion from the Accreditation Scheme, which prevents the Energy Assessor from producing EPCs.

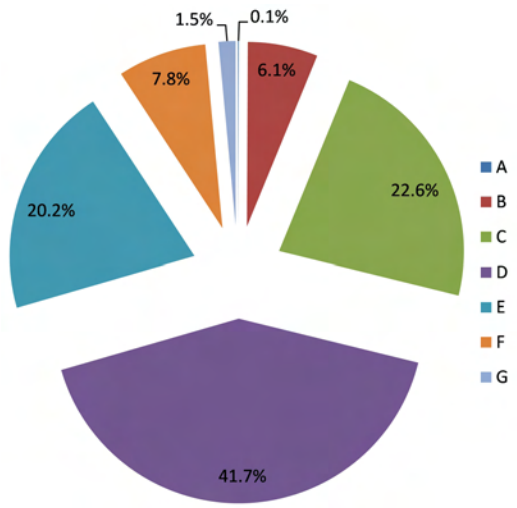


Figure 9: Residential EPCs to August 2014, Northern Ireland. Percentages by EPC band.

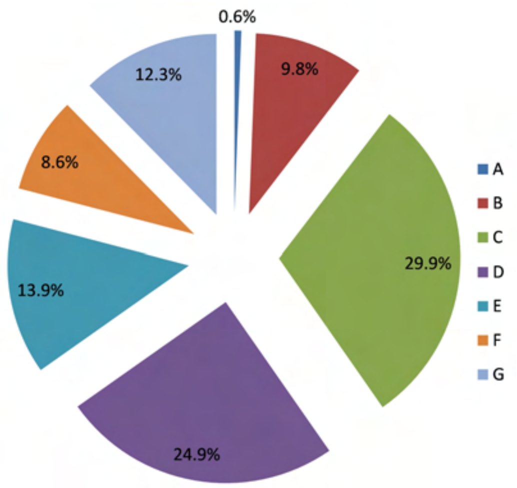


Figure 10: Non-residential EPCs to August 2014, Northern Ireland. Percentages by EPC band.

Compliance levels by sector

District Councils are responsible for enforcing the Energy Performance of Building Regulations 2008 (as amended) for buildings within their district areas. DFPNI is responsible for enforcement in respect of District Council buildings. DFPNI funds a central team, located within Belfast City Council, which undertakes awareness-raising activities, provides a telephone helpline, coordinates and reports on compliance activities undertaken by District Councils. DFPNI undertakes compliance checks on District Council buildings and conducts audits on a quarterly basis. For the period April to June 2014, District Councils reported that EPC compliance levels were 98% for the completion of new build and modified properties, 71% for estate agents visited, and 93% for website advertisements. The compliance level for DECs in the audited buildings of four District Councils was 100% at the end of August 2014.

Assessor types	Assessor numbers
Domestic EPCs (existing buildings) RdSAP	21,457
Domestic EPCs (new buildings) SAP	1,316
Non-domestic EPCs (level 3)	3,435
Non-domestic EPCs (level 4)	2,297
Non-domestic EPCs (level 5)	442
Display Energy Certificate (DEC)	1,180
AC inspection (level 3, simple)	677
AC inspection (level 4, complex)	574
Total Assessors	***31,378***

Notes
RdSAP: Reduced Standard Assessment Procedure
SAP: Standard Assessment Procedure
EPC: Energy Performance Certificate
DEC: Display Energy Certificate
AC: Air-Conditioning
EPC level 3: simple non-domestic buildings
EPC level 4: medium complexity non-domestic buildings
EPC level 5: complex non-domestic buildings
AC level 3: simple packaged AC
AC level 4: complex central AC

Table 3: Energy Assessors qualifications and numbers, on 31 August 2014, Northern Ireland.

Enforcement with building owners and real estate actors

District Councils are the enforcement authorities in their respective jurisdictions. They have the powers to require the "relevant person" (i.e., the seller of the building, or the prospective landlord) to produce copies of the EPC for inspection and to take copies if necessary. In 2013 these powers were extended to include the "relevant person's agent" for example Estate or Letting Agents.

Penalties vary depending on the type of building:

> for residential properties the penalty is 200 £ (ca. 250 €);
> for non-residential properties the penalty is a sum equivalent to 12.5% of the rateable value of the building, subject to a minimum of 500 £ (ca. 625 €) and a maximum of 5,000 £ (ca. 6,250 €) depending on the net annual value of the "hereditament" (generally, the rental value of the building).

District Councils operate a two-stage enforcement letter process to encourage compliance prior to a penalty charge notice being issued. At the end of July 2014, over 4,300 such letters had been issued. At the time of writing this report, the Northern Ireland Government is not aware of enforcement proceedings or penalties paid for non-compliance since the coming into force of the EPC requirements in 2008. While a number of penalty charge notices have been issued, all have been withdrawn because the certificate was then obtained or the property removed from the market prior to completion of the transaction.

Quality Assurance (QA) of EPCs

Accreditation Schemes operating in England and Wales are also approved to operate in Northern Ireland. At the end of 2014, there are no Accreditation Schemes approved to operate in Northern Ireland only. Therefore, Northern Ireland benefits from the QA requirements (i.e., the Scheme Operating Requirements – SORs) implemented in England and Wales (see the England report for details).

III.ii. Progress and current status on public and large buildings visited by the public

Overview

Display Energy Certificates (DECs) are issued and displayed in buildings larger than 500 m² that are occupied by a public authority, and are frequently visited by members of the public. This threshold will fall to 250 m² from 9 July 2015. A DEC is valid for one year and the accompanying Advisory Report is valid for seven years.

From February 2013, it is a requirement for all non-residential buildings over 500 m² that are frequently visited by the public to display an EPC where one is produced for that building, or building unit, for the purposes of its construction, sale or rent (Table 4). Relevant buildings include banks, cinemas, shops, restaurants, etc. The EPC is to be displayed in a prominent place where it is clearly visible to members of the public who visit the building. Details of the non-residential EPCs are provided in section III.i.

EPCs are based on an Asset Rating approach, i.e., predicted energy consumption based on standardised conditions, while DECs are based on an Operational Rating approach, i.e., measured energy consumption which is normalised to allow cross-sector comparison.

Format and content of the EPC

Except for a reference to Northern Ireland, the DECs used in Northern Ireland are the same as those in England and Wales. Please see the England report for details.

Activity levels

DEC data to 31 August 2014 is included in Table 5 and Figure 11.

Table 4: Energy performance display requirements.

Occupier	Floor area	Requirements	Validity
Public authority*	Greater than 500 m²	Produce and display a DEC	1 year
		Produce an Advisory Report	7 years
		If an EPC has been produced (for construction, sale or rent) the EPC must be displayed**	10 years
Commercial premises*	Greater than 500 m²	If an EPC has been produced (for construction, sale or rent) the EPC must be displayed**	10 years

* The building must be frequently visited by the public.
** EPCs (produced for construction, sale or rent) must be accompanied by a Recommendations Report.

	DEC lodgements by band							
	Total	A	B	C	D	E	F	G
Total	9,222	55	538	2,380	3,105	1,614	617	913
Percentage	100%	0.6%	5.8%	25.8%	33.7%	17.5%	6.7%	9.9%

Table 5: Display Energy Certificates (DECs) to August 2014, Northern Ireland.

Costs

The cost of DECs varies greatly. Indicative starting costs, i.e., lowest market costs (based on internet search in July 2014) is about 200 £ (ca. 250 €). This cost includes the registration fee payable each time a DEC is recorded on the Northern Ireland non-residential buildings register. This fee is aligned on the England and Wales registration fee.

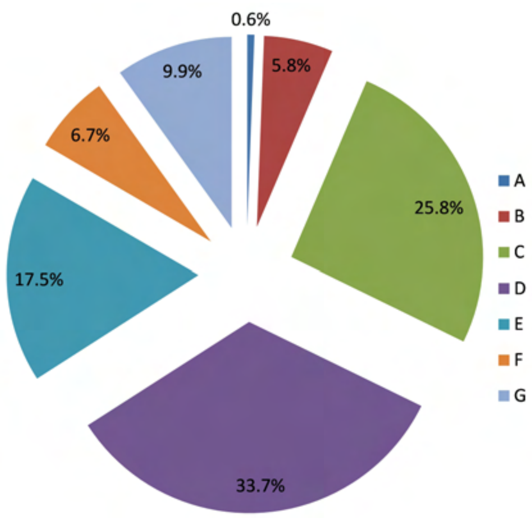


Figure 11: Display Energy Certificates (DECs) to August 2014, Northern Ireland. Percentages by DEC band.

Assessor corps and Quality Assurance (QA) of EPCs

The administration processes (Energy Assessors accreditation, quality assurance, etc.) are the same as those applied in England. Please see the England report for details.

III.iii. Implementation of mandatory advertising requirement

From February 2013 Regulations (SR 2013 No. 12) mandate that a property (or building unit) cannot be advertised for sale or rent without an EPC. Estate or Letting Agents (acting on behalf of sellers or landlords) must be satisfied that an EPC is available, or has been commissioned, before the property is marketed.

Any commercial media used to advertise a property (such as brochures, leaflets, websites or classified ads) must contain the coloured bar chart energy indicator from the EPC. Where there is not enough space to include the colour coded chart energy indicator on advertisements, the EPC energy rating must be stated, e.g., EPC F36.

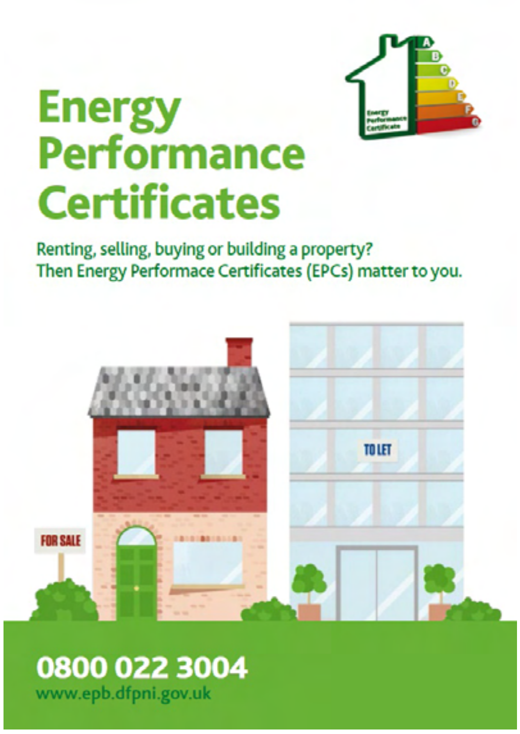


Figure 12: EPC information leaflet cover [7].

The landlord or seller must ensure that a copy of the EPC is shown, free of charge, to interested parties when they first make an enquiry about the property. For details about enforcement and penalties, please refer to section III.i.

III.iv. Information campaigns

Since the introduction of the EPBD requirements in 2008, information campaigns have used a diversity of outlets including website, advertising (through radio, press and information leaflets) (Figure 12), targeted seminars, guidance documents, roadshows, and proactive enforcement by a dedicated team. Information is also available from the DFPNI website[8] .

Other initiatives to improve the energy efficiency of buildings have benefited from publicity campaigns such as those

[7] *Full version available at www.dfpni.gov.uk/publications/energy-performance-certificate-quick-guide-leaflet*
[8] *www.dfpni.gov.uk/articles/energy-performance-certificates*
[9] *www.nidirect.gov.uk - the official Northern Ireland Government website for citizens*

associated with the Energy Wise pages[9] (Figure 13) and Invest NI's resource efficiency programme[10] which delivers a range of support to help companies implement resource and energy efficiency cost saving opportunities.

III.v. Coverage of the national building stock

This section is adapted from the UK National Energy Efficiency Action Plan (NEEAP) and gives a statistical overview of the main features of the building stock in the UK. The UK's building stock, including the building stock in Northern Ireland, varies widely both in age and type. The data presented in Figure 14 is taken from the Northern Ireland national register of EPCs. EPCs are only required under specific circumstances so this is not fully representative of all building types.

The UK has 27 million homes, across a wide range of housing types, of which approximately 0.76 million are in Northern Ireland. Figure 14 shows the distribution of about 317,000 residential EPCs in Northern Ireland.

Figure 13: Extract from the official Northern Ireland Government website for citizens [11].

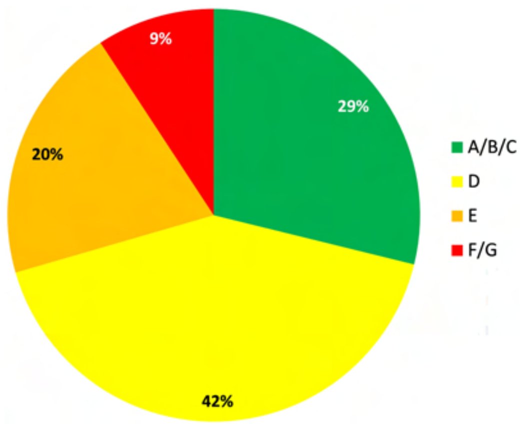


Figure 14: Energy efficiency rating of Northern Ireland housing stock, based on residential EPC records to 2014.

There are over 1.8 million non-residential premises in the UK, which are responsible for around 17% of the total UK energy consumption. Of the non-residential premises, 72,500 are in Northern Ireland. Specific data for the energy efficiency rating by building type in Northern Ireland is not available.

The numbers of EPCs issued in Northern Ireland in 2013 (for new and existing buildings) were: 93,186 residential building EPCs, 3,169 non-residential building EPCs, and 1,802 DECs.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

The UK (England, Wales, Scotland and Northern Ireland) adopted alternative measures for heating systems and inspections for Air-Conditioning (AC) systems. Please refer to the England report for details of the heating systems measures. Heating systems measures specific to Northern Ireland include the Warm Home scheme (for advice and insulation/heating measures), a boiler replacement scheme (for low income households), the Northern Ireland Housing Executive advice and information line, etc.

The Northern Ireland arrangements for AC inspections mirror the English provisions. For example, Northern Ireland approved the same Accreditation Schemes as those licensed in England and Wales to accredit Energy Assessors for the production of AC inspection reports.

Provisions that are specific to Northern Ireland include:

- The mandatory registration of AC inspection reports on the Northern Ireland EPC Register from February 2013. In 2013, 310 AC inspection reports were registered, while in the period February 2013 to August 2014, more than 730 reports were recorded in total.
- A range of activities have been undertaken in Northern Ireland to promote the AC inspections including an Energy Wise media campaign with radio coverage, posters and leaflets, workshops and presentations to key stakeholders groups, e.g., heating and ventilation contractors.

[10] www.investni.com
[11] www.nidirect.gov.uk/energy-wise

Enforcement and penalties

District Councils are responsible for ensuring that owners of AC systems (over 12 kW) are in possession of a valid inspection report, except for their own buildings for which DFPNI is the enforcement authority.

The penalty for failing to ensure that an accredited Energy Assessor inspects an AC system every five years or failing to possess a valid inspection report is 300 £ (ca. 375 €).

District Councils have a two-stage enforcement letter process to encourage compliance prior to a penalty charge notice being issued. To date, 42 such letters have been issued. At the time of writing, DFPNI is not aware of penalties imposed for non-compliance since the coming into force of the AC requirements.

Impact assessment

Two Regulatory Impact Assessments (RIAs)[12] were undertaken. One in 2008 for the transposition of the EPBD, Directive 2002/91/EC, another in 2013 for the transposition of the Directive 2010/31/EU and other amendments.

The costs of the mandatory inspection of AC systems over 12 kW every five years and reporting were estimated at 600 £ (ca. 750 €) for a centralised system, and 100 £ (ca. 125 €) for packaged units. The principal benefit of AC inspections was expected to arise from the improved efficiency and reduced electricity consumption of existing and new systems if the recommendations included in the inspection report were implemented. Benefits were deemed difficult to quantify accurately, but very large energy savings were expected from the replacement of older systems. Other benefits such as improved workplace conditions were also expected.

Mandating the recording of AC inspection reports on the national Northern Ireland register was expected to bring together a central source of information on AC systems in buildings and to improve the measurement of compliance. Costs were estimated at 15 £ (ca. 19 €) statutory fee per registration, plus the Accreditation Scheme fee. From April 2014, the fee for registering an AC report on the non-residential register decreased to 9.73 £ (ca. 12.5 €).

3. A success story in EPBD implementation

In Northern Ireland, the DFPNI funded a dedicated EPB Enforcement Team (the EPB Team) in April 2010. The EPB Team coordinates and facilitates cross-council working and delivers awareness-raising activities, with the aim of ensuring consistency in approach and messaging across the 26 council areas.

DFPNI carried out audits of four District Councils during 2013 - 2014. This included an assessment of the effectiveness of the EPB Team such as raising awareness of changes in legislation, assisting in the setting up of databases, checking compliance of estate agents when marketing properties for sale, display of EPCs and identifying properties with AC to assist councils in meeting their enforcement responsibilities. The audits carried out by DFPNI confirmed that the guidance and support provided by the EPB Team was very beneficial to councils. The team also provides DFPNI with quarterly reports detailing enforcement activities across councils and is the single point of contact for councils to help reduce their administrative burden.

District Councils reported a 98% EPC compliance for new buildings and modified properties in the quarter ending June 2014. The percentage compliance of EPCs advertised in commercial media increased throughout 2013, from 41% in the first quarter to 92% in the final quarter. AC compliance also rose substantially from 14% for the year ending March 2013 to 81% for the year ending March 2014.

Given the success of the EPB Team to date, DFPNI has secured funding to enable them to continue to operate over the period of the Local Government reform process which will result in the number of District Councils reducing from 26 to 11 in 2015.

4. Conclusions, future plans

The UK is divided into four jurisdictions: England, Wales, Scotland and Northern Ireland. In some instances the mix of approaches transposing the requirements of the Energy Performance of Buildings Directive (EPBD) differs between

[12] *RIAs are available at www.dfpni.gov.uk/consultations/2012-consultation-energy-performance-buildings-certificates-and-inspection-regulations*

jurisdictions. In other cases similar approaches were adopted by two or more jurisdictions.

Northern Ireland is the smallest jurisdiction of the UK (with the smallest population, least number of homes, etc.). It relies heavily on the research, development and Regulations from other jurisdictions (principally England) for the development of its own Regulations and technical guidance. To date, Northern Ireland has adopted the majority of the English provisions to transpose the EPBD and Northern Ireland Ministers have committed to follow moves in England towards Zero Carbon Homes.

Northern Ireland has also developed and implemented measures specific to its jurisdiction, including Air-Conditioning (AC) inspection information campaigns, and a successful compliance and enforcement approach which includes a two-stage enforcement letter process and a Department-level coordination/ enforcement team.

The transposition of the EPBD and associated benefits have been and continue to be reviewed by each UK jurisdiction as part of their respective programmes to achieve national energy efficiency objectives and carbon emissions reduction.

Implementation of the EPBD in the United Kingdom Scotland

STATUS IN DECEMBER **2014**

1. Introduction

This report provides information about the implementation of the Energy Performance of Buildings Directive (EPBD) in Scotland. It updates the previous UK-wide reports published in 2010 and 2012. The implementation of the EPBD in the other three UK jurisdictions (England, Wales and Northern Ireland) is addressed in separate reports.

The implementation of the EPBD in Scotland is the responsibility of the Local Government and Communities Directorate, Building Standards Division. The main legislation transposing the EPBD in Scotland includes:

> *the Building (Scotland) Regulations* 2004;*

> *the Energy Performance of Buildings (Scotland) Regulations* 2008.*

This report introduces the most recent requirements. It also addresses certification and inspection of systems including quality control mechanisms, the training of Qualified Experts (Energy Assessors), information campaigns, incentives and subsidies. For more details please visit the referenced websites or contact the responsible institution.

(*) This is the main Regulation. Subsequent amendments must also be considered, they include:

> *the Building (Miscellaneous Amendment) (Scotland) Regulations 2013;*

> *the Building (Scotland) Amendment Regulations 2012 (SSI** 2012/209);*

> *the Building (Scotland) Amendment Regulations 2011;*

> *the Building (Scotland) Amendment Regulations 2010;*

> *the Building (Scotland) Amendment Regulations 2009;*

> *the Building (Scotland) Amendment Regulations 2008;*

> *the Building (Scotland) Amendment Regulations 2007;*

> *the Building (Scotland) Amendment Regulations 2006;*

> *the Building Standards Advisory Committee (Scotland) Regulations 2004;*

> *the Energy Performance of Buildings (Scotland) Amendment Regulations 2013;*

> *the Energy Performance of Buildings (Scotland) Amendment (No. 3) Regulations 2012;*

> *the Energy Performance of Buildings (Scotland) Amendment Regulations 2012 (SSI** 2012/190);*

> *the Energy Performance of Buildings (Scotland) Amendment (No. 2) Regulations 2012 (SSI** 2012/208);*

> *the Energy Performance of Building (Scotland) Regulations 2008.*

"The Sullivan Report, A Low Carbon Building Standards Strategy for Scotland", first published in 2007, and its updates have also steered work to reduce energy use and carbon dioxide emissions from buildings in Scotland.

(**) SSI = Scottish Statutory Instrument.

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NATIONAL WEBSITE
www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards

2. Current status of Implementation of the EPBD

I. ENERGY PERFORMANCE REQUIREMENTS

I.i. Progress and current status

In 2013, the Scottish Government reconvened to revisit the recommendations for staged improvements in energy standards for 2010 and 2013. Following a consultation exercise and in consideration of the economic impact and timing of the changes, a Ministerial announcement was made to defer the 2013 energy standards within Building Regulations until October 2015. It was recommended that subsequent reviews of energy standards for achieving Nearly Zero Energy new Buildings should be aligned with the Directive 2010/31/EU requirement for Nearly Zero-Energy Buildings (NZEBs) from 2019, where practical.

Minimum energy performance requirements, for new buildings and for work to existing buildings, are set out in the Building (Scotland) Regulations 2004 (as amended). Technical Handbooks provide guidance on achieving the standards set in the Regulations. These standards were reviewed and improved in 2002, 2007 and 2010 (Figures 1 and 2, where 2002 standards are used as the baseline). Following recent review, the latest updates of the Technical Handbooks[1] were to be published in late 2014, setting out the changes to Building Regulations and guidance that will come into force on 1 October 2015. These Technical Handbooks are the documents most commonly used by building sector professionals rather than the Regulations themselves.

Figure 1: Residential Building Regulations improvements (historical and anticipated) for new buildings in Scotland.

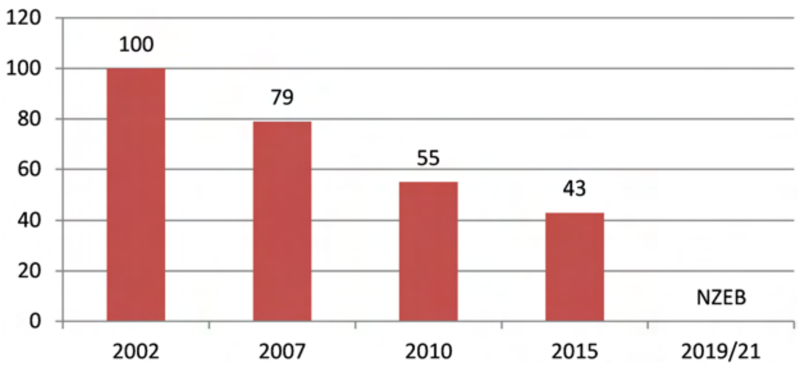
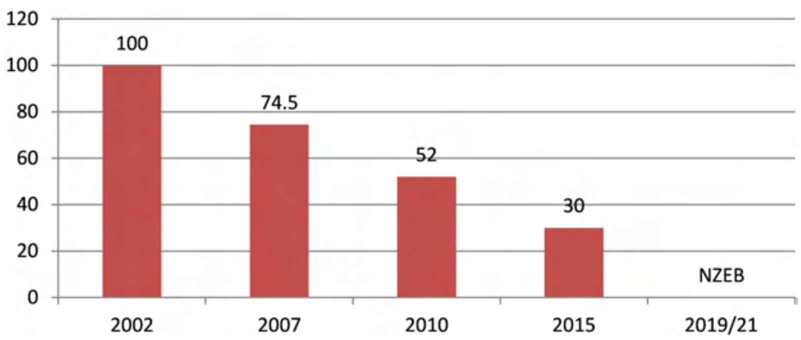


Figure 2: Non-residential Building Regulations improvements (historical and anticipated) for new buildings in Scotland.



Scotland is continuing to make significant progress towards the EPBD requirement for new buildings to achieve 'nearly zero-energy'. In late 2014, proposals were expected to be put forward for further review of Building Regulations to meet the requirements of EPBD Article 9, i.e., all new buildings (occupied/owned by public authorities) to be NZEB from 2019, and for all other buildings from 2021. The Government will investigate whether recommendations for further reduction in carbon dioxide (CO_2) emissions will also deliver 'nearly zero-energy' new buildings.

I.ii. Format of national transposition and implementation of existing regulations

Two Technical Handbooks provide practical guidance on complying with Building Regulations. Two sections of these Technical Handbooks relate to the energy requirements of the Building Regulations: Technical Handbook Domestic (new and existing buildings) and Technical Handbook Non-domestic (new and existing buildings). These handbooks were last updated in 2014. The handbooks include references to best practice guides such as Eurocodes (EN). Ten criteria are set for residential and non-residential buildings (see below). Under particular circumstances (including those allowed by the EPBD), some existing buildings works may be exempted, for example small conservatories below 50 m^2. The ten criteria are:

1. Ensure that the estimated Building CO_2 Emission Rate (BER) is no greater than the Target Emission Rate (TER). A provision for photovoltaic panels (as a percentage of floor area) is included in

[1] *All Technical Handbooks (including Energy and Sustainability Handbooks) are available at www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks*

TER calculations for new residential and non-residential buildings.
2. Reduce heat losses through the insulated envelope (including minimum fabric performance values, thermal bridging at junctions and air permeability standards). Scotland-specific Accredited Construction Details are available and, subject to some exceptions, airtightness testing is required.
3. Energy efficient space heating and hot water systems (including controls, minimum systems performance, etc.).
4. Minimum insulation levels for pipes, ducts and vessels.
5. Energy efficient artificial and display lighting (for example, a minimum of 60 lamp lumens/circuit-watt in offices) and controls.
6. Reduce overheating (for example through the proportion and orientation of translucent glazing, solar shading/control, thermal mass, etc.) and ensure energy efficient mechanical ventilation and air-conditioning (AC) (including controls).
7. Commissioning of building services to achieve optimum energy efficiency.
8. Written information for building occupiers on the operation and maintenance of the building services and energy supply systems.
9. The provision of Energy Performance Certificates (EPCs).
10. Metering of fuel and power of separate buildings/building parts and of their various end-uses.

The Technical Handbooks detail the building specifications to calculated the Target Emission Rate (TER), and reference the Scottish Building Services Compliance Guides which set out recommended minimum energy efficiency standards. Standards higher than many of the recommended minimum will be required to achieve the TER.

For residential buildings, the Standard Assessment Procedure (SAP) 2012 (details at www.ncm.bre.co.uk) is the methodology used throughout the UK for producing EPCs and calculating the energy performance of residential units to demonstrate compliance with Building Regulations. An EPC includes both an Energy Efficiency (EE) Rating (which takes into account fuel costs) and an Environmental Impact (EI) Rating (which assigns carbon emissions from fuels against energy used). Both ratings are based on the energy demand for a residential building which is calculated using the assessor's inputs that describe the building and a range of standard assumptions on occupancy and use. The EE Rating calculates energy used for heating, Domestic Hot Water (DHW), lighting and ventilation, and applies fuel costs to that energy use to give an overall rating for the residential building. Different fuels produce different amounts of CO_2 for every kWh of energy used. The Environmental Impact Rating of a residential unit is calculated by applying these 'carbon factors' to each of the fuels used (see Table 1 for examples).

For non-residential buildings, the Simplified Building Energy Model (SBEM), updated in 2014, must be used (details at www.ncm.bre.co.uk). SBEM uses an Asset Rating, i.e., predicted energy consumption based on standard conditions. The Government has developed the SBEM software which is available free of charge. Other proprietary software packages and interfaces (e.g., Dynamic Simulation Models – DSMs) may be used for more complex buildings, providing they have been approved by the Government. These tools are also used to produce EPCs on construction, sale, rent and for display in large "public buildings".

The Technical Handbooks refer to the use of Accredited Construction Details (ACDs) to assist compliance with Building Regulations. ACDs focus on providing insulation continuity at junctions (minimising cold bridging) and airtightness, to assist designers adopting a

Table 1: Carbon emission factors, extracted from Table 12, SAP 2012.

Fuel	Standing charge, £ [a]	Unit price p/kWh	Emissions kg CO_2 per kWh [b]
Gas:			
mains gas	120	3.48	0.216
bulk LPG	70	7.60	0.241
bottled LPG		10.30	0.241
LPG subject to Special Condition 18 [c]	120	3.48	0.241
biogas (including anaerobic digestion)	70	7.60	0.098
Oil:			
heating oil		5.44	0.298
biodiesel from any biomass source [d]		7.64	0.123
biodiesel from vegetable oil only [e]		7.64	0.083
appliances able to use mineral oil or biodiesel		5.44	0.298
B30K [f]		6.10	0.245
bioethanol from any biomass source		47.0	0.140
Solid fuel: [g]			
house coal		3.67	0.394
anthracite		3.64	0.394
manufactured smokeless fuel		4.61	0.433
wood logs		4.23	0.019
wood pellets (in bags for secondary heating)		5.81	0.039
wood pellets (bulk supply for main heating)		5.26	0.039
wood chips		3.07	0.016
dual fuel appliance (mineral and wood)		3.99	0.226
Electricity: [a]			
standard tariff	54	13.19	0.519

practical approach to eliminate all reasonably avoidable thermal bridges. An example of the Scottish ACDs[2] is given in Figure 3.

Local Authorities administer the Building Standards system. They are responsible for granting permission for work to be done (Building Warrant) and for a completed building to be occupied (Completion Certificate). An EPC (including EE and EI ratings) is required at both stages where the property is constructed, as well as when it is sold or rented out. Local Authorities are subject to regular monitoring and periodic inspection under a performance framework developed by the Scottish Government and launched in May 2012. The intention of the new national Key Performance Outcome (KPO) framework is to provide more effective comparisons of consistency and quality of customer service, and service outputs. Formal enforcement notices for non-compliance with EPC requirements are not currently reported under the framework.

I.iii. Cost-optimal procedure for setting energy performance requirements

A UK-wide cost-optimal report, covering Scotland, was published in May 2013. Tables 2 to 5 list the results for Scotland.

Please refer to the England report for further details.

I.iv. Action plan for progression towards Nearly Zero-Energy Buildings (NZEBs)

National application of the NZEB definition

The UK national plan titled “Increasing the number of Nearly Zero Energy Buildings” covers all four jurisdictions: England, Wales, Northern Ireland and Scotland. Please refer to the England report for details.

In Scotland, the Climate Change (Scotland) Act 2009 creates a statutory framework to deliver greenhouse gas emissions reductions. The Act sets an interim target of a 42% reduction in emissions (compared to 1990) by 2020, and an 80% reduction target for 2050. The Scottish Government’s “Low Carbon Scotland: Meeting the Emissions Reductions Targets 2010 - 2022” (dated 2011) sets out how Scotland can deliver its 42% target. This includes successive improvements in new-build energy standards through changes to the Building Regulations (see Figures 1 and 2 for historical trends).

NZEB statistics are not maintained at the Scottish or UK levels.

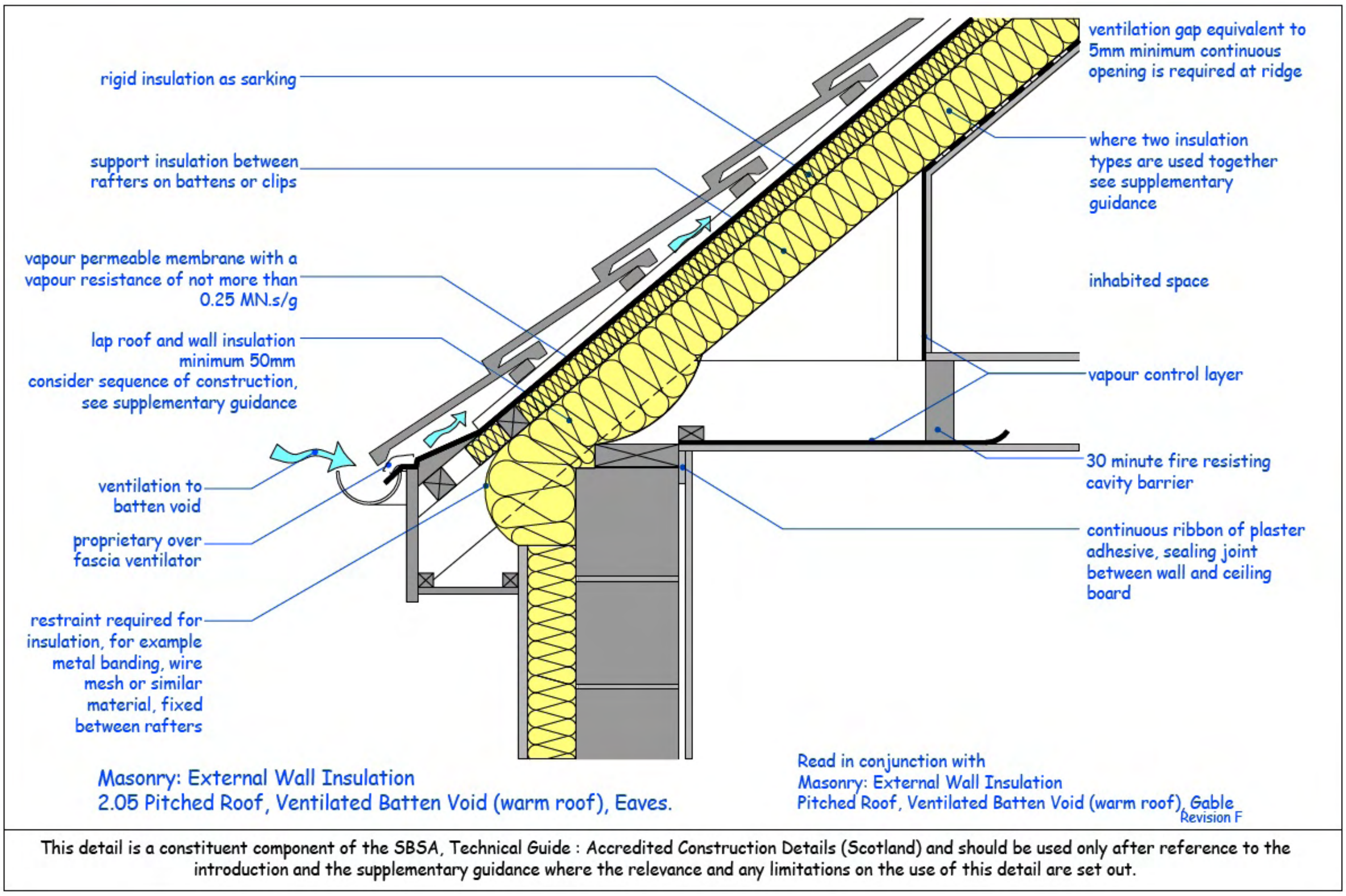


Figure 3: Illustration from ACD for pitched roof. Extracted from ACDs for masonry external wall insulation.

[2] www.scotland.gov.uk/topics/built-environment/building/building-standards

I.v. Implementation of the Energy Efficiency Directive (EED) regarding building renovation and the exemplary role of public buildings

The UK Department of Energy & Climate Change (DECC) is responsible for the transposition of the Energy Efficiency Directive (EED) which will mostly be implemented on a UK-wide basis. In a number of areas, where the Devolved Administrations in Northern Ireland, Wales and Scotland have responsibility for implementation, they have opted to pursue a UK-wide approach, though in some areas implementation will be undertaken by the Devolved Administrations.

The UK National Energy Efficiency Action Plan (NEEAP) was published in April 2014. It includes a Building Renovation Strategy in compliance with Article 4 of the EED. The Scottish policies and programmes to deliver this strategy include:

> the Sustainable Housing Strategy which sets targets for 2020 on insulation, boiler efficiency, and uptake of renewable heat for space and water heating;

> the Home Energy Efficiency Programmes for Scotland (HEEPS) which includes insulation programmes;

> the Energy Company Obligation (ECO) (to obligate larger energy suppliers to deliver energy efficiency measures to residential premises);

> Section 63 of the Climate Change (Scotland) Act 2009 which requires non-residential building owners to improve energy performance and reduce emissions.

The UK decided to implement the alternative approach allowed for by Article 5(6) and notified the Commission of the alternative measures that will be adopted to achieve an equivalent improvement in the energy performance of the buildings within the Central Government estate, which includes Central Government buildings in England, and buildings for UK-wide Government departments and in the Devolved Administrations. Alternative measures include behavioural change, facilities management, estate management, installing energy efficient Information Technology (IT) hardware, and installing energy efficient technology.

Each year the Scottish Government publishes an assessment of progress towards improving the energy efficiency and wider sustainability of buildings within the civil estate in Scotland[3]. The Government has also updated its Environmental Policy[4] which sets out its commitment to continuous improvement. Targets for the future performance of the civil estate, and actions necessary for their

Table 2:
New residential units. Comparison table between current requirements and cost-optimal for Scotland.

Reference building	Cost-optimal level (kWh/m².year)	Current requirements (kWh/m².year)	Gap (%)
Semi-detached	141	110	+22% better than cost-optimal
Mid-floor flat	116	91	

Table 3:
Existing residential units. Comparison table between current requirements and cost-optimal for Scotland.

Reference building (averages)	Cost-optimal level	Current requirements	Gap (%)
Cavity Walls	U=0.55 W/m².K	U=0.22 W/m².K	+60% better than cost-optimal
Solid Walls	U=0.4 W/m².K	U=0.22 W/m².K	S: +45% better than cost-optimal
Windows	U=1.6 W/m².K	U=1.6 W/m².K	cost-optimal
Roof	U=0.20 W/m².K	U=0.18 W/m².K	cost-optimal
Heating	88% (gas boiler)	88% (gas boiler)	cost-optimal

Table 4:
New non-residential buildings. Comparison table between current requirements and cost-optimal for Scotland.

Reference building	Cost-optimal level (kWh/m².year)	Current requirements (kWh/m².year)	Gap (%)
Office (AC)	163	162	-7% worse than cost-optimal
Office (NV)	89	76	
Secondary school	143	122	
Hospital	279	230	
Hotel (AC)	419	443	
Dist. warehouse	131	134	
Retail warehouse (AC)	193	348	
Average	202	216	

Table 5:
Existing non-residential buildings. Comparison table between current requirements and cost-optimal for Scotland.

Reference building (averages)	Cost-optimal level	Current Requirement	Gap
Cavity walls	U=0.30 W/m².K	U=0.30 W/m².K	cost-optimal
Other walls	U=0.20 W/m².K	U=0.30 W/m².K	-50% worse than cost-optimal
Roof	U=0.24 W/m².K	U=0.25 W/m².K	-4% worse than cost-optimal
Heating	84% (gas boiler)	86%	cost-optimal
Floor	U=0.22 W/m².K	U=0.25 W/m².K	-14% worse than cost-optimal
Windows	U=1.64 W/m².K	U=1.6 W/m².K	cost-optimal
Lighting	61 lm/W	55 lm/W	-10% worse than cost-optimal
Chiller	3.9	3.5	-10% worse than cost-optimal

[3] See www.scotland.gov.uk/Topics/Government/sustainabilityperformance/reporting/climatechangeact
[4] www.gov.uk/government/uploads/system/uploads/attachment_data/file/307993/uk_national_energy_efficiency_action_plan.pdf

delivery, are embedded in an updated Carbon Management Plan that will be published in late 2014. The Carbon Management Plan is expected to save 27.5 GWh by 2020. Over the last three years, 1.5 £ million (ca. 2 M€) has been spent on energy efficiency projects in Scotland including voltage optimisation, lighting upgrades, building management systems, and building fabric improvements.

The NEEAP[5] includes further details of other initiatives for all UK jurisdictions.

Figure 4: Domestic and Non-domestic Building Services Compliance Guides for Scotland, 2015 Editions.

II. REQUIREMENTS FOR TECHNICAL BUILDING SYSTEMS (TBS)

II.i. Coverage of heating, domestic hot water, air-conditioning and large ventilation systems

The 2013 Domestic and Non-domestic Building Services Compliance Guides, developed by the UK Government to support the English Building Regulations, have been adopted by Scotland. The two guides are referenced in the 2014 Scottish Technical Handbooks. Please refer to the England report for details.

Scotland published its own 2015 Domestic and Non-domestic Building Services Compliance Guides (Figure 4) for use from October 2015 in Scotland only with the 2015 Technical Handbooks. Selected extracts from the Non-domestic Guide are included in Table 6.

The Technical Handbooks, which support the Building Regulations, include minimum HVAC system efficiencies and reference the 2013 UK and 2015 Scottish Building Services Compliance Guides.

Table 6: Selected examples of recommended minimum energy efficiency standards. Non-domestic Building Services Compliance Guide for Scotland, The Scottish Government, 2015 Edition.

Building services type	Recommended minimum energy efficiency standard
Natural gas, single boiler system ≤ 2 MW output (for new buildings)	Gross seasonal efficiency: 91%
Biomass, independent boiler, automatic [feed], pellet/ woodchip (for new buildings)	Gross seasonal efficiency: 75%
Oil, single boiler system (for new buildings)	Gross seasonal efficiency: 84%
Heat pump – electrically driven (not air to air): space heating	Heat generator Coefficient of Performance (COP) 2.5 at rating conditions in EN 14511
Heat pump – electrically driven (not air to air): domestic hot water	Heat generator Coefficient of Performance (COP) 2.0 at rating conditions in EN 14511
Air distribution systems, central balanced mechanical ventilation with heating only	Specific Fan Power (SFP) (max): 1.5 W/(l.s)
Air distribution systems, plate heat exchanger	Dry heat recovery efficiency: 50%
Internal lighting, general lighting in office, storage and industrial areas	Effective lighting efficacy: 60 lamp lumens per circuit-watt
Comfort cooling, vapour compression cycle chillers, water cooled > 750 kW	Energy efficiency ratio (EER): 4.7

II.ii. Regulation of system performance, distinct from product or whole building performance

The commissioning of TBS is specifically addressed in the Technical Handbooks to help ensure HVAC systems are commissioned to achieve optimum energy efficiency. The Technical Handbooks reference relevant industry guidance, including the CIBSE Commissioning Codes and BSRIA Commissioning Guides.

II.iii. Applicability to new, replacement and upgraded systems in existing buildings

The Technical Handbooks include specific requirements for residential and non-residential buildings, they also reference the relevant Domestic and Non-domestic Building Services Compliance Guides.

In non-residential buildings, under certain circumstances (e.g., where new work to an existing building includes the provision of new fixed building services or extends the capacity of existing fixed building services), the existing fixed building services must be improved to meet the current performance recommendations given in the Technical Handbook.

II.iv. Provisions for installation, dimensioning, adjustment and control

The Technical Handbooks include specific requirements on controls and commissioning of building services systems. The handbooks also reference the relevant Domestic and Non-domestic Building Services Compliance Guides.

II.v. Encouragement of intelligent metering

Requirements for the metering of energy use within buildings are included in the Technical Handbook for non-domestic buildings. The overall aim is that each building or part of a building designed for different occupation is fitted with fuel and power meters. Sub-metering should be provided to allow monitoring of fuel and power consumption to the various end uses (heating, lighting, low carbon equipment, etc.). The handbook references industry best practice for the installation of sub-meters, i.e., CIBSE TM 39 Building Energy Metering. Automatic meter reading is referenced as a good practice measure, but it is not mandated.

[5] www.gov.uk/government/uploads/system/uploads/attachment_data/file/307993/uk_national_energy_efficiency_action_plan.pdf

There are no metering/sub-metering requirements for new and existing residential buildings in the Domestic Technical Handbook. The metering of incoming utilities in residential buildings is a matter reserved to the UK Government, i.e., it is addressed at the UK level, not by the Devolved Administrations such as Scotland. Utilities providers (e.g., gas companies) provide meters to enable correct charging for fuel used by residential customers. See England report for more details.

II.vi. Encouragement of active energy-saving control (automation, control and monitoring)

Provisions are included in both the Domestic and Non-domestic Technical Handbooks for TBS to be controlled to achieve optimum energy efficiency. From 2015, the Scottish Building Regulations will give credit for the installation of automated monitoring systems in new non-residential buildings where the Building Emission Rate may be reduced by 5% in buildings that feature Automatic Monitoring and Targeting (AMT) with alarms for out of range values.

III. ENERGY PERFORMANCE CERTIFICATES (EPCs) REQUIREMENTS

III.i. Progress and current status on sale or rental of buildings

Overview and administration system

The overarching systems in place to produce EPCs in Scotland are identical across all building sectors and broadly similar to those implemented in England and Wales.

The Scottish Government entered into protocols with a number of “Approved Organisations” to deliver EPCs. Regulations require Approved Organisations to “ensure that members are fit and proper persons who are qualified by their education, training and experience to carry out the preparation and issuing of EPCs”. Members of Approved Organisations prepare and issue EPCs (and other regulatory outputs) which must be created using Government-approved calculation methodologies and software tools.

Under an agreed Operating Framework, Approved Organisations have specific Quality Assurance (QA) responsibilities, for example maintaining a register of assessors and checking at least 2% of EPCs produced by assessors for accuracy. Assessor members of these organisations must comply with the terms and conditions of the Framework. From 2014, each Approved Organisation will be audited by the Government to ensure compliance with the Operating Framework requirements.

All EPCs must be produced from data recorded on the Scottish EPC Register[6] which holds both residential and non-residential EPCs data. EPCs may be retrieved from the register by members of the public using the EPC’s unique Report Reference Number (RRN). The Building (Scotland) Regulations require that the EPC is ‘affixed’ to the building, associated guidance suggests that the EPC be located in a boiler or meter cupboard.

How flats are certified in apartment buildings

> *New residential units*: An EPC must be produced for each building unit (in the same building) which may be sold separately, for example each apartment in an apartment block must be provided with an individual EPC on completion of the construction works.

> *Existing residential units*: Certification for individual apartments/units may be based on the assessment of another representative apartment/unit in the same block. The data used in the calculation must be verified by a visit to each apartment/unit to be certified. Dependent upon the quality and comprehensiveness of the existing data, such visit may not be as exhaustive as a full survey but would require the assessor to verify any data items that are either unrecorded or potentially subject to change. Supporting evidence is required to demonstrate the apartment/unit is representative. Alternatively, individual EPCs for each apartment/unit may also be produced.

Format and content of the EPC

> *Residential buildings:* The EPC provides an asset rating (i.e., a calculated energy rating) of the current and potential energy efficiency of the building on a scale from A to G (Figure 5). A is very efficient and G is the least efficient. This asset rating is based on the characteristics of the building itself, its services, a standardised occupancy

[6] *www.scottishepcregister.org.uk*

profile and the building's energy consumption cost. The average Energy Efficiency (EE) rating for a residential building in Scotland is band D (61).
The EPC also includes an Environmental Impact rating, which shows the effect of a residential unit on the environment in terms of CO_2 emissions (Figure 6). The average Environmental Impact (EI) rating for a residential building in Scotland is band D (59).
The first page of the EPC for new and existing residential buildings is shown in Figure 7. The EPC includes a list of cost-effective recommendations specific to the residential unit to improve the energy efficiency of the building, and indicates the potential Energy Efficiency and Environmental Impact ratings if all cost-effective measures were implemented.

> *Non-residential buildings*: The first page of the EPC for non-residential buildings is shown in Figure 8. Energy performance is shown as a single CO_2-based asset rating against an A to G scale, but differs significantly from the other UK EPCs as the banding is based on absolute CO_2 emissions, rather than the relative approach adopted in England and Wales (i.e., "actual building" vs "reference/notional building"). Absolute primary and delivered energy consumptions are shown on the EPC. The non-residential EPC includes one benchmark, the energy rating if the property were constructed to the Building Regulations applicable at the time of the assessment (Figure 9). Cost-effective recommendations are included in the accompanying Recommendations Report and are categorised as:
  - short term - payback less than three years;
  - medium term - payback between three and seven years;
  - long term - payback more than seven years.

Other recommendations may also be provided, based on the assessor's inspection.

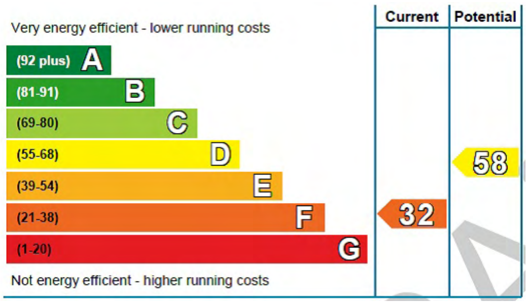


Figure 5: Example of residential Energy Efficiency bands, asset ratings, current and potential ratings.

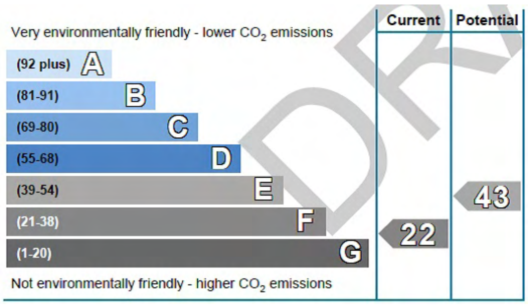


Figure 6: Example of residential EPC Environmental Impact Ratings, current and potential ratings.

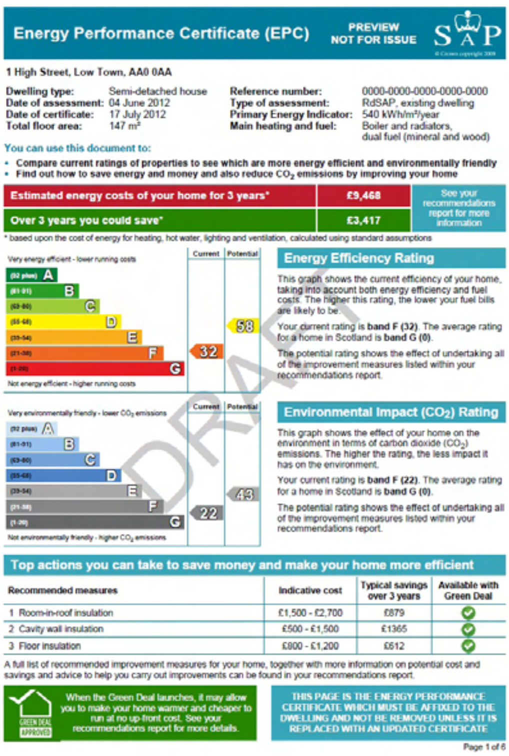


Figure 7: First page of residential EPC[7].

EPC activity levels

Until October 2012, only EPCs for existing residential units were recorded on the Scottish central register, the Home Energy Efficiency Database (HEED). EPCs for new residential units were submitted to Local Authorities as part of the Building Warrant process, and EPCs for existing non-residential units were not recorded. A new Scottish register has been developed and, as of January 2013, EPCs for all building types (new and existing, residential and non-residential) have been recorded. The number of EPCs reported in Tables 7 and 8 and Figures 10 and 11 reflects these historical arrangements.

Asset rating-based EPCs are produced for buildings on construction, sale, rent and for display in large public buildings. Both residential and non-residential EPCs are valid for 10 years. EPCs become legally valid after the data used to produce them have been recorded on the central register.

[7] www.scotland.gov.uk/Resource/0041/00414384.pdf

EPCs that are recorded on the Scottish central register are only accessible to building owners and their agents who have access to the EPC unique Report Reference Number (RRN). Historical data to July 2014 is included in Tables 7 and 8, Figures 10 and 11.

Typical EPC costs

The cost of EPCs varies greatly. Indicative starting costs, i.e., lowest market costs (based on internet search in July 2014) are comparable to England and Wales:

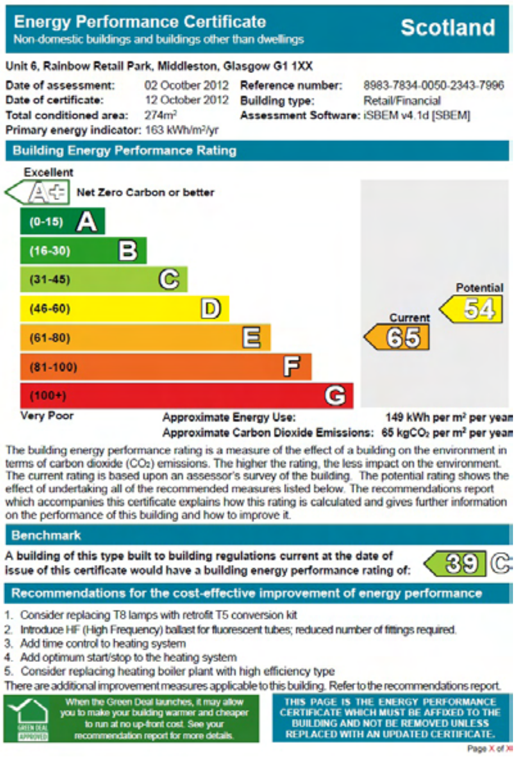
> for residential buildings: from 35 £ to 60 £ (ca. 44 € to 75 €);

> for non-residential buildings: from 129 £ to 150 £ (ca. 160 € to 190 €).

The above costs include the registration fee payable each time an EPC is recorded on the Scottish register. The fee for registering a residential EPC is maximum 1.15 £ (ca. 1.5 €) and 5.36 £ (ca. 7.25 €) for a non-residential EPC record.

Assessor corps

The Scottish Government worked with those delivering EPBD services to produce an Operating Framework for Approved Organisations. The Framework requires Approved Organisations to reference the UK National Occupational Standards (NOS) when establishing requirements for Energy Assessors to deliver EPCs. The NOS specify the qualifications and skills Energy Assessors should meet to be accredited to produce regulatory outputs. These are described in the England report. However, only four types of registration (instead of eight for the rest of the UK) are available


Energy Performance Certificate
Non-domestic buildings and buildings other than dwellings
Scotland

Unit 6, Rainbow Retail Park, Middleston, Glasgow G1 1XX

Date of assessment: 02 Ocotber 2012
Date of certificate: 12 October 2012
Total conditioned area: 274m²
Primary energy indicator: 163 kWh/m²/yr
Reference number: 8983-7834-0050-2343-7996
Building type: Retail/Financial
Assessment Software: iSBEM v4.1d [SBEM]

Building Energy Performance Rating

Excellent
A+ Net Zero Carbon or better
(0-15) A
(16-30) B
(31-45) C
(46-60) D
(61-80) E
(81-100) F
(100+) G
Very Poor
Current 65
Potential 54

Approximate Energy Use: 149 kWh per m² per year
Approximate Carbon Dioxide Emissions: 65 kgCO₂ per m² per year

The building energy performance rating is a measure of the effect of a building on the environment in terms of carbon dioxide (CO₂) emissions. The higher the rating, the less impact on the environment. The current rating is based upon an assessor's survey of the building. The potential rating shows the effect of undertaking all of the recommended measures listed below. The recommendations report which accompanies this certificate explains how this rating is calculated and gives further information on the performance of this building and how to improve it.

Benchmark

A building of this type built to building regulations current at the date of issue of this certificate would have a building energy performance rating of: 39 C

Recommendations for the cost-effective improvement of energy performance

1. Consider replacing T8 lamps with retrofit T5 conversion kit
2. Introduce HF (High Frequency) ballast for fluorescent tubes; reduced number of fittings required.
3. Add time control to heating system
4. Add optimum start/stop to the heating system
5. Consider replacing heating boiler plant with high efficiency type

There are additional improvement measures applicable to this building. Refer to the recommendations report.

GREEN DEAL APPROVED
When the Green Deal launches, it may allow you to make your building warmer and cheaper to run at no up-front cost. See your recommendation report for more details.

THIS PAGE IS THE ENERGY PERFORMANCE CERTIFICATE WHICH MUST BE AFFIXED TO THE BUILDING AND NOT BE REMOVED UNLESS REPLACED WITH AN UPDATED CERTIFICATE.

Page X of X

Figure 8: First page of non-residential EPC[8].


Benchmark

A building of this type built to building regulations current at the date of issue of this certificate would have a building energy performance rating of: 39 C

Figure 9: Non-residential EPC benchmark.

Table 7: Residential EPCs to July 2014, Scotland.

Domestic EPC lodgements by band								
	Total EPCs	A	B	C	D	E	F	G
Total	1,140,600	684	48,590	374,573	448,484	184,891	63,189	20,189
Percentage	100%	0.1%	4.3%	32.8%	39.3%	16.2%	5.5%	1.8%

Table 8: Non-residential EPCs to July 2014, Scotland.

Non-domestic EPC lodgements by band								
	Total EPCs	A	B	C	D	E	F	G
Total	12,216	73	340	1,000	1,639	2,254	1,802	5,108
Percentage	100%	0.6%	2.8%	8.2%	13.4%	18.5%	14.8%	41.8%

Figure 10: Residential EPCs to July 2014, Scotland. Percentages by EPC band.

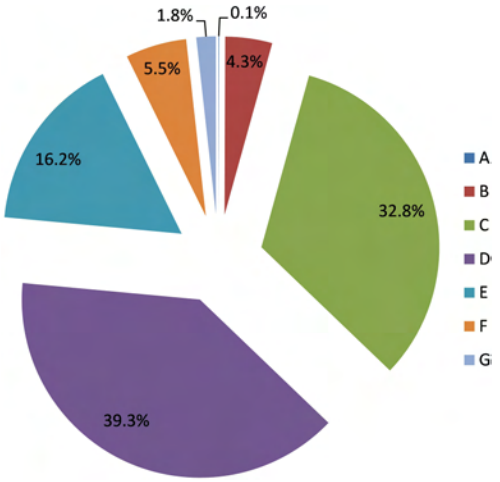
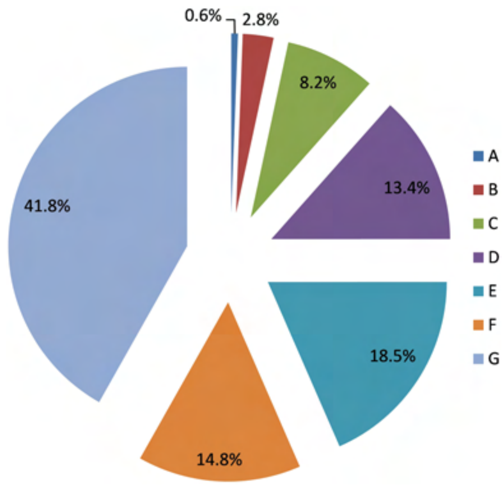


Figure 11: Non-residential EPCs to July 2014, Scotland. Percentages by EPC band.



[8] *www.scotland.gov.uk/Resource/0041/00414385.pdf*

to would-be Energy Assessors depending on the type of the assessed building (residential or non-residential) and whether the building is existing or new (Table 9). Continued Professional Development (CPD) is required by the Operating Framework. A minimum number of CPD hours per year is not specified by the Scottish Government, but a minimum level of CPD hours is usually specified by each Approved Organisation.

Compliance levels by sector

Compliance is the responsibility of Local Authorities. The Scottish Government does not monitor or hold central compliance data.

Enforcement with building owners and real estate actors

Local Authorities are the enforcement authorities in their respective jurisdictions. They have the powers to require building owners to produce copies of the EPC for inspection and to take copies if necessary. Failing to include the EPC rating in commercial media (when marketing a property) can also result in enforcement actions and penalties for building owners. Penalties depend on the type of building:

> for residential units the penalty is 500 £ (ca. 625 €);

> in any other case, the penalty is 1,000 £ (ca. 1,250 €).

Local Authorities can also consider criminal action.

At the time of writing this report, the Scottish Government has no statistical information detailing enforcement proceedings or penalties paid for non-compliance since the coming into force of the EPC requirements in 2008. Government is aware that complaints have been investigated and, where appropriate, EPCs obtained.

Table 9: Energy Assessors qualifications and numbers.

Assessor types	Assessor numbers
Domestic EPCs (existing buildings)	2,316
Domestic EPCs (new buildings)	139
Non-domestic EPCs (existing buildings)*	435
Non-domestic EPCs (new buildings)	216
AC inspection (level 3, simple)	24
AC inspection (level 4, complex)	211
Total Assessors	***3,341***
Notes	
* includes public buildings	
EPC: Energy Performance Certificate	
AC: Air-Conditioning	
AC level 3: simple/ packaged AC	
AC level 4: complex/ central AC	

Note: levels 1 and 2 do not exist.

Quality Assurance (QA) of EPCs

From January 2013, the Scottish Government requires Approved Organisations to undertake sample checking of a statistically representative sample of EPCs as outlined in the Operating Framework. In effect, sample checking repeats the calculation process using data recorded (on the Scottish central register) to verify the outcome reported and to confirm that sufficient evidence was gathered and correct processes were used. For example, the Operating Framework requires Approved Organisations to undertake QA of at least 2% of the total number of EPCs produced by their Energy Assessors. Other requirements apply with regard to the frequency of checks (depending on the level of activity of assessors), the accuracy target from the QA (e.g., 95% of assessed EPCs within ±5%), etc. The Operating Framework also establishes the requirements for Scottish Government audits of Approved Organisations.

In 2013, the total number of EPCs produced was 252,520 of which 6,181 (i.e., 2.45%) were subject to sample checking. Most sample checks are desk-based, i.e., no building site visit. Assessors' outputs are checked at least every six months, poor performance can lead to targeted auditing, retraining and ultimately suspension, or being struck off. Approved Organisations who fail to meet the terms of their protocol agreement could ultimately have their agreement terminated by the Scottish Government.

III.ii. Progress and current status on public and large buildings visited by the public

Overview

Unlike other UK jurisdictions, in Scotland the asset rating EPC (produced on construction, sale and rent) is also used for display in “public buildings”, rather than the operational rating (i.e., measured energy rating) Display Energy Certificate used in England, Wales, and Northern Ireland.

From January 2013, the requirement to display an EPC applies to two categories of larger non-residential buildings which are frequently visited by the public:

- buildings occupied by public authorities with a floor area of 500 m² or more which are frequently visited by members of the public ("public buildings") until 9 July 2015, and 250 m² or more after this date;
- other non-residential buildings with a floor area of 500 m² or more which are frequently visited by members of the public.

The key difference between the two categories is that public buildings must obtain and display an EPC, while other large buildings, which are frequently visited by members of the public, must display the EPC only if they have one.

The EPC displayed is the same as the non-residential EPC produced on construction, sale and rent and described in section III.i.

EPCs are valid for 10 years, but may be updated before their expiry date, e.g., after refurbishment works. Activity levels for the display of EPCs are not specifically recorded. Non-residential EPCs activity levels are provided in section III.i.

III.iii. Implementation of mandatory advertising requirement

An EPC must be produced when a new building has been constructed (at the completion stage of the building warrant process) and if the building owner intends to sell or rent the building to a new tenant.

For sale or rental, an existing EPC can be used if it is still valid. Otherwise a new EPC must be obtained. The EPC and accompanying Recommendations Report must be available to any prospective buyer or tenant. From January 2013, any commercial advertising of a building for sale or rent must contain the 'energy performance indicator' from the EPC to identify the rating of the property, e.g., EPC = C. These responsibilities rest with the building owner. An enforcement authority may, if it believes that an owner has breached the Regulations, give a penalty charge notice to the owner. The amount payable is 500 £ (ca. 675 €) for residential units, or 1,000 £ (ca. 1,350 €) for non-residential buildings.

III.iv. Information campaigns

Government invested in excess of 40 million £ (ca. 50 M€) in non-residential energy efficiency advice and support programmes since 2007. Government continues to fund the Energy Saving Trust to provide advice and support to businesses, public sector organisations, and the wider public at large to reduce energy consumption and associated costs through improved energy efficiency and carbon management.

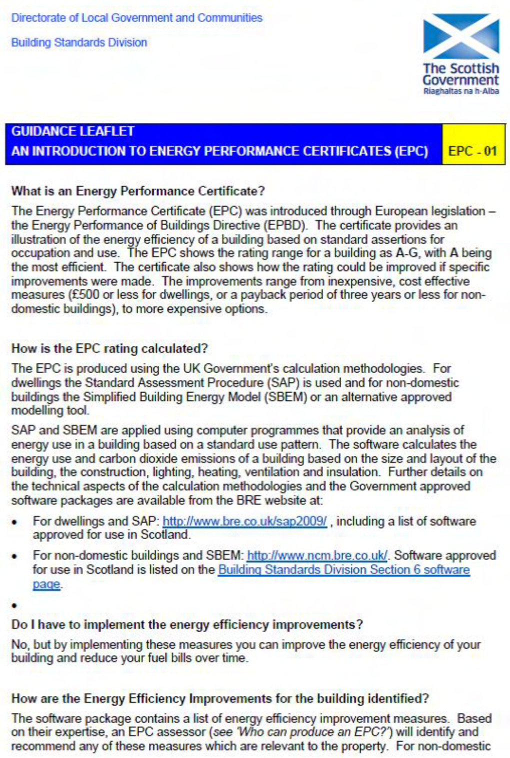
National information campaigns have used a diversity of outlets including website, advertising (through radio, press and information leaflets, e.g., Figure 12), targeted seminars, guidance documents, roadshows, and proactive enforcement by a dedicated team. Information is also available on the Government website[9].

Other Government initiatives to improve the energy efficiency of buildings have benefited from publicity campaigns such as the launch of the Green Deal in 2013.

III.v. Coverage of the national building stock

This section is adapted from the UK National Energy Efficiency Action Plan (NEEAP) and gives a statistical overview of the main features of the building stock in the UK. The UK's building stock (including Scotland) varies widely both in age and type. The data presented in Figure 13 is taken from the Scottish central register of EPCs. EPCs are only required under specific circumstances so this is not fully representative of all building types.

The UK has 27 million homes, roughly 2.4 million in Scotland across a wide



Directorate of Local Government and Communities

Building Standards Division

The Scottish Government
Riaghaltas na h-Alba

GUIDANCE LEAFLET
AN INTRODUCTION TO ENERGY PERFORMANCE CERTIFICATES (EPC) | EPC - 01

What is an Energy Performance Certificate?

The Energy Performance Certificate (EPC) was introduced through European legislation – the Energy Performance of Buildings Directive (EPBD). The certificate provides an illustration of the energy efficiency of a building based on standard assertions for occupation and use. The EPC shows the rating range for a building as A-G, with A being the most efficient. The certificate also shows how the rating could be improved if specific improvements were made. The improvements range from inexpensive, cost effective measures (£500 or less for dwellings, or a payback period of three years or less for non-domestic buildings), to more expensive options.

How is the EPC rating calculated?

The EPC is produced using the UK Government's calculation methodologies. For dwellings the Standard Assessment Procedure (SAP) is used and for non-domestic buildings the Simplified Building Energy Model (SBEM) or an alternative approved modelling tool.

SAP and SBEM are applied using computer programmes that provide an analysis of energy use in a building based on a standard use pattern. The software calculates the energy use and carbon dioxide emissions of a building based on the size and layout of the building, the construction, lighting, heating, ventilation and insulation. Further details on the technical aspects of the calculation methodologies and the Government approved software packages are available from the BRE website at:

- For dwellings and SAP: http://www.bre.co.uk/sap2009/ , including a list of software approved for use in Scotland.
- For non-domestic buildings and SBEM: http://www.ncm.bre.co.uk/. Software approved for use in Scotland is listed on the Building Standards Division Section 6 software page.
-

Do I have to implement the energy efficiency improvements?

No, but by implementing these measures you can improve the energy efficiency of your building and reduce your fuel bills over time.

How are the Energy Efficiency Improvements for the building identified?

The software package contains a list of energy efficiency improvement measures. Based on their expertise, an EPC assessor (*see 'Who can produce an EPC?'*) will identify and recommend any of these measures which are relevant to the property. For non-domestic

Figure 12: Guidance leaflet "An introduction to Energy Performance Certificates (EPCs)", Scottish Government.

[9] *www.scotland.gov.uk*

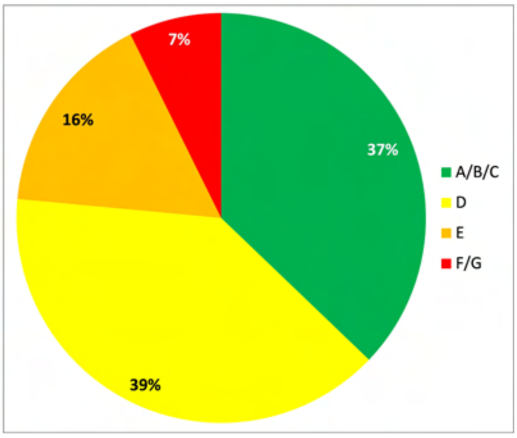


Figure 13: Energy efficiency rating of Scottish housing stock (based on EPC records from 2008 to July 2014).

range of housing types, including a significant proportion of older buildings. Figure 13 shows the distribution of ca. 1.14 million residential EPCs in Scotland at the end of 2014.

There are over 1.8 million non-residential premises in the UK, about 200,000 in Scotland. Specific data for the energy efficiency rating by building type in Scotland is not available.

EPCs recorded in 2013, for new and existing, residential and non-residential buildings in Scotland was 252,520. There was a total of about 12,000 non-residential EPCs on the Scottish register at July 2014.

IV. INSPECTION REQUIREMENTS – HEATING AND AIR-CONDITIONING (AC) SYSTEMS

The UK (England, Wales, Scotland and Northern Ireland) adopted alternative measures for heating systems and inspections for Air-Conditioning (AC) systems. Please refer to the England report for details of the heating systems measures. Scotland-specific schemes include the Energy Assistance Package, which targets fuel poverty and aims to reduce fuel bills and improve the energy efficiency of homes, Home Energy Efficiency Programmes, and Warmer Homes Scotland.

IV.i. Progress and current status on AC systems

Overview, technical method and administration system

The inspections of AC equipment was phased between January 2011 (for systems over 250 kW) and January 2013 (for systems over 12 kW). In the same building, individual systems each 12 kW or less, but totalling more than 12 kW together, only qualify if they are linked by a central control. Portable systems and AC of processes only (e.g,. computer equipment rather than for occupiers' comfort) do not qualify.

Building owners are subject to a continuing requirement. This means inspections are required throughout the life of a new or existing building, for as long as it has an AC system. Building owners must ensure that installations are inspected by an accredited expert who is a member of a "Protocol Organisation". Accredited experts issue a report to the occupier of the building which sets out the timescales for the next inspection, i.e., three to five years, subject to the efficiency of the system at the time of the inspection. There is no requirement for AC inspection reports to be recorded on a central register.

Arrangements for assurance, registration and promotion of competent persons

The procedures to undertake AC inspections are set out in the Government's General Technical Handbook Non-domestic (section 0). For the assessment process and reporting of advice, reference is made to the Technical Memorandum 44 (TM 44) Inspection of Air-conditioning Systems published by the Chartered Institution of Building Services Engineers (CIBSE)[10]. The handbook also lists the issues that should be considered in setting an inspection frequency greater than five years.

An Operating Framework has been established for organisations that have entered into a protocol with the Government for the inspection of AC systems in existing buildings. The framework requires these "Protocol Organisations" to reference the UK National Occupational Standards (NOS), which have been established for AC inspections. NOS set the minimum competencies and skills Energy Assessors must demonstrate to become accredited. Two levels of competence are available to assessors: "Level 3" for simple/packaged cooling systems, and "Level 4" for complex/centralised systems. See England report for details.

Promotional activities

To date, the Government has not run promotional activities specifically focused on the inspection of AC systems.

[10] *www.cibse.org/Knowledge/CIBSE-TM-(1)/TM44-Inspection-of-Air-Conditioning-Systems*

Enforcement and penalties

Local Authorities are responsible for ensuring that building owners have commissioned an inspection of AC systems (over 12 kW) and that building occupiers are in possession of a valid inspection report.

Local Authorities may serve an enforcement notice where the building owner is failing to comply. If the building owner has not complied by the date specified on the enforcement notice, the Local Authority may carry out such work as is necessary to comply with the notice and may recover, from the building owner, any expenses reasonably incurred.

At the end of 2014, there are no published Scotland-wide records of enforcement notices imposed by Local Authorities for non-compliance.

Quality control of inspection reports

The Operating Framework for Protocol Organisations sets out minimum requirements for the QA of inspector output and process, and for the Audit of Protocol Organisations by the Government. These requirements include:

> ensuring that at least 2% of the total number of inspection reports are checked for accuracy;

> ensuring that output from active inspectors is checked at least every six months; all new members should have output checked within the first month of active membership;

> Protocol Organisations to maintain records in a form that allows Government audit of the successful implementation of the functions set out in the Operating Framework.

Inspection activity figures

A total of 966 inspection reports were produced in 2013. Note that due to the climate in Scotland, there are relatively few large AC systems.

At least 2% of these reports should have been randomly selected and checked for accuracy. The actual number of AC inspection reports controlled in 2013 was 26, i.e., 2.7% of the reports produced in the year.

Impact assessment

The costs of the mandatory inspection of AC systems over 12 kW and reporting are comparable to England and Wales costs which are estimated as follows:

> for a centralised system 600 £ (ca. 750 €);

> for packaged units 100 £ (ca. 125 €).

The principal benefit of AC inspections was expected to arise from the improved efficiency and reduced electricity consumption of existing and new systems if the measures recommended in the inspection report were implemented. Benefits are difficult to quantify accurately, but very large energy savings are expected from the replacement of older systems. Other benefits such as improved workplace conditions are also expected.

3. A success story in EPBD implementation

Integration of the EPC into the Scottish 'Home Report'

In Scotland, the introduction of EPCs coincided with the introduction of domestic legislation to provide comprehensive information to potential purchasers of marketed residential units. All owners of residential units marketed for sale have to provide a 'Home Report'. This is a pack of three documents: a Single Survey, an Energy Report (which includes the EPC) and a Property Questionnaire. The Home Report is provided free of charge to prospective home buyers.

The Single Survey contains an assessment by a surveyor of the condition of the home, a valuation and an accessibility audit for people with particular needs.

The Energy Report contains an assessment by a surveyor of the energy efficiency of the home and its environmental impact. It also recommends ways to improve its energy efficiency. The EPC and the Recommendations Report are provided with the Energy Report.

The Property Questionnaire is completed by the seller of the home. It contains additional information about the home, such as Council Tax banding and factoring costs that will be useful to buyers.

The generation of the EPC as part of this process provides a 'one-stop-shop' for the seller, in that a building expert provides all documents, following just one visit to the property and for a fixed fee. This process also ensures that the EPC rating is available for inclusion in the advertisement and ensures a significantly high rate of compliance with Energy Performance of Buildings legislation. The provision of the EPC recommendations with the building survey also assists potential buyers to make informed choices in deciding how to improve the energy efficiency of the building if sale contracts are exchanged.

4. Conclusions, future plans

The UK is divided into four jurisdictions: England, Wales, Scotland and Northern Ireland. In many instances the mix of approaches transposing the requirements of the Energy Performance of Buildings Directive (EPBD) differs between jurisdictions. In some instances similar approaches were adopted by two or more jurisdictions. The transposition of the EPBD and associated benefits have been and continue to be reviewed by each UK jurisdiction as part of their respective programmes to achieve national energy efficiency objectives and carbon emissions reduction.

In some instances, these reviews validated the current implementation approach, for example the Display Energy Certificates (DECs) review by CIBSE. Changes have and will continue to be made to the implementation instruments where deemed appropriate.

In Scotland, since late 2007, the recommendations of “The Sullivan Report, A Low Carbon Building Standards Strategy for Scotland” have steered work to reduce energy use and carbon dioxide emissions from buildings. Amongst the recommendations of the 2013 updated report from the Sullivan Panel was the review of energy standards beyond 2015 to be aligned with the European Commission’s timetable for delivery of Nearly Zero-Energy new Buildings.

In addition to action to transpose the EPBD, in 2015 Scotland plans to introduce DECs and the reporting of operational energy use as a component of legislation for the assessment and improvement of existing non-residential buildings.

The Scottish Government recognises that the data recorded on the Energy Performance Certificate (EPC) register is a valuable asset, already used in support of a number of domestic policies and initiatives. Government plans to publish this data to support research, modelling uses, and broader carbon and energy efficiency improvements to the building stock.

Co-funded by the Intelligent Energy Europe
Programme of the European Union

www.epbd-ca.eu

ISBN 978-972-8646-32-5

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