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REFURBISHMENT OF THE PUBLIC BUILDING STOCK TOWARDS NZEB

ACRONYM OF THE PROJECT: REPUBLIC_ZEB

**D3.1 REPORT ON THE STATE-OF-THE-ART OF THE EPBD NATIONAL
IMPLEMENTATION, DESCRIBING POLICY MAPPING COMPRISING
THE ASSESSMENT OF THE EXISTING NATIONAL PLANS, POLICIES
AND REGULATORY FRAMEWORKS OF TARGET COUNTRIES,
EXISTING BARRIERS AND BEST PRACTICES**

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RePublic_ZEB Project

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Project overview

The RePublic_ZEB project is focused on the energy and CO₂ emissions associated with existing public buildings and their refurbishment towards nZEB.

The **core objective** of the project is to:

- Define costs-benefit optimized “packages of measures” based on efficient and quality-guaranteed technologies for the refurbishment of the public building stock towards nZEB that are standardized and adopted by builders and building owners.

From this stems three **basic objectives**:

- (i) State-of-the-art assessment of the public building stock through a country-specific evaluation of the energy consumption and CO₂ emissions;
- (ii) Define reference buildings; and;
- (iii) Develop a common framework and a harmonized methodology for the definition of a nZEB concept for public buildings.

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1. EXECUTIVE SUMMARY

This report represents the deliverable D3.1 of WP3 of RePublic_ZEB project, and presents the comprehensive work performed within Task 3.1.

The starting of the report is an analysis of previous EU project outcomes (ENTRANZE, Annex 52, Annex 53), which may serve useful information and best practices for RePublic_ZEB project.

The target countries of the project are Bulgaria, Croatia, Former Yugoslav Republic of Macedonia, Greece, Hungary, Italy, Portugal, Romania, Slovenia, Spain (Catalonia Region) and United Kingdom. In Chapter 3, each partner of the target countries presents the national regulatory framework of nearly zero energy building (nZEB) legislation, providing information especially on national nZEB definition and its application in practice, the numerical requirements of nZEBs, as well as the requirements at cost optimal level. The relevant content of national plans (National Energy Efficiency Action Plan, National Plan for increasing the number of nZEBs, Renewable Energy Action Plan) is also presented country by country. At the end of these country reports the characteristics of the given target country is presented, such as climatic conditions, energy prices, etc.

After completing the country reports in Chapter 3, an evaluation of these data was undertaken in Chapter 4. The existing regulatory frameworks for nZEB legislation, the numerical requirements for primary energy consumption and mandatory share of RES related to nZEBs are considered for a broad cross-country comparison. As a result of the evaluation it can be concluded that the national legislation process of nZEB definition and the application in practice show variety between the target countries of RePublic_ZEB project. Some countries have not transposed the nZEB definition into the national legislation yet, other countries have introduced only the general nZEB definition without any numerical requirement. A few countries supplemented the requirements with numerical values but confirmation of these values is in progress, while other countries have already officially transposed the definition with numerical values.

In most cases the available numerical requirements for different types of buildings show large variety among target countries. It is partly due to different climatic conditions, but it is worth noting that the variation still applied even with similar climate. There is also a great variety in the numerical figures of mandatory share of RES; furthermore in some countries the basis is primary energy, while elsewhere the basis is final energy (delivered energy to the building), or only some part of final energy.

The major and most common drivers and barriers of transformation of existing buildings towards nZEB level are also presented in this deliverable. Other indicators have also been identified that are closely connected to drivers and barriers. These indicators are climatic conditions, energy prices, GDP per capita, main heating sources of public buildings, and primary energy factors. Grouping of countries have been made in terms of these indicators in order to better assess the common nZEB framework in D3.2.

The overview of national regulatory frameworks as regards nZEB legislation, presenting the national nZEB definitions and numerical requirements, as well as policies and measures for the promoting of nZEBs, furthermore evaluating the drivers and barriers of refurbishment of existing public buildings towards nZEB level are essential results for the further work in the RePublic_ZEB project, especially for the D3.2 and WP5 activities.

2. ASSESSMENT OF PREVIOUS EU PROJECTS

The implementation of the EPBD, especially in nZEBs, depends on the mutual support of many stakeholders, including local and central government, builders, homeowners, social groups, researchers, NGOs etc., especially because this issue is processed at a different level in the EU and beyond. This is essentially true of access to government institutions to the obligations defined by Directive (Directive 2009/28 / EC), while in the private sector it is understood that the driving force is the market conditions.

This part of the report covers the international and European projects working on the implementation of EPBD. We believe that there are other developments related to the implementation of measures to accelerate the construction of such facilities, not yet published.

The nZEB as common goal is in the focus of several funding programmes, like the research EU programmes and IEA programmes. There are several different international projects that have worked on different aspects for nZEB.

Due to the large volume of work and results that these projects produced, their results are of significant importance for the RePublic_ZEB project. RePublic_ZEB aims at capitalizing their accomplishments and to build on their results.

2.1 Policies to Enforce the Transition to Nearly Zero Energy Buildings in the EU-27 – ENTRANZE [1]

The main objective of ENTRANZE was to provide support to the policy making by providing data, analysis and guidelines towards nZEB and RES-H/C of the existing national building stocks. The project connected several key stakeholders like building experts, research and academia personnel and decision makers.

The main objective of the project is to prepare the necessary data to facilitate dialogue between decision makers and other stakeholders. To achieve these goals the project prepared the necessary databases relating to buildings of national building stocks, especially to nZEB buildings and elements that distinguish them from other categorizations (especially in terms of passive houses). The data are analyzed and offer more scenarios which can then be used by other countries, depending on the national legislation, and financial instruments. In order to achieve the goals envisaged in the project, the participants are from different areas of expertise. This includes primarily academic institutions through their representatives (and research institutions), decision-makers at the state level, as well as experts from the sector of construction of buildings.

This project provides support to decision makers through training tools for collecting and analyzing data on buildings, energy efficiency indicators and best practices, as well as the analysis of cost-optimal levels for nZEB. The results of the project are very important for other stakeholders towards implementation of nZEBs. Other outputs of this project are a set of decisions and policy scenarios based on existing structures, analysis of existing scenarios etc.

To sum up, the ENTRANZE project has created an online data tool with an in-depth analysis of the structure and dynamics of buildings and related energy systems in EU. This tool can be useful in the gathering of data on RePublic_ZEB, as well as creating templates to gather and share the necessary data.

The ENTRANZE project also created analyses regarding cost-optimal levels of nZEB. The aim of this analysis is to set the costs of different energy efficiency measures to be considered in the scope of this project. This analysis is an essential input for the main calculations and forecasts carried out in further reports. The group of energy efficiency measures considered in this report is set to be applied to four different kinds of buildings: single family houses, apartment blocks, offices

and schools. However, the data gathered are also valid to evaluate the global cost for a large typology of buildings.

From this, it can be seen that this ENTRANZE report is closely related to RePublic_ZEB “packages of measures”, which will be undertaken within D3.4.

2.2 Annex 52 “Towards Net Zero Energy Solar Buildings” / Task 40 [2]

This project has been developed as an initiative of IEA. The purpose of this project is to develop a common understanding, a harmonized international definitions framework, tools, innovative solutions and industry guidelines for Net Zero-Energy Buildings, taking into account real case studies of current Net Zero, near Zero and very low energy buildings.

The project offered solutions, tools, guidelines and manuals for further implementation of the analyzed solutions.

With the implementation of the project activities, nZEB is predicted to become a reality in the construction market.

The project expects to achieve its core goal through several types of activities.

First, a common definition approach for nZEB concept has been studied through an extensive review of existing nZEB definitions and data (site/source energy, emissions, exergy, costs, etc.) with respect to the demand and the supply side, study of grid interaction (power/heating/cooling) and time-dependent energy mismatch analysis and the development of a monitoring, verification and compliance guide for checking the annual balance in practice (energy, emissions and costs) harmonized with the definition.

Secondly, design approaches and tools to support industry adoption of innovative demand/supply technologies for nZEBs has been refined by documenting processes and tools currently being used to design nZEBs and under development by participating countries, assessing gaps, needs and problems and inform simulation engine and detailed design tools developers of priorities for nZEBs.

Third, developing and testing innovative, whole building net-zero solution sets for cold, moderate and hot climates with exemplary architecture and technologies that would be the basis for demonstration projects and international collaboration. This work has been achieved using a database created with existing current nZEBs all over the world (<http://www.enob.info/en/net-zero-energy-buildings/map/>) by investigating advanced integrated design concepts and technologies in support of the case studies, demonstration projects and solution sets, and developing NZEB solution sets and guidelines with respect to building types and climate and to document design options in terms of market application and CO₂ implications.

Finally the dissemination of the results obtained during the development of the project was accomplished through various tools, such as the website of the project, published books, transfer of knowledge towards national working groups and creation of educational networks.

In conclusion, there are three noticeable outcomes from ANNEX 52 that should be considered in following deliverables of WP3:

1. The objective of the Subtask A is to establish an internationally agreed understanding on nZEBs based on a common methodology.
2. Developing and accessing case studies and demonstration projects in close cooperation with practitioners. This highlights the already accomplished show cases and their experience can be a significant help.
3. Developing nZEB solution sets and guidelines with respect to building types and climate and to document design options in terms of market application and CO₂ implications is also of importance for RePublic_ZEB.

2.3 Towards nearly zero-energy buildings [4]

This project has a direct task to ensure successful implementation of the EPBD after the changes in 2010. One of the main changes is related to Article 9 through which EU Member States shall ensure that each new building after December 31st 2020 will be nZEB. For public buildings the same rule applies after December 31st 2018. These conditions provided by the Directive are assessed as very difficult to fulfill, especially financially.

Initially, the project produced analysis and identification of existing opportunities, as well as analysis of the practical application of the definition for nZEB. It then prepared a template for the report that each country should deliver, to ensure submissions were harmonized and consistent. A methodology for the analysis of various types of facilities was also created, in terms of energy performance of buildings and costs.

Task 1 deals with existing definitions for nearly zero-energy buildings in the Member States. For RePublic_ZEB, the existing definitions for nZEB in EU can be a foundation for the creation of a common regional methodology for nZEB especially in D3.2.

Depending to their significance they can be identified as follows:

- Financial support measures
- Strengthening of building regulation
- Awareness raising and education
- Demonstration and pilot projects
- Research

2.4 Ongoing: Nearly Zero Energy Hotels

This IEE project focuses on hotels. The duration of the project is from 2013 to 2016 and aims to accelerate the refurbishment of the hotels towards nZEB by providing technical support, training for the staff and stakeholders, promoting best practices, etc. As beneficiaries of this project, 14 hotels across Europe will participate in its implementation. In addition, this project will establish a European network of nZEB hotels. Practical electronic tools will be available to all interested hotels.

2.5 Ongoing: NeZeRPromotion of smart and integrated nZEB renovation measures in the European renovation market

This IEE project started in 2014 and will finish in 2017. The aim is to develop and promote best practices and prepare technical solutions for the renovation of buildings towards nZEB. The project will prepare feasibility study that will present the advantage of the renovation towards nZEB, versus traditional renovation. This project will create city action plans towards nZEB, along with manuals for these and related action plans. The ultimate goal of the project is to develop the market for renovations towards nZEB in Europe.

2.6 Ongoing: Task Force - nZEB in Warm/Mediterranean climates

This task force is part of the initiative 'POWER HOUSE nearly-Zero Energy Challenge!'. The task force completes its work in 2015.

The objectives of the task force are to define the obstacles of housing organizations in meeting the nZEB goals. The target group consists of existing and new housing. In addition, the task force defines technical solutions and elements inherent to specific climates – in this case

warm/Mediterranean climate. The aim is to develop reports on costs and utilization, as well as guidelines and recommendations for national roadmaps.

To obtain reliable and useful results, the initiative 'POWER HOUSE nearly-Zero Energy Challenge!' monitors the situation in more than 30 buildings. The aim is to identify the actual energy characteristics, rather than the projected values of the designers in the planning stage.

2.7 Ongoing: NZB2021 'Doors Open Days' – sharing experiences from low energy buildings to meet nearly zero-energy building standards by 2021

This IEE project is being implemented from August 2012 to March 2015. The purpose of this project is through campaign, along with showcase visits, to “show” to the citizens the importance of nZEB. Events in 2013 and 2014 were organized in 10 European countries. Between 1,000 buildings participated in the campaign. The attendance of these events was about 20000 to 30000 people. The website of the project has a section with mini documentaries as well, which further helps in the raising awareness.

3. COUNTRY DATA

3.1 BULGARIA

3.1.1 State-of-the-art of the EPBD implementation

The requirements of the EU legislation regarding energy efficiency in buildings are incorporated into the Bulgarian legislation. The national definitions, as included in the laws and regulations on the energy efficiency of buildings, are updated and aligned with those of the Directive 2010/31/EC, CDR (EU) No 244/2012 and of the set of European standards applicable to their implementation.

The national methodology for calculating the energy demand and performance of buildings is developed on the basis of BDS EN ISO 13790 and the good European practices for establishment of annual energy demand for heating, ventilation, cooling and hot water. The unified methodology for the establishment of energy-demand parameters and calculation of the integrated energy performance of buildings was updated in 2010.

The following EU documents were transposed into national legislation:

- Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings (recast)
- Directive 2009/28/EC on the promotion of the use of energy from renewable sources
- Directive 2006/32/EC on energy end-use efficiency and energy services
- Directive 2002/91/EC on the energy performance of buildings
- Directive 89/106/EEC on the approximation of laws, regulations and administrative provisions of the Member-States relating to construction products
- Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC
- New Approach Directives and the standards falling within their scope, as well as technical norms, methods and principles of good European practices.

The national legislation in the area of energy efficiency includes:

- Energy Efficiency Act, in force since 14 Nov 2008 (last amendment in State Gazette No. 22/11.03.2014 and No. 33/11.04.2014), <http://www.seea.government.bg/documents/ZEE.pdf>
- Spatial Planning Act (last amendment in SG No. 49 and No. 53/2014), <http://www.seea.government.bg/documents/ZUT.pdf>
- Technical Requirements Towards Products Act (last amendment in SG No. 68/2.08.2013), <http://lex.bg/bg/laws/ldoc/2134683136>
- Energy Act, <http://www.mi.government.bg/bg/library/zakon-za-energetikata-256-c25-m0-1.html>
- Energy from Renewable Sources Act, <http://www.seea.government.bg/documents/ZEVI.pdf>
- National Standardisation Act, <http://www.lex.bg/bg/laws/ldoc/2135512321>
- Regulation No. 7 of 2004 on energy efficiency, heat conservation and energy savings of buildings (last amended and supplemented, No. 2 of 2010 and No 80 and 93 of 2013), <http://www.seea.government.bg/documents/Naredba%207.pdf>

ZEROING IN ON ENERGY

- Regulation No. 16-1594/13.11.2013 on energy efficiency audits, and the certification and assessment of energy savings in buildings (SG No. 101/22.11.2013), http://www.seea.government.bg/documents/NR_16_%201594.pdf
- Regulation No. RD-16-1058 of 2009 on the parameters for energy consumption and energy performance specifications of buildings (SG, No. 103 of 2009), <http://www.seea.government.bg/documents/Naredba-RD-16-1058.pdf>
- Regulation No. 15/2005 for technical rules and standards for design, construction and exploitation of projects and equipment for production, transportation and distribution of heating energy, <http://www.mi.government.bg/bg/library/naredba-15-ot-28-07-2005-g-za-tehnicheski-pravila-i-normativi-za-proektirane-izgrajdane-i-eksploa-405-c78-m260-3.html>
- Regulation No. RD-16-932/23.10.2009 for the terms and order in execution of energy efficiency verification of boilers and air-conditioning systems according to art. 27, par.1 and art. 28, par. 1 from Energy Efficiency Act and for creating, maintenance and using of database with these data, <http://www.seea.government.bg/documents/Naredba-RD-16-932.pdf>
- Ordinance on the essential requirements of construction works and conformity assessment of construction products (adopted by a Decree of the Council of Ministers of the Republic of Bulgaria No. 325 of 6 December 2006 and effective as of 1 January 2007, promulgated in State Gazette, Issue No. 106 of 27 December 2006, as subsequently amended), <http://www.lex.bg/bg/laws/ldoc/2135540641>

3.1.2 EPBD implementation until 2020

For the implementation of nZEB legislation, an update of the following legislative documents is needed:

- Regulation No. 7 of 2004 on energy efficiency, heat conservation and energy savings of buildings (last amended and supplemented, No. 2 of 2010 and No 80 and 93 of 2013)
- Regulation No. RD-16-1058 of 2009 on the parameters for energy consumption and energy performance specifications of buildings (SG, No. 103 of 2009)
- Regulation No. 15/2005 on technical rules and standards for design, construction and exploitation of projects and equipment for production, transportation and distribution of heating energy

Regulation No. 7 is envisaged for amendment with the results of the research on improvement of energy performance of buildings in accordance with Directive 2010/31/EC and the standards of its scope, and the requirements of Regulation (EU) No. 305/2011 laying down the harmonised conditions for marketing of construction products, foreseen in investment projects related to buildings. The new norm's scope covers:

1. Introduction of scales with quantities related to energy consumption classes for 10 building categories
2. Norms for definition of conditioned area
3. New values for primary energy transformation factor and ecological equivalence factor
4. New reference values for factors of heat transfer through the surrounding elements bordering outside air (walls, roof, windows)
5. Methodology for calculation of thermal bridges

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6. Methodology for calculation of economic efficiency and effectiveness of ESM and packages of ESM for the period of their life cycle
7. Methodology for calculation of solar energy share in DHW
8. Introduction of nZEB definition

In its working version, Regulation No. 15 proposes an obligation to all buildings to dispose of designed and constructed common or independent HVAC systems. This applies also to residential buildings with condominium, for which one or more normative microclimate parameters are required. Currently there are requirements for design of HVAC systems only for buildings with built-up area of more than 250 m². Furthermore, the document suggests decreasing water temperature at the entrance of heating body in conventional systems for centralized water heating to 60°C, instead of 90°C as it is now.

In order to support the increase of the number of nearly zero-energy buildings, the Bulgarian government envisages developing a National plan for nearly zero-energy buildings.

3.1.2.1 nZEB definition

As a result of the performed investigation a national definition of nearly-zero energy buildings has been formulated. The national definition is illustrated on Figure BG-1.

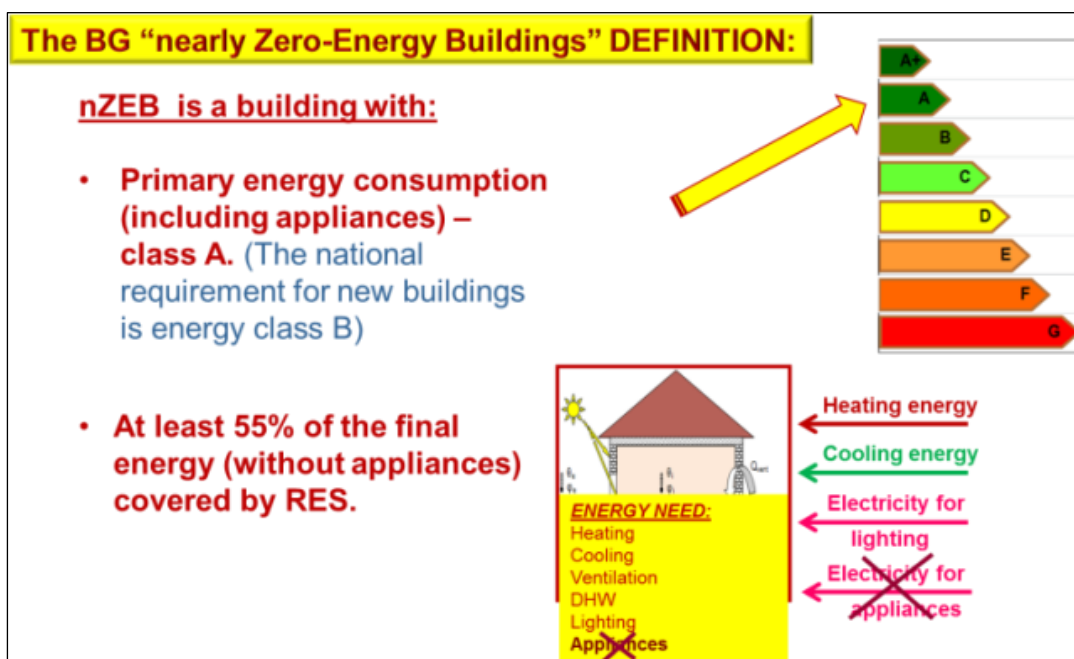


Figure BG-1: Definition of nZEB

3.1.2.1 Cost-optimal level requirement

Regarding the results from calculation of the optimal parameters for the needs of the national legislation the following can be presented: in 2014, in line with the provisions of the Directive 2010/31 and Regulation 244, a vast investigation of the Bulgarian building stock has been carried out. The detailed classification of the building stock was followed by a simulation, based on 4922 models of annual energy consumption. The simulation covered the two most typical climate zones in the country: Zone 7 – including Sofia city and the Sub-Balkans valleys, and Zone 1 – the Northern Black Sea coast (Varna region). The different regimes of use depending on the buildings’ functions and the different total built-up area were taken into

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consideration, with taking into account the factor related to the form and the different heating baselines. For each representative building, 10 to 14 packages of differently combined energy saving measures, identified through a matrix approach, have been surveyed.

The assessment of the effect of the individual or packages of energy saving measures is based on two main *calculation methods*:

- method for calculating of the annual energy consumption, and
- method for calculating of the economic indicators of the measures.

The next figure shows the values of the coefficient for calculating of heat transfer through the building envelope. The values relating to 2014 are a result of the carried out procedure for optimization of consumption.

Table BG-1: Requirements (U-values - W/m²K)

Year	1987	2005	2009	2012	2014
Walls	1,11	0,5	0,35	0,35	0,28
Windows	2,65	2	1,7	1,7	1,4
Suspended facades			1,9	1,9	1,7
Roofs	0,603	0,3	0,28	0,28	0,25
Floors	0,503	0,4	0,4	0,4	0,4

Derived are numerical scales for the energy consumption of 10 main categories of buildings. The next figures depict the scales of several buildings categories.

Table BG-2: Primary energy consumption scale for Office buildings

Клас	EPmin, kWh/m ²	EPmax, kWh/m ²	АДМИНИСТРАТИВНИ
A+	<	70	
A	70	140	
B	141	280	
C	281	340	
D	341	400	
E	401	500	
F	501	600	
G	>	600	

Table BG-3: Primary energy consumption scale for Hospitals

Клас	min, kWh/m ²	max, kWh/m ²	СГРАДИ ЗА ЗДРАВЕОПАЗВАНЕ
A+	<	70	
A	70	140	
B	141	280	
C	281	365	
D	366	450	
E	451	563	
F	564	675	
G	>	675	

Table BG-4: Primary energy consumption scale for Buildings for cultural events




Клас	min, kWh/m ²	max, kWh/m ²	СГРАДИ ЗА КУЛТУРА И ИЗКУСТВО
A+	<	55	
A	55	110	
B	111	220	
C	221	270	
D	271	320	
E	321	400	
F	401	480	
G	>	480	

Table BG-5: Primary energy consumption scale for School buildings


Клас	EPmin, kWh/m2	EPmax, kWh/m2	УЧИЛИЩА
A+	<	25	
A	25	50	
B	51	100	
C	101	130	
D	131	160	
E	161	200	
F	201	240	
G	>	240	

Table BG-6: Primary energy consumption scale for Kindergarten buildings

Клас	EPmin, kWh/m2	EPmax, kWh/m2	ДЕТСКИ ГРАДИНИ
A+	<	33	
A	33	65	
B	66	130	
C	131	195	
D	196	260	
E	261	325	
F	326	390	
G	>	390	

The results of the investigation are presented in a special report, required by the EC from all the EU member-states on 30.11.2013. Based on these results, the national legislative framework has been updated and sent to the EC for notification. The standstill period for receiving the answer to the notification was 09.12.2014. Until now (beginning of January 2015) there is no reaction.

3.1.3 Overview of existing national plan

The Bulgarian Energy Strategy by 2020 incorporates the Government's vision of Bulgaria's development within the common EU context, taking into account the current European energy policy framework and the global tendencies towards the development of energy technologies. The Energy Strategy is the fundamental document for the national energy

policy development. Approved by the Council of Ministers and by the National Assembly in 2011, the Strategy's aim is to ensure a reliable, efficient and cleaner energy system. The main accents in sustainable energy development by 2020 are a 20% improvement of energy efficiency, increase of the share of renewable sources to 16% (20%) of the energy end-use and a 20% reduction of greenhouse gas emissions compared to 1990 levels. The Bulgarian Government therefore will focus on improving the efficiency of generation of electricity and heat, reducing transmission and distribution losses, improving the energy performance of existing buildings and introducing more stringent energy standards for new buildings, including energy-independent buildings.

The National Renewable Energy Action Plan and the Second National Energy Efficiency Action Plan (Second National Plan) are based on Directive 2006/32/EC on energy end-use efficiency and energy services and covering the period 2011–6 and the forecast to 2020.

One of the sub-targets of the Second National Action Plan is the National Target for nearly zero energy buildings. A strategy to increase the number of these buildings in accordance with the Directive 2010/31/EU has been proposed by:

- assisting the construction of new nearly-zero energy buildings and achieving the same energy characteristics when existing buildings undergo major refurbishment;
- analysing and revising the existing national legislation, documents and measures to support the implementation of Directive 2010/31/EU;
- analysing the state of the construction sector (growth of the construction process, business environment, financial and administrative obstacles, socio-economic conditions, market principles, etc);
- regulating the introduction of renewables in the construction of new buildings or the reconstruction, major refurbishment, major repair or conversion of existing buildings;
- fine-tuning the powers and functions of the competent authorities arising from the implementation of the new requirements of Directive 2010/31/EU with regard to the building sector (public and residential buildings);
- planning measures to assign and implement applied research tasks to determine national parameters and requirements to the energy performance of NZEB; supplementing the national calculation methodology with new elements from the relevant European standards for designing sustainable and smart buildings, taking into account standards for passive buildings and the level of technologies for heating, cooling and ventilation systems using conventional or renewable energy; systematic analysis of data in the information system of the Sustainable Energy Development Agency (SEDA) regarding the state of energy use in existing buildings; and preparing projects, approving and publishing legislation, by-laws and administrative regulations;
- planning measures defining the national targets, implementation mechanisms, activities related to recording, documenting and reporting results; pilot projects for new public-sector nearly zero-energy buildings; an approximate definition of the provisional target for 2015 of 1-1.5% of the total floor space of new buildings occupied by central or local government departments with an energy performance corresponding to nearly zero-energy use; drafting a National Plan to increase the number of nearly zero-energy buildings;
- adapting the National Programme for Housing Renovation in Bulgaria from 2005, to the EU's harmonised energy efficiency policy and the Government's new policy towards large-scale renovation of multi-family residential buildings;

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- schemes for providing of financial aid under the Operational Programme “Regional Development” (Supporting energy efficiency in multi-family residential buildings);
- giving priority for the renovation of concrete panel and other multi-family buildings, and linking this process with the necessary energy certification and energy auditing of buildings;
- drawing up a pilot programme for the uptake of nearly zero-energy public buildings;
- harmonising the package of legislative acts and regulations in accordance with the Energy Performance of Buildings Directive of 2010 by supplementing the national legislative requirements. These relate to thermal transmittance (U value, W/m^2K) of walls and glazed apertures, and building features, taking into account the novelties in the manufacture of building materials and products (Regulation No. 7 of 2004 on energy efficiency, thermal insulation and energy economy in buildings, as amended in 2010, Regulation No. RD-16-1058 of 2009 on energy use indicators and the energy performance of buildings, and Regulation No. 15 on the technical rules and standards for the design, construction and operation of buildings and facilities for the production, transmission and distribution of heat energy);
- stimulating the establishment of associations of owners as provided by the Condominium Management Act, and assisting with auditing of condominiums.

Currently the energy consumption level is determined by an individual scale for each building. In 2014, following the requirements of Directive 2010/31, 10 energy consumption scales have been developed: 1 for residential buildings and 9 for public buildings (administrative, schools, kindergartens, universities, sport, commercial, hospitals, culture, hotels). The scales are designed according to BDS EN 15217 and correspond to the specific overall primary energy included appliances. The requirements are as follows: new buildings - class B, renovated buildings - class C, nZEB - class A, +55% RES (from the delivered energy for heating, cooling, ventilation, DHW and lighting).

3.1.4 Identification of aspects on refurbishment of public buildings into nZEB level

After the economic crisis during the period 2008 – 2009, when GDP had been decreasing by 5.5% annually, Bulgaria is now in a state of unreliable increase of GDP, which is lower than forecasted. The industrial production continues to shrink, the construction of new buildings is insignificant compared to its intensive development before the crisis.

The political instability of Ukraine and the Russia’s countermeasures against Bulgarian export, restrain trade and are a serious threat against the weak Bulgarian economy.

The state and municipal budgets are restricted and the investments in the EE of public buildings are realized mainly due to the European programmes’ financing.

The new Bulgarian Government has declared its understanding of the importance of EE of buildings and engaged to work hard towards securing higher financing for buildings’ renovation. Since its mandate has just started, it is too early to speak about any possible or achieved progress.

There should also be mentioned the unfavourable demographic tendency – low birth rate and increased emigration of young specialists to West Europe and North America. With this, the enormous resource invested in their education is being lost, which is directed towards the rich and well developed countries and cannot be compensated at all.

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According to the reference scenario of the National Energy Efficiency Action Plan, GDP is expected to grow by up to 2.2% p.a. between 2014 and 2020, however no perspective for such growth is visible at the moment.

As for climatic data, Bulgaria has variable and complex climate due to its location between the continental and Mediterranean climatic zones.

In summer, the temperatures often exceed 30°C. In the town of Sandanski, near Blagoevgrad, has been recorded the highest known temperature: 45°C. The average temperature in August is 19°C in climate zone 1 (Black sea region), 16.5°C in climate zone 2 (Continental), and 20.8°C in climate zone 3 (South Bulgaria). Winters are cold and snowy, milder in the South regions of the country. The average winter temperature for the Northern regions is about 1°C, and 4°C to the South. The recorded absolute minimum temperature of -38.3°C is registered in the town of Tran.

Table BG-7: Primary energy factors

Type of resource/energy	Primary energy conversion coefficient
Industrial gasoil	1,10
Heavy oil	1,10
Natural gas	1,10
LPG	1,10
Black coal	1,20
Lignite/brown coal	1,20
Hard coal	1,20
Briquettes	1,25
Wood pellets	1,05
District heating	1,30
Electricity	3,00

From legislative and regulative point of view, there are no obstacles to carrying out the process, required by the Directive on buildings.

Three impediments limiting its development could be outlined:

- The first one is connected with the economic crisis, which has been lasting for 7 years already. Governmental and public bodies do not dispose of enough budget even for the urgent needs, which makes them able only to co-finance projects, the major finance for which comes from the EU programmes and funds.
- There exists a systematic difficulty, which is connected with the low level of energy prices in Bulgaria. This comes from the State policy, which seeks to unburden the poor stratum amounting large number of people. In this manner this policy is fulfilled with contradictions, putting obstacles to the efficient utilization of energy.
- Low capacity of the Local Authorities – there are no experts in many of the municipalities, who can assess the meaning of nZEB and propose options for building renovations. In this perspective the role of Horizon 2020 Coordination & Support Action can be significant.

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No matter the existing difficulties, the laying down of the required legislation base is a great success, which sets favourable conditions for the implementation of the EPBD requirements.

The first Bulgarian nZEB: The research centre of the Technical University – Sofia.

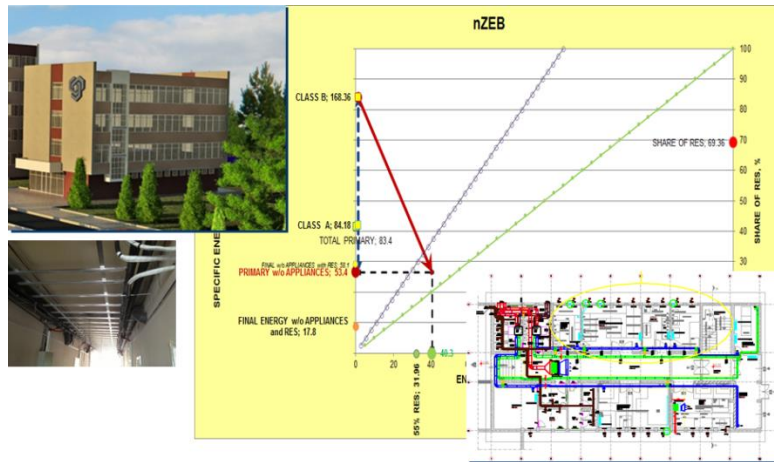


Figure BG-2: Implementation of the EPBD in Bulgaria - Status in September 2014

3.2 CROATIA

3.2.1 State-of-the-art of the EPBD implementation

In Croatia the transposition of the EPBD into national legislation started in 2005. Since 2012, responsibility for the implementation is within Ministry of Construction and Physical Planning.

EPBD has been since fully transposed into the national legislation through Energy efficiency act (OG 127/14); Building Act (OG 153/13), Building products Act (OG 76/13 and 30/14) and related regulations. Energy certification of the buildings is mandatory from 2010.

Technical regulation on rational energy use and thermal protection in buildings (OG 97/2014) set forth requirements for new buildings and major refurbishment separately for residential and non – residential buildings for:

- maximum permitted annual energy use for heating and cooling per m² of usable floor area
- maximum permitted heat transfer coefficients
- prevention of overheating due to solar radiation in summer
- limitation of building air tightness
- minimisation of thermal bridges; prevention of surface condensation and condensation of water inside building component
- primary energy consumption for heating, cooling, DWH and lighting
- renewable energy share

New buildings and major renovations have to comply with all requirements. Regulation applies to entire Croatia, for two climate zones – continental and coastal Croatia, with difference in quantitative requirements for coastal and continental Croatia.

Energy certificates use energy performance levels of buildings assessed through on useful heating energy requirement, while cooling energy, DHW, heating, cooling and DHW system losses and lighting energy are expressed in EPC.

For residential buildings, energy rating scale is given in specific useful heating energy per heated building area, and for non-residential scale is defined in relative scale compared to maximum useful heating energy allowed for exact building form factor.

Building energy ratings are defined in Ordinance on energy audit of the buildings and energy performance ratings (OG 48/14).

Table HR-1: Building energy performance

Building energy performance level	Building energy performance expressed in $Q''_{H,nd}$ (kWh/m ² a)	Building energy performance expressed relative to $Q_{H,nd,max}$ %
A+	≤15	≤15
A	≤25	≤25
B	≤50	≤50
C	≤100	≤100
D	≤150	≤150
E	≤200	≤200
F	≤250	≤250
G	>250	>250

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Values for energy needs for energy rating C are equivalent to minimum energy requirements for new buildings and major refurbishment.

EPC's are mandatory delivered, together with report on energy audit of the building to Ministry of Construction and Physical Planning, which keeps the database of issued energy performance certificates.

Ordinance on review of energy performance audits of the buildings and energy performance certificates (OG 81/12 and 79/13) sets obligation on Ministry for Construction and Physical Planning to select EPC's (3% of issued certificates) through random selection of total number of EPC's, random selection of EPC's for specific energy rating and building use, and by complaint. Besides that, each licensed person or EPC rating has to have at least one energy audit report and EPC checked in three year period.

3.2.2 EPBD implementation until 2020

According to the EPBD recast new terms and requirements were added into the national legislations. Changes were in definition of energy performance rating through primary energy demand and diversified requirements for different building uses.

Building uses specified are:

- single family homes
- multiapartment buildings
- office buildings
- buildings for education
- retail buildings
- hotels and restaurants
- health care buildings
- sports halls

Requirements for each building use was set by cost optimal calculation and set through primary energy requirement including heating, cooling, ventilation, DHW and lighting energy demand.

3.2.2.1 nZEB definition

Definition of nearly energy zero building was included in Technical regulation on rational energy use and thermal protection in buildings (OG 97/2014 and 130/14) in August 2014 for single family buildings, and for other building uses in September 2014.

Nearly zero energy requirement is defined by primary energy demand and 30% of RES coverage for energy demand of the building by RES produced on site or nearby.

Primary energy for new and nZEB is set to the values given in Table HR-2.

Table HR-2: Primary energy requirements for new and NZEB buildings

requirements for new and NZEB buildings				
	new		NZEB	
	continental	coastal	continental	coastal
	E_{prim} kWh/m ² a	E_{prim} kWh/m ² a	E_{prim} kWh/m ² a	E_{prim} kWh/m ² a
single family houses	100	60	40	30
multiapartment buildings	120	90	80	50
office	65	65	30	25
buildings for education	60	55	55	50
hotels and restaurants	120	70	80	65
retail	450	280	170	140
health care	280	280	200	190
sports halls	400	170	190	100
other non-residential	150	80	-	-

Detailed RES requirements are set separately for all new buildings, not specifically nZEB – to allow for more options regarding the micro location, and new building fulfils criteria for RES if:

- 20% of energy need is covered by RES
- or share of RES in delivered energy for heating and cooling and DHW is at least:
 - 25% from solar sources
 - 30% from gaseous biomass
 - 50% from solid biomass
 - 70% from geothermal energy
 - 50% from surroundings
 - 50% from cogeneration or
 - 50% is covered through district heating complying with previous requirements

Building components are limited to values presented in Table HR-3.

Table HR-3: The requirements for the heat transfer coefficient in cost optimal level

	continental $\theta_{int} \geq 18^{\circ}\text{C}$	coastal $\theta_{int} \geq 18^{\circ}\text{C}$	continental $12 \leq \theta_{int} \leq 18^{\circ}\text{C}$	coastal $12 \leq \theta_{int} \leq 18^{\circ}\text{C}$
Building envelope structure	U [W/m ² K]	U [W/m ² K]	U [W/m ² K]	U [W/m ² K]
External wall	0,30	0,45	0,50	0,60
Windows, glazed external envelope	1,40	1,80	2,50	2,80
Glazing	1,10	1,10	1,40	1,40
Roofs	0,25	0,30	0,40	0,50

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ceilings above unheated and outside air	0,25	0,30	0,40	0,50
walls and ceilings towards unheated spaces	0,40	0,60	0,90	1,20
floors and walls towards ground	0,30	0,50	0,65	0,80
external doors	2,00	2,40	2,90	2,90
roller shutters boxes	0,60	0,80	0,80	0,80
ceilings and walls between different users	0,60	0,80	1,20	1,20

3.2.2.2 Cost-optimal level requirement

Cost optimal methodology was used in definition of requirements for new buildings and nZEBs. Further requirement on use of this methodology in design and definition of energy performance for buildings is not stipulated.

3.2.3 Overview of existing national plan

Targets for increase the number of nZEBs by 2020 have been set in Plan for increase of nZEB by 2020 set by MCPP in October 2014, and include estimate of building stock, savings and definition of nZEB buildings. The requirement concerning nearly zero energy building will be introduced in two phases according to 2010/31/EU:

- New public buildings, after 31st December 2018.
- All new buildings, after 31st December 2020.

3.2.4 Identification of aspects on refurbishment of public buildings into nZEB level

In Croatia the definition and the requirement concerning the nZEB is clear, and it is introduced in the relevant legislation, as a consequence there is not legislative barrier to increase the number of nearly zero energy buildings.

In general, main problem with nZEB refurbishments of public building stock (and building stock in general) is due to late definition of nZEB buildings in Croatia: nZEB definition of single family home was available in august 2013, and definitions of nZEB for multi apartment and non-residential buildings are available from October 2014. In time since adoption of this definitions none of the projects could have been developed, although several project, some very significant, of very low energy buildings (residential and public) have been executed in previous years. Visibility of such projects is very low, as construction sector is struggling to survive decline of total activity towards 1996 level which was lowest ever in history, and only in last two to three years energy refurbishment is gaining momentum and becoming significant driver of construction activities.

Climatic conditions

Croatia has continental climate in majority of territory covering approximately 75% of building stock, and Mediterranean climate for the rest of the stock setting specific requirements for energy efficiency measures for each climate (from heating dominated continent to cooling dominated coastal areas).

Table HR-4: Energy prices for residential and non-residential users

	Part of total consumption (residential/non-residential)	Price excl. VAT (HRK/kWh)	Price Incl. VAT (HRK/kWh)
Average fuel for residential buildings	100%/0%	0,400	0,500
Average fuel for nonresidential	0%/100%	0,537	0,671
Natural gas	36%/34%	0,336	0,420
Heating oil	8%/15%	0,568	0,710
District heating	10%/10%	0,340	0,425
LPG	4%/3%	0,512	0,640
Electricity	14%/38%	0,784	0,980
Wood pellets	28%/0%	0,267	0,333

Heating sources: According to the statistic data presented in D2.1, the main energy sources in public buildings are natural gas, district heating and oil.

Primary energy factors:

Table HR-5: Primary energy factors

energy source	primary energy factor				tCO ₂ /TJ (kgCO ₂ /GJ)
	total	renewable portion	non-renewable portion	import	
stone coal	1,038	0,0000	1,038	0,0000	95,49
brown coal	1,054	0,0000	1,054	0,0000	98,09
lignite	1,082	0,0001	1,081	0,0001	105,13
firewood	1,111	1,0001	0,111	0,0001	8,08
wood briquettes	1,180	1,0334	0,117	0,0296	9,10
wood pellets	1,191	1,0364	0,123	0,0322	9,56
wood chips	1,211	1,0303	0,154	0,0268	11,76

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energy source		primary energy factor				tCO ₂ /TJ (kgCO ₂ /GJ)
		total	renewable portion	non- renewable portion	import	
wood coal		1,286	1,1866	0,100	0,0002	7,27
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
LPG		1,162	0,001	1,160	0,001	72,47
petroleum		1,033	0,000	1,033	0,000	73,54
extra light oil		1,140	0,001	1,138	0,001	83,21
light 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		1,523	0,022	1,494	0,008	100,69

3.3 FORMER YUGOSLAV REPUBLIC OF MACEDONIA

3.3.1 State-of-the-art of the EPBD implementation

Energy Law

The Energy Law regulates the goals of the national energy policy and the manner of its implementation, the energy activities and the regulation of the energy activities, construction of energy buildings, the energy market, the natural gas market, oil market and heating energy market, the requirements for energy efficiency and promotion of Renewable Energy utilization and the other issues with relevance for the energy sector. [8]

The Energy Law sets the foundation for the implementation of the EPBD on national level.

The Article 135 Paragraph 5 sets the requirements and needs for the Rulebook for Energy Audits.

Article 136 Paragraph 8 from the Energy Law sets the Energy Performance of Buildings.

Rulebook for Energy Performance of Buildings [9]

Based on Article 136 (8) of the Energy Law, this regulation is harmonized with Directive 2010/31/EU of the European Parliament and Council from 19 May 2010 on the energy performance of buildings. Article 2 of the Regulation explains the need for the existence of such a by-law:

The purpose of this rulebook is the policy of achieving energy efficiency in buildings through measures and activities for efficient use of energy, providing services for energy efficiency and meeting the obligations of the public sector in terms of energy efficiency and energy savings, ensuring realization of the objectives of sustainable energy development, reducing negative impacts on the environment when performing energy activities and energy consumption, improve the reliability of energy supplies, and fulfilment of international obligations of the Republic of Macedonia.

It provides:

- Methodology for determination of the energy performance of buildings
- Minimal requirements for energy efficiency of new buildings, or major reconstruction of old buildings
- Manner of control for harmonization of the buildings, appliances and systems with the articles of the Rulebook
- Conditions for designing and construction of new buildings and major reconstruction of old buildings with accent of energy efficiency
- Manner of control for heating systems with effective power more than 20 kW
- Manner of control for single air-conditioning systems with effective power more than 12 kW
- Types of buildings in public ownership for which implementation of solar thermal collectors is mandatory (in new buildings and major reconstruction of old buildings)
- Labelling of buildings for energy efficiency
- Form, content and harmonization statement for the basic design for construction or reconstruction with the minimal requirements for energy efficiency
- Form, content and period of validity for the certificate for energy performance of buildings

Rulebook for Energy Audits

The Rulebook for Energy Audits closely defines the way of implementation of Energy Audits for buildings and sets methodology for the process. The Annexes of the Rulebook defines the templates the mandatory reports from the Energy Audits.

The Rulebook requirements are [10]:

- Implementation of Energy Audits
- Determination of energy needs
- Form and content of the mandatory reports
- Manner of issuing certificates for energy auditors, etc.

Other relevant bylaws are:

- Rulebook on issuing guarantees of origin for electricity produced from renewable energy sources and the content, form and manner of keeping the register of issued guarantees of origin for electricity produced from renewable energy sources
- Rulebook on highly efficient cogeneration plants
- Rules for labelling of energy consumption and other resources on products that benefit energy

3.3.2 EPBD implementation until 2020

This is one of the key elements for introduction of nZEB in common practice. Unfortunately, no plans for the future implementation of EPBD are foreseen by now.

Macedonia is signatory of the Energy Community. Pursuant to the Treaty, the Energy Community extends the EU internal energy policy to South East Europe and Black Sea region on the ground of legally binding framework. The tasks and obligations under the Treaty break down to three distinct tiers. Also, the scope of Parties involved differs from Title to Title [11]:

- Extension of the Acquis Communautaire
- Mechanism for operation of Network Energy Markets
- Creation of a Single Energy Market

As a signatory country, Macedonia has to harmonize its legislation to the European one. According to that, it is expected that the country will analyse and update the existing policy according to the latest European practises.

There are indications for review of the EPB rulebook.

3.3.2.1 nZEB definition

As it is written above, in the current status there is no nZEB definition in the legislation.

3.3.2.2 Cost-optimal level requirement

In the current status there is no cost-optimal level requirement in the legislation.

3.3.3 Overview of existing national plan

Strategy for Energy Development in the Republic of Macedonia until 2030

This strategic document lays out two scenarios according which energy consumption will be developed. In addition, energy facilities to provide safe energy supply have been projected as well. Due to the unfavourable structure of the available energy resources – limited coal reserves, limited hydro power potential capacity, energy efficiency is being acknowledged as significant energy resource. While energy efficiency does not solve the problem of energy supply, it substantially decreases the pressure for construction of new generation facilities and fuel imports. [12] [13]

Strategy for Utilization of Renewable Energy Sources in Republic of Macedonia until 2020

The Strategy focuses on opportunities for utilization of RES to a higher degree in Macedonia. The aim is to enable the RES energy production of up to 21% till 2020 as portion of the total final energy consumption. Three scenarios were considered and the estimated total investments to achieve this target are about EUR1.5 billion for construction of new facilities for RES utilization and increased utilization of energy efficiency measures. The required legislative and fiscal framework is anticipated in the Strategy as well. [14]

Strategy for Improvement of Energy Efficiency in Republic of Macedonia until 2020

The Strategy describes in detail the measures and instruments necessary to realize the energy policy of Macedonia, and specifies the required investments and commitments to be made by the Government. The EE Strategy further estimates the energy saving potential, which can be realized under current economic circumstances. The projections and simulations of the possible measures and instruments are in accordance with the realization requirements of the energy policy principles laid out in Strategy for energy sector development. [15]

The types of measures that are provided in this strategic document and are related to nZEB are:

- Update and setting new standards for nZEB and passive buildings
- Easing the financing from banks for ESCO
- Campaigns

National Strategy for Sustainable Development of the Republic of Macedonia

Part I/II (2009 - 2030)

The goal of the strategy is to secure sustainable development of the country in six areas including: National policy and regulatory framework; Environment; Energy; Rural Development; Social Issues; SMEs and infrastructure: transport and industry. The Strategy anticipates measures for electrical appliances labelling and from the realization point of view it stipulates soft loans for energy efficiency measures implementation. [16]

3.3.4 Identification of aspects on refurbishment of public buildings into nZEB level

The barriers for implementation of the EPB Rulebook are:

Regular updates and harmonization of the policies

The secondary legislative needs urgent improvement for the policy to be successfully implemented in practise. In the case of the Energy Performance of Buildings Rulebook, there are known obstacles for its implementation and they will be addressed in near future.

Lack of Energy Efficiency Fund

The Energy Efficiency Fund is essential for the implementation of the EPBD. In national documents, this instrument is recognized as essential and it is implemented as an objective in the national strategies.

The Ministry of Economy and World Bank are working together in the process of establishing the first Energy Efficiency Fund that will help and speed up the refurbishments of the public buildings and certification of ones.

Capacity

Relevant institutions have problems with capacity, in form of human resources and technical knowledge. This issue causes slower and overall inefficient implementation of the policies.

Public awareness

Public awareness is key element for major implementation of the EPBD, especially, when it comes to residential, commercial and industry sectors.

In order to overcome this particular issue, public buildings should become a showcase of best practises. Also, campaigns and information sessions (technical) will improve the situation.

Drivers:

Certificate for energy performance of buildings

Certification process for the buildings started in 2014, and the first buildings already gained their energy performance certificates.

The certificates are source of information about the compliance of the buildings characteristics with the requirements set in the EPBD. Also, they present the means to improve the buildings regarding energy efficiency.

The certificates are visible in the entrance of the buildings, which is great way to improve the awareness of the general public.

Renovation of public buildings

Several public buildings were completely renovated few years ago and they represent important example of implementation of energy efficiency and renewable energy measures.

Large number of those buildings was schools and kindergartens.

Policy measures on local level: The municipality of Karpos was the first municipality that introduced Rulebook for energy efficiency on local level. The rulebook contained the minimum requirements for new buildings in the municipality in order for the investor to gain permission for construction. If the investor decides to implement Energy Efficiency measures according to the Rulebook of Karpos, he will gain 20% refund from the communal taxes.

Climatic conditions

Even though Macedonia has small area (25,713 km²), the country still has diverse climate, with eight climatic regions. There are several characteristic climate regions with sub-Mediterranean, continental and mountain climate.

Three climatic zones are defined in the Rulebook for energy performance of buildings which are distinguished by the value of the degree-days. The data for the three climatic zones are [17]:

Table MC-1: Climatic data

Climatic Zone:	1	2	3
January average outside temperature [°C]:	-1	-1.1	-2.3
August average outside temperature [°C]:	25.5	24.6	23
Average global horizontal radiation [kWh/m² yr]:	1478	1482	1383
Annual heating degree days [°Cd/yr]:	1900-2400	2401-2650	<2650

Energy prices

The price of electricity for household is 0.07 EUR/kWh without VAT. The commercial consumers have different prices. Low voltage consumers have two groups of prices. The subgroup I has electricity price of 0.06 EUR/kWh for the high price and 0.03 EUR/kWh low price. The subgroup two has electricity price of 0.14 EUR per kWh. For public lighting, the electricity price is 0.09 EUR/kWh.

The price of natural gas is 0.42 EUR/nm³.

The light heating oil price is 0.78 EUR/l.

Heating sources

According to the statistical data presented in D2.1, the main energy sources in public buildings are light heating oil, electricity and fire wood. In Skopje, the situation is different, because most of the buildings are using district heating, while smaller part are on light heating oil, heavy oil and natural gas.

Primary energy factors

Table MC-2: Primary energy factors

Energy source	Primary energy factor
Biomass	1.5
Coal	1.7
Light heating oil	1.2
Natural gas	1
Geothermal	1.1
Electrical energy	2.5
Heating energy (district heating)	1.2

Renewable Energy Ratio (RER) requirement

There are no requirements for RER yet.

Grants

There are not national grant especially for increasing the number of nZEB, but there are several favourable loans for investment in the energy efficiency.

3.4 GREECE

3.4.1 State-of-the-art of the EPBD implementation

The implementation of EPBD is in effect since 2010 under the Law 3661/19-05-2008 “Measures to reduce buildings energy consumption and other provisions” [18]. A number of executing orders were necessary for the implementation of the EPBD were issued as a Ministerial Decision for the “Regulation of Energy Performance of Buildings” (KENAK) in April 2010 (Ministerial Decision D6/B/5825 National Gazette 407/09-04-2010) [19]. The Presidential decree necessary for the definition of the qualifications and training of energy auditors was published in the National Gazette in October 2010 (Presidential decree 100/NG177/06-10-2010) [20].

The full implementation of the EPBD implementation, i.e. for all types of buildings and building use, new or existing undergoing major renovation, started in January 2011.

The energy performance calculation procedure is based on the monthly methodology of EN13790 and a set of national parameters defined where necessary. The classification of buildings in nine energy classes is done according to the scale shown in the table below. Class B corresponds to the minimum acceptable class of new buildings and of those undergoing major renovation. “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 GR-1 for all the structural elements.

Table GR-1: Definition of energy classes

Class	Limits
A+	$E.A. \leq 0,33K.A.$
A	$0,33 K.A. < E.A. \leq 0,50 K.A.$
B+	$0,50 K.A. < E.A. \leq 0,75 K.A.$
B	$0,75 K.A. < E.A. \leq 1,00 K.A.$
Γ	$1,00 K.A. < E.A. \leq 1,41 K.A.$
Δ	$1,41 K.A. < E.A. \leq 1,82 K.A.$
E	$1,82 K.A. < E.A. \leq 2,27 K.A.$
Z	$2,27 K.A. < E.A. \leq 2,73 K.A.$
H	$2,73K.A. < E.A.$

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))

Law 3661/19-05-2008 has been modified according to the provisions of the EPBD recast and the new Law is 4122/19-02-2013 “Energy Efficiency of Buildings - Compliance with Directive 2010/31/EC of the European Parliament and of the Council and other provisions” [21]. This Law foresees the revision of the minimum requirements through a cost optimum calculation methodology. This cost optimum study is to be launched by the Ministry for the Environment, Energy and Climate Change within the next few months.

It is noted that the Building Energy Regulation - i.e. the methodology for the calculation of the building energy performance – remains valid until a new Ministerial Decree be issued where the updated methodology will be defined.

3.4.2 EPBD implementation until 2020

3.4.2.1 nZEB definition

The nZEB definition has already been introduced to the national legislation, by amendment, in June 2010 and it coincides with the precise EPBD definition. This definition is also included in Law 4122/2013 (recast for the energy efficiency of buildings). The law specifies that, after 1/1/2015, every new building of the public sector should be nZEB. This obligation is also applied to all new buildings constructed after 1/1/2020. However, the national application of the nZEB definition has not yet been made.

3.4.2.2 Cost-optimal level requirement

The new Law 4122/2013 introduces the cost-optimal concept and the calculation methodology, according to the EU Regulation 244/2012 supplementing the Directive 2010/31. However, the national study for the cost optimal procedure for setting EP requirements is still in the implementation phase; after its completion a number of executing orders will be issued for the implementation of the new procedure and requirements.

3.4.3 Overview of existing national plan

The national energy plan is based on the second National Energy Efficiency Action Plan (NEEAP). It was developed in September 2011 and describes and evaluates all the measures that have been, are being or are planned to be implemented to energy end-use sectors in Greece.

Currently, the Greek market lags behind other EU countries on energy efficiency. In particular, energy efficiency, energy saving and rational use of energy still have great potential to grow and to be established in the energy behaviour of final consumers. The poorly developed market for energy services and access for all consumers and market players to integrated and high-quality energy services provides a high potential for future growth in energy efficiency and will be a key priority for Greece's energy policy.

The residential sector is a sector with very high savings potential, representing 24% of total final energy consumption in Greece in 2009. For example, it is noted that since the majority of buildings was constructed before 1980, they do not meet the requirements of the Regulation on thermal insulation and therefore their energy saving potential is very high. Therefore, by making effective and rational use of energy-saving technologies, both technically and economically, it is possible to improve the energy efficiency of these buildings leading to significant environmental and social benefits.

Institutional interventions concerning the energy certification of buildings are expected to contribute significantly to achieving this, and the goal that new buildings should cover their entire primary energy consumption with energy supply systems based on renewable energy sources is expected to radically restructure the energy performance of buildings.

Meanwhile, emphasis should be placed on the provision of incentives for the implementing and / or disincentives for not implementing measures to improve energy efficiency identified when issuing energy certificates.

However, as recognized at EU level, the energy upgrade of existing buildings is the biggest challenge for meeting the energy savings targets in the building sector, as the energy behaviour of the existing building stock will in effect determine the future energy efficiency index in the building sector.

In the framework of the National Energy Efficiency Action Plan (NEEAP), a National Energy Data System is developed, from the Ministry of Environment, Energy and Climate Change, in order to develop a computer tool regarding developments of the national energy strategy as well as establishing a service providing information to the general public. The main sections include:

- Information on the competent organizations, legislation and standards.
- A database with statistics regarding production, processing and consumption of energy. The presentation of such statistics facilitates their use for the compilation of analysis and reports on the energy system.

The development of market mechanisms, such as Energy Service Companies (ESCOs) to promote energy efficient services will significantly help in this direction, especially in tertiary sector buildings, where such actions should be supported both financially and regulatory.

Whatever institutional and financial incentives are ultimately developed, they will not be enough on their own to help achieve the energy saving target, because especially in the building sector, the factor of human behaviour plays a key role in energy consumption. In this context, it is necessary to ensure the continued adoption and implementation of measures related to informing and educating consumers so that they choose highly energy-efficient buildings / products and changes their behaviour regarding energy use and consumption.

3.4.4 Identification of aspects on refurbishment of public buildings into nZEB level

The lack of the national application of the NZEB definition is a legislative barrier since it is not possible to identify NZEB buildings and thus promote the refurbishment of buildings towards nZEB level.

Climatic conditions

The climate in Greece is typical of the Mediterranean climate, which is mild and rainy winters, relatively warm and dry summers with, generally, long sunshine duration almost all the year. A great variety of climate subtypes, always in the Mediterranean climate frame, are encountered in several regions of Greece. This is due to the influence of topography (great mountain chains along the central part and other mountainous bodies) on the air coming from the moisture sources of the central Mediterranean Sea.

The coldest months are January and February, with, on average, mean minimum temperature ranging between 5 -10°C near the coasts and 0 - 5 over mainland areas, with lower values (generally below freezing) over the northern part of the country.

Greece is divided into four climate zones based on heating degree days, as shown in figure GR-1.

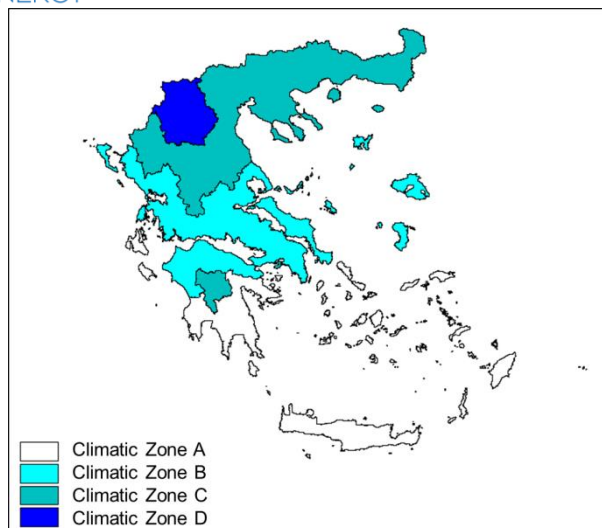


Figure GR-1. Climatic zones of Greece

The following table presents climatic data for representative cities of each climatic zone.

Climatic Zone A: Naxos Island

Climatic Zone B: Athens

Climatic Zone C: Ioannina

Climatic Zone D: Kastoria

Table GR-2: Climatic zones

	Climatic Zone			
	A	B	C	D
January average outside temperature [°C]:	12.1	10.3	4.7	2.2
August average outside temperature [°C]:	24.8	28.0	24.5	23.2
Average global horizontal radiation [kWh/m ² *yr]:	1680	1637	1476	1492
Annual heating degree days [°Cd/yr]:	735	947	1937	2420

Energy prices for commercial user (not household) without VAT in 2014: natural gas 0.0614 EUR/kWh; electricity 0.08259 EUR/kWh or 0.10153 EUR/kWh depending on the installed power.

Heating sources: there is no available data for public buildings.

Primary energy factors:

Table GR-3: Primary energy factors

Energy source	Primary energy factor
Electricity	2.90

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Natural gas	1.05
Liquid gas	1.05
Oil	1.10
Biomass	1.00
District heating from electricity	0.70
District heating from RES	0.50

Renewable Energy Ratio (RER) requirement: renewables are being promoted by the Greek Law 3851/04-06-2010 “Accelerating the development of Renewable Energy Sources to address climate change and other provisions under the jurisdiction of the Ministry of Environment, Energy and Climate Change”, which sets that buildings for which an application for issue of a building permit is submitted to the relevant Planning Service after 1.1.2011 are required to cover part of their needs for domestic hot water with solar thermal systems. The minimum percentage of solar share on an annual basis is set to 60%.

Grants: There are no specific calls for public building renovation towards nZEB.

Gross domestic product (GDP) per capita: 21.617 USD/capita

3.5 HUNGARY

3.5.1 State-of-the-art of the EPBD implementation

In Hungary the transposition of the EPBD into national legislation has been made since 2006, starting with the Decree 7/2006. (V.24.) TNM (Hungarian Regulation for Determining the Energy Performance of Buildings). The recast of this Decree was performed in 2012 and 2014, as a consequence by now it is completely harmonized with Directive 2010/31/EU. The last modification of this national Decree was carried out to fulfil the following regulations of the Directive: Article 2 (2) (3) (4) (5) (7) (9) (10) (12) (13) (19), Article 3, Article 4, Article 6, Article 8 Article 9 (1) and Annex I.

Decree 7/2006. (V.24.) TNM describes the terms and definitions in relation with energy performance of buildings, and describes in detail the methodology for building energy calculations and sets the minimum requirements for new buildings and major renovations. The Hungarian requirement system has three levels [22]:

1. Heat transfer coefficient (U value) of building envelope structures: requirement is set in W/m^2K for every type of building envelope structure.
2. Specific heat loss coefficient (q) for the building: requirement is set in W/m^3K , in consideration of Area/Volume (A/V) ratio of the building, where “A” is the sum of the surfaces around the heated air volume, and “V” is the heated air volume.
3. Total primary energy consumption (Ep): reference value of the annual primary energy consumption of the building is set in kWh/m^2a , in consideration of A/V ratio and function of the building. Calculation formula exists for residential, educational and office buildings, in case of other buildings, the reference value of total primary energy must be determined individually taking into consideration several criteria for building and HVAC system given in 7/2006. TNM Decree.

New buildings and existing buildings with undergoing major renovation must comply with all three requirements. The regulation shall be applied to all area of Hungary, due to there are not any additional local regulation concerning building energy, and there is only one climate zone within Hungary.

Member States have to define the classification of the energy consumption of buildings, i.e. the energy performance level. In Hungary, the quantitative values for energy performance levels of buildings are set in Government Decree 176/2008. (VI. 30.) in the given structure that can be seen in Table HU-1.[23]

Table HU-1: Building energy performance

Building energy performance level	Building energy performance expressed in percentage of the reference value	Building energy performance level in text form
A+	<55%	Highly energy efficient
A	56-75%	Energy efficient
B	76-95%	Better than requirements
C	96-100%	Meets the requirements
D	101-120%	Nearly meets requirements
E	121-150%	Better than average
F	151-190%	Average

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G	191-250%	Nearly average
H	251-340%	Poor
I	341%<	Bad

The registering of building energy certificates is mandatory according to Government Decree 313/2012. (XI. 8.). There is a website, where the registration number is given after the professional uploads the energy certification. Government Decree 176/2008. (VI. 30.) specifies the regular review of energy certifications. Therefore 2.5% of registered energy certifications must be reviewed by the Hungarian Engineering Chamber.

3.5.2 EPBD implementation until 2020

On 19 May 2010, a recast of the Energy Performance of Buildings Directive was adopted by the European Parliament and the Council of the European Union in order to strengthen the energy performance requirements and to clarify and streamline some of the provisions from the 2002 Directive it replaces.

According to the EPBD recast new terms and requirements were added into the Hungarian 7/2006. Decree. The main changes related to nearly zero energy buildings, and requirements accordingly the cost optimal level.

3.5.2.1 nZEB definition

In Hungary, the definition of nearly energy zero building was added into Decree 7/2006. (V.24.) TNM, in March 2014:

The building has nearly zero energy demand, if it is implemented accordingly the cost-optimal level, or it is more energy efficient, and at least 25% of annual primary energy need is covered by energy from renewable source, including renewable energy produced on-site or nearby [22].

Regarding the cost-optimal level, which has to be satisfied by each nearly zero energy building, the Decree 7/2006. (V.24.) TNM sets requirement for heat transfer coefficients, specific heatloss coefficients, and primary energy consumption (Annex V. of Decree 7/2006. TNM). These requirements can be seen in Table HU-2, Table HU-3 and Table HU-4.

Table HU-2: The requirements for the heat transfer coefficient in cost optimal level

Building envelope structure	Requirements for heat transfer coefficient, U [W/m ² K]
External wall	0.24
Flat roof	0.17
Envelope structures around heated attic	0.17
Slab under attic	0.17
Bottom slab above arcade	0.17
Bottom slab above unheated spaces	0.26
Glazing	1.00

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Special glazing*	1.20
Glazed doors and windows on facade, wood or PVC frame, >0.5 m ²	1.15
Glazed doors and windows on facade, metal frame	1.40
Glass wall on facade, curtain wall	1.40
Glass roof	1.45
Skylight roof, fume extractor or cupola	1.70
Roof window	1.25
Industrial, and fire-protective doors and gates (around heated space)	2.00
Door on facade, or between heated and unheated area	1.45
Gate on facade, or between heated and unheated area	1.80
Wall between heated and unheated spaces	0.26
Wall between heated buildings	1.50
Plinth wall, the wall contact with the soil to a depth of 1 m ground level (The part below the ground level is related only for new buildings)	0.30
Floor, lying on the ground (new buildings)	0.30
Traditional energy collection panels (e.g. mass wall, Trombe wall)	1.00

*Glazing with high acoustic or security requirement.

Table HU-3: The requirements for the specific heat loss coefficients

A/V ratio of the building	The maximum permitted value of the specific heat loss coefficients, [W/m ³ K]
$A/V \leq 0,3$	$q_m = 0.16$
$0,3 < A/V < 1,3$	$q_m = 0.079 + 0.27(A/V)$
$A/V \geq 1,3$	$q_m = 0.43$

Table HU-4: The requirements for total primary energy in cost optimal level

A/V ratio of the building	Total primary energy, [kWh/m ² a]		
	Residential buildings	Office buildings	Educational buildings
$A/V \leq 0,3$	$E_P = 110$	$E_P = 132$	$E_P = 90$
$0,3 < A/V < 1,3$	$E_P = 30(A/V) + 101$	$E_P = 28(A/V) + 123.6$	$E_P = 60(A/V) + 72$
$A/V \geq 1,3$	$E_P = 140$	$E_P = 160$	$E_P = 150$

3.5.2.2 Cost-optimal level requirement

As it is presented in the previous chapter, the Decree 7/2006. TNM contains the requirements that fulfil the cost-optimal level according to the (2) article of 2010/31/EU. Every nearly zero energy buildings at least have to meet these requirements (Table HU-2, Table HU-3, Table HU-4). Furthermore, there are other requirements related to the cost-optimal level:

From 1st January 2015, every energy saving project, which is implemented with the usage of national or EU funding grants, shall meet these requirements:

- no major renovation of existing building: the heat transfer coefficients of building envelopes which forms part of the renovation shall meet the cost-optimal requirements. (Annex V, part I, Decree 7/2006. TNM)
- new building, and major renovation of existing building: the heat transfer coefficients, the specific heatloss coefficient of the building, and the total primary energy need shall meet the requirements. (Annex V, part I, part II, part III. Decree 7/2006. TNM)

From 1st January 2018, the cost-optimal requirement will be mandatory not only for national or EU funded projects, but in all other cases as well.

3.5.3 Overview of existing national plan

National Building Energy Strategy

The National Building Energy Strategy of Hungary has been made from 2012 to 2014. The public consultation of the Building Energy Strategy began 11th September 2014, and finished one month later, therefore the processing of comments and proposals is being made when this report was written.

The Hungarian Building Energy Strategy analyses the current status of residential and public buildings, and it shows the main building types and its characteristics, and also its energy performance. Furthermore the report analyses two refurbishment scenarios for residential and public building stock:

1. Refurbishment on cost-optimal level.
2. Refurbishment on nearly-zero energy level.

The document presents the energy saving and the necessary investment cost for both refurbishment scenarios. Based on these results, the aims of the refurbishment scenarios for residential and public building stock were identified.

There are a number of measures, which help to realize the aims of Building Energy Strategy, and some of the measures have been already in progress, but the majority are new initiatives. The proposed measures for the refurbishment of current building stock [24]:

1. Compilation of National Building Energy Action Plan (until 30/06/2015).
2. Development of new supporting and financing scheme for energy efficiency projects of residential and public buildings (until 31/12/2014).
3. Promote the usage of energy supply based on renewable energy (solar panel, biomass, heat pumps) for heating and cooling of buildings (until 30/06/2015).
4. Renewable energy based electricity supply of buildings with photovoltaic panels (until 30/06/2015).

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There is a measure especially for buildings of state and local governments, which is the development of an energy efficiency requirement system. The deadline to elaborate this requirement is 30/06/2015.

All of the measures will be presented in detail in the Building Energy Action Plan, which will be completed as part of the III. National Energy Efficiency Action Plan. The deadline to complete the Building Energy Action Plan is 30/06/2015.

The Hungarian Building Energy Strategy presents a national plan for increasing the number of nearly zero energy buildings, which is the most relevant information for Re-Public_ZEB project. According to this national plan, the requirements for nearly zero energy buildings can be introduced gradually. Therefore the first step is that the requirement of cost-optimal level will be mandatory in two phases: from 2015 for national and EU funded projects, and from 2018 for all energy saving projects, as it is presented in 3.5.2.2 chapter. Nonetheless, the cost-optimal requirement is also an economic interest at consumer level, since it ensures the lowest expenditures for the owner concerning 30 years time period stock [24]. The introduction of cost-optimal level requirement will help the preparation for nearly zero energy requirement, which is even stricter, because on the one hand the building shall meet the cost-optimal level requirement, or shall be more energy efficient, but on the other hand it requires at least 25% of annual primary energy need covered by energy from renewable source, including renewable energy produced on-site or nearby.

The requirement concerning nearly zero energy building will be introduced in two phases according to 2010/31/EU:

1. New public buildings, after 31st December 2018.
2. All new buildings, after 31st December 2020.

Measures, which encourage the construction of nZEBs:

Policy measures

The requirements of nearly zero energy buildings, and the deadline for introducing the requirements will be taken into account for the elaboration of III. National Energy Efficiency Action Plan, especially related to the Building Energy Subprogram. The requirements of nearly zero energy buildings will also be taken into account during the next review of Renewable Energy Action Plan of Hungary.

Financial support

Complete transition onto nZEB level can be realized only gradually. The fulfilment of nearly zero energy requirements needs additional costs from building owners. Thus, on the one hand the housing subsidy system must provide financial background for private people, on the other hand the possibility for gradual transition and also financial background need to be ensured for construction of new public buildings. The usage of the local renewable energy sources in the building energetic systems should be preferred in case of construction of new public buildings. Construction of heat supply and building cooling systems with solar collector and heat pumps, power supply with photovoltaic panels, installation of low power cogeneration plants for combined heat and power supply of the buildings, and with considering the local capability, possibilities of biomass stations should be preferred.

Demonstration, information, awareness

The faster dissemination of the construction of new buildings according to the nZEB requirements should be promoted with establishing such demonstrational projects, which enable the builders to get to know the benefits fulfilling the nZEB requirements, the practical requirements and technical solutions of the construction, included the utilization of technologies of local renewable energy sources. The demonstrational projects should present beside the technical solutions as well the financial possibilities of the constructions.

Knowledge sharing, propagative and informing systems should be developed about the construction and operation methods according to the nZEB.

Renewable Energy Action Plan of Hungary

The Renewable Energy Action Plan (REAP) has been made to define the principles, action directions and measures, which can provide the compliance with prescribed share of energy from renewable sources. The Action Plan was framed with the content and structure of the 2009/28/EK Directive and 2009/548/EK commission decision. The Directive prescribes for Hungary 13% share of energy from renewable sources in gross final consumption on energy in 2020. Over this target, Hungary undertook to reach 14.65% share of energy from renewable sources by 2020.

The proposed measures will colligate the energy efficiency development of residential, public and other buildings, the usage of RES and the renovations and new constructions. Although, the institution of regulations for minimum share of energy from renewable sources and maximum emission of CO₂ will be introduced only gradually. In the first phase the regulations will be mandatory for public buildings, in the second phase for commercial and industrial buildings with bigger footing area, and in the next phase for the bigger new apartment buildings.

The public buildings owned by the state are one of the highest energy consumers in the building sector. Hence it is a seeded priority to reduce the energy consumption in the highest degree which is technically and financially realistic. This can result a significant cost reduction for the government.

The aim is to motivate a complex refurbishment on the public buildings, which can reach a 60% energy saving with thermal insulation of the walls, changing the windows, modernizing the HVAC system, producing heat energy with RES and setting up electricity generation units. The tendering system treats the public buildings at high priority level, as the energetic modernizations can obtain even 100% financial support ratio.

3.5.4 Identification of aspects on refurbishment of public buildings into nZEB level

In Hungary the definition and the requirement concerning the nZEB is quite clear, and it is introduced in the relevant legislation, as a consequence there is not legislative barrier to increase the number of nearly zero energy buildings.

In Hungary there is only one climate zone, which may facilitate the developing the appropriate refurbishment solutions towards nZEB.

The draft of National Building Energy Strategy presents the potential energy saving and the estimated investment cost for the main types of residential and public buildings concerning the refurbishment towards nZEB level. This result will be taken into account for making the detailed measures in the III. National Energy Action Plant, however it will be completed only until 30/06/2015. As of today, the financial support how to increase the numbers of nZEBs, and how to promote better the renewable energies has not been presented by the relevant Ministry, therefore at the moment the lack of appropriate financial support is a barrier.

The term “nearly zero energy building” is very new, as it is introduced in the relevant national legislation just a few months ago. The nZEB requirement will be mandatory for new public buildings after 31st December 2018, therefore as of today there is not any best practice which followed particularly this nZEB definition. However, many public buildings refurbished with EU funding grant (Environment and Energy Operative Program), which proves the value of energy efficiency, but in a limited level compared to the nZEB requirement. It is anticipated

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that best practices would accelerate the refurbishment of public buildings towards nZEB level.

The energy prices are relatively low in Hungary, furthermore the Government started the “Overhead reduction” campaign in 2013. The campaign reduces significantly the energy prices in the residential sector, as the energy prices are set centrally by the Government. As a result the price of natural gas reduced with 25.19%, the price of district heating reduced with 22.63%, and the price of electricity reduced with 24.55% [25]. By now, the “Overhead reduction” campaign is related only to the residential sector, but it may be extended to the public sector as well. The lower energy prices hinder the implementing of energy efficiency projects, since the lower energy prices increase the payback time of an investment which focuses on reducing energy consumption and cost.

Climate

Hungary has continental climate, the temperature is the lowest in January (average temperature is 0..-4°C), and the highest in July (average temperature is 18..22°C). The design outdoor temperatures for sizing the heating and cooling systems: -11, -13 or -15°C in winter (depends on the location within the country), and +32°C in summer.

The number of hours of sunshine is between 1750-2200 per year, the global horizontal radiation is 1150-1332 kWh/m²a.

In Hungary, the average geothermal gradient is 5°C / 100 m, which is about one and a half times higher than worldwide average. The measured heat flow values are also high: 90.4 mW / m², while the European continent has 60 mW / m² on average [26]. The high geothermal gradient forms a good possibility for installing geothermal heat pumps.

Energy prices for industrial user (not household) without VAT in 2013: natural gas 0.041 EUR/kWh; electricity 0.096 EUR/kWh.

Heating sources: According to the statistic data presented in D2.1, the main energy sources in public buildings are natural gas and district heating. Natural gas is the heating source in approximately 60% of the public buildings, while district heating in 10% of the buildings.

Primary energy factors:

Table HU-5: Primary energy factors

Energy source	Primary energy factor
Electricity	2.50
Electricity (non peak)	1.80
Natural gas	1.00
Oil	1.00
Coal	1.00
Renewable (1): wood, biomass, energy generated directly or indirectly from biomass, energy from biogas, pellet	0.60
Renewable (2): energy, which is from sun, wind, wave, water, geothermal, hydrothermal, air	0.00
District heating	0.5-1.26*

* It depends on the energy source, and the rate of the combined thermal energy production

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Renewable Energy Ratio (RER) requirement: in the current status, the usage of RES is not mandatory, but the requirement for primary energy use can be fulfilled easier if use of RES is considered. Later, from 2019 (public buildings), and 2021 (all buildings), 25% share of RES will be mandatory for new, nearly zero energy buildings.

Grants: KEOP 2014-2020 EU funding financial source will be available. The calls have not been published, therefore the details are not known yet. In the past years there were applications, in which the funding intensity was even 100% for public buildings (offices of central or local authorities, schools, hospitals, etc.).

3.6 ITALY

3.6.1 State-of-the-art of the EPBD implementation

In Italy the EPBD has been transposed into Legislative Decree 192/2005 as modified by Legislative Decree 311/2006, while the EPBD recast has been transposed into Law 90/2013. Furthermore, Directive 2009/28/EC has been transposed into Legislative Decree 28/2011. All the mentioned legislative decrees have then been implemented through a series of regulations:

- Presidential Decree 59/2009 defines the general criteria, the calculation methods and the minimum requirements for the building energy consumption reduction as to achieve the EPBD objectives;
- Ministerial Decree 26/06/2009 defines the guidelines on the building energy certification;
- Presidential Decree 74/2013 defines general criteria relating to the management, control, maintenance and inspection of the building thermal systems for the space heating and cooling, and for the domestic hot water production;
- Presidential Decree 75/2013 enforces the art. 10 of the EPBD on the independent experts for the certification of buildings, the drafting of the accompanying recommendations and the inspection of boilers and air-conditioning systems.

Italian regulations can be freely downloaded to the official journal website <http://www.gazzettaufficiale.it>. The website is in Italian language. A direct link for the download of the above mentioned legislation is provided as follow:

- Legislative Decree 192/2005:
http://efficienzaenergetica.acs.enea.it/doc/dlgs_192-05.pdf
- Legislative Decree 311/2006:
http://efficienzaenergetica.acs.enea.it/doc/dlgs_311-06.pdf
- Law 90/2013:
<http://www.gazzettaufficiale.it/eli/id/2013/08/03/13G00133/sq>
- Legislative Decree 28/2011:
http://www.acs.enea.it/doc/dlgs_28-2011.pdf
- Decree 59/2009:
http://efficienzaenergetica.acs.enea.it/doc/dpr_59-09.pdf
- Ministerial Decree 26/06/2009:
http://efficienzaenergetica.acs.enea.it/doc/dm_26-6-09_completo.pdf
- Presidential Decree 74/2013:
<http://www.gazzettaufficiale.it/eli/id/2013/06/27/13G00114/sq>
- Presidential Decree 75/2013:
<http://www.gazzettaufficiale.it/eli/id/2013/06/27/13G00115/sq>

3.6.2 EPBD implementation until 2020

According to Law 90/2013, in the near future a series of decrees will define:

- a) The methods for the application of the methodology for the energy performance calculation and the use of renewable energy sources in buildings, in relation to Directive 2010/31/EU, paragraphs 1 and 2 of Annex 1, taking into account the following general criteria:

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1. the energy performance of buildings is defined according to UNI and CTI technical standards, in line with the CEN standards;
 2. the global annual energy demand is calculated for each energy service, expressed in primary energy on a monthly basis. With the same criteria the renewable energy produced within the boundary of the building system is determined;
 3. it is defined the daily (monthly average) compensation between energy needs and renewable energy produced within the boundary of the system, for energy carrier and up to cover the total energy demand for that carrier.
- b) The application of minimum requirements updated every five years, for the energy performance of new buildings and refurbishment, based on the application of the comparative methodology (Article 5 of Directive 2010/31/EU), according to the following general criteria:
1. the minimum requirements comply with the technical and economic feasibility, based on the cost/benefits analysis on the economic life cycle of buildings;
 2. for new construction and major renovation, the minimum requirements are determined with the use of a “reference building”, according to the building type and climatic zones;
 3. as to ensure the compliance with the prescribed energy quality, for the reference building are provided the minimum values for specific parameters, in terms of performance indices and thermal transmittance as well as overall parameters, like the efficiency of the heat distribution system;
 4. Factors for the conversion of the delivered energy in primary energy are defined;
 5. For minor renovation the compliance of the single parts of the building (i.e.: windows) or of the plants (i.e.: boiler efficiency) is required.

3.6.2.1 nZEB definition

According to Law 90/2013 since 2019 public building should be nZEB; since 2021 all new buildings should be nZEB. The law establishes a “nearly zero energy building” as a building characterized by a very high energy performance in which the very low energy demand is significantly covered by renewable sources, produced within the building system boundaries. Moreover, the nZEB has to be performed according to energy requirements that will be defined in further regulations expected by 2014 or spring 2015.

According to Law 90/2013, specific building energy parameters are expected for the definition of nZEB, as thermal transmittance and building thermal and global energy performance indexes, both total and non renewable. According to the draft copy of the expected regulation implementing the Law 90/2013, the following indexes will be required:

- Mean transmission heat transfer coefficient [W/m^2K];
- Ratio of summer effective collecting areas to net floor area [-];
- Specific ideal energy need for heating [kWh/m^2];
- Heating system global efficiency [-];

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- Energy performance index for heating, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Ideal energy need for DHW index [kWh/m²];
- DHW system global efficiency [-];
- Energy performance index for DHW, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Energy performance index for ventilation, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Specific ideal energy need for cooling [kWh/m²];
- Cooling system global efficiency [-];
- Energy performance index for cooling, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Energy performance index for lighting, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Global energy performance index (heating, cooling, DHW, ventilation, lighting), expressed in non renewable primary energy and in total primary energy [kWh/m²].

According to the draft copy of the regulation implementing Law 90/2013, a building is defined as nZEB if the values of the above mentioned energy parameters are lower than those referred to the target building, and the use of renewable sources complies with Legislative Decree 28/2011. In this decree it is not specified yet if the renewable energy ratio (RER) requirements refer to primary or to delivered energy:

Table IT-1: Renewable energy ratio (RER) requirements

	2015-2016	2017
Share of renewable energy for DHW	50%	50%
Share of renewable energy for space heating/cooling and DHW	35%	50%
Electrical power installed per building footprint unit surface [kW/m ²]	0,015	0,02

The target building is a virtual building geometrically equivalent to the planned one, but meeting the energy parameters and minimum thermal characteristics (e.g. thermal transmittance) to be achieved by the year 2020.

The following tables show the thermal parameters values that should be used for the definition of the target building, according to the draft copy of the expected regulation.

Two steps regarding the regulation implementation, are considered:

- from July 2015;
- from 2019 for public buildings and from 2021 for all the buildings.

Table IT-2: Thermal transmittance

Components	Period	Thermal transmittance U [$\text{W}/\text{m}^2\text{K}$] thermal bridges included				
		Climatic Zone				
		A and B	C	D	E	F
Vertical opaque components facing outdoors/unconditioned zone/ground	from 2015	0,42	0,36	0,32	0,28	0,26
	from 2019/2021	0,38	0,32	0,28	0,24	0,22
Roof opaque components facing outdoors/unconditioned zone	from 2015	0,36	0,36	0,28	0,25	0,23
	from 2019/2021	0,34	0,34	0,24	0,22	0,20
Floor opaque components facing outdoors/unconditioned zone/ground	from 2015	0,46	0,40	0,32	0,30	0,28
	from 2019/2021	0,42	0,36	0,28	0,26	0,24
Windows and rolling shutter box	from 2015	3,20	2,40	2,00	1,8	1,5
	from 2019/2021	3,00	2,20	1,80	1,40	1,10
Interbuilding opaque components	from 2015	0,80	0,80	0,80	0,80	0,80
	from 2019/2021	0,80	0,80	0,80	0,80	0,80

Table IT-3: Total solar energy transmittance

Components	Period	Total solar energy transmittance g_{gl+sh} [-]				
		Climatic Zone				
		A and B	C	D	E	F
Windows with shading devices	from 2015	0,35				
	from 2019/2021					

Energy efficiency mean values are also given for each technical sub-system to be used for the target building definitions; heating, cooling, DHW and electricity systems are considered.

3.6.2.2 Cost-optimal level requirement

According to the National plan for increasing the number of nearly-zero energy buildings dated 22th October 2013, the comparison of the optimal levels coming from the Italian application of the Cost Optimal Methodology with the requirements currently in force shows that “in almost all the buildings, it is more cost-effective to

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exceed the minimum legal requirements and construct higher-performance buildings than those required by the current law. This will make it possible to obtain not only energy savings but also cost savings during the building's useful life. Lastly, as concerns performance of individual building elements, the minimum requirements currently in force, as laid down in Legislative Decree No. 311/2006, have been found to be on the whole in line with optimal values, with the exception of the colder climate zones, where there is room for some improvement. Finally, Decree Law No. 63/2013, implementing Directive 2010/31/EU provides that the results of the "cost-optimal methodology" shall be used to determine the new energy performance requirements for buildings. Thus these requirements are destined to be revised and expanded, including certain services currently excluded, first and foremost space cooling".

3.6.3 Overview of existing national plan

The Energy Efficiency Directive (EED, 2012/27/EU) states that since January 1st 2014, MS shall ensure the 3% of the total floor area of conditioned buildings owned and occupied by central government is recovered each year to meet at least the minimum energy performance requirements. Italy opted for an alternative approach, by implementing other cost-effective measures, such as: behavior change, contracting, envelope and technical systems renovation, energy management, inspections. This alternative approach shall lead to at least an equivalent amount of energy savings as compared to the default approach. Thus, the expected energy saving potential is about 458.000 MWh, based on a eligible central governmental owned and occupied reference floor area of 13.763 m².

The EED has been transposed in Italy by the Legislative Decree 102/2014 that establishes a framework of measures for the energy efficiency promotion and improvement. The regulation also lays down rules aimed to remove barriers in the energy market and overcome market failures. These energy efficiency measures aim to reduce the overall primary energy consumption of about 20 Mtoe within 2020 that correspond to 15,5 Mtoe of final energy consumption, counted from 2010.

The Legislative Decree enforces the refurbishment of the 3% of the central authorities public buildings conditioned area or the reduction of the energy consumption of 0,04 Mtoe in the period 2014-2020. Each year a list of energy efficiency measures towards this goal is defined. Buildings with net floor area lower than 250 m² are excluded, as well as buildings with net floor area lower than 500 m² until July 2015.

According to the Legislative Decree 102/2014, the 2014 Energy Efficiency National Plan (PAE 2014) states that for Public Administrations the reduction of primary energy consumption until 2020 is estimated around 0,8 Mtoe, corresponding to 0,57 Mtoe of final energy consumption, subdivided as follow:

- 0,1 Mtoe by saving energy national requirements;
- 0,5 Mtoe mainly by renewable thermal energy sources ("Conto termico");
- 0,06 Mtoe by energy saving (White Certificates).

White certificates, also known as "Energy Efficiency Certificates" (EEC), are tradable instruments giving proof of the achievement of end-use energy savings through energy efficiency improvement initiatives and projects. The white certificates scheme was introduced into the Italian legislation by the Ministerial Decrees of 20 July 2004, as subsequently amended and supplemented. Under the scheme, electricity and natural-gas distributors are required to achieve yearly quantitative primary-energy saving targets, expressed in toe saved. Each certificate is worth one t of oil equivalent saved. Electricity and gas distributors may fulfil their obligation by implementing

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energy efficiency projects entitling to white certificates or by buying white certificates from other parties in the Energy Efficiency Certificates Market.

The “Conto termico” has been introduced at the end of 2012 by the Legislative Decree 28/2011 as support for small-scale projects of energy efficiency improvement reserved to the public administration and production of thermal energy from renewables. The decree allocates funds for a maximum yearly cumulative disbursement of € 200 million for projects implemented or to be implemented by public administrations and a yearly cumulative disbursement of € 700 million for projects implemented by private parties. Eligible projects for public administration concern: energy efficiency improvements in existing building envelopes (thermal insulation of walls, roofs and floors, replacement of doors, windows and shutters, installation of solar shadings); replacement of heating generators with more efficient ones (condensing boilers). The projects eligible for other entities are: replacement and, in some cases, construction of new renewable-energy systems (heat pumps, biomass boilers, heaters and fireplaces, solar thermal systems, including those based on the solar cooling technology). The decree also introduces - subject to specific requirements - incentives for energy auditing and energy certification associated with the above projects. The incentive (contribution to the costs incurred for the project) will be paid in yearly instalments over a variable support period (2 to 5 years), depending on the projects.

Indeed, building system and technical system requirements are fixed by the Decree 59/2009 as follows (however this decree will be updated soon):

- Thermal insulation control: thermal transmittance limit values, for heat transfer opaque (thermal bridges included) and transparent components;
- Moisture control;
- Solar control: for new buildings and big restorations, compulsory use of movable external solar shading;
- Thermal inertia control: periodic thermal transmittance limit values and time shift or decrement factor qualitative values;
- Natural ventilation efficiency;
- Thermal energy performance for cooling: limit values for new buildings according to the climatic zone and the building use;
- Primary Energy performance for heating: limit values for new buildings according to the climatic zone, the compactness ratio and the building use;
- Control and distribution subsystem requirements for saving energy;
- Heating system global efficiency: limit values;
- Compulsory use of renewable sources (thermal solar system, PV system):

Table IT-4: Compulsory use of renewable sources

	Currently	2015-2016	2017
Share of renewable energy for DHW	50%	50%	50%
Share of renewable energy for space heating/cooling and DHW	20%	35%	50%
Electrical power installed per	0,015	0,015	0,02

building footprint unit surface [kW/m ²]			
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- Compulsory building provision for district heating.
It is not specified yet

3.6.4 Identification of aspects on refurbishment of public buildings into nZEB level

As mentioned before, in Italy the regulation implementing the nZEB definition is already missing. The draft copy of the regulation refers to a “target building” that should be defined according to the geometry of the real building, but characterized by thermal transmittance and total solar energy transmittance values defined by the regulation for climatic zone, and technical systems efficiencies values also defined by the regulation. These parameters values will not be compulsory for nZEB, but the energy performance indexes of the target building as defined should be used to identify the nZEB soil for the real building classification. The thermal parameters values for each climatic zone as well as the technical systems energy efficiencies defining the target building should come from the Italian cost-optimality analysis.

From an administrative point of view Italy is divided in 20 administrations (regions) which can chose to apply the national transposition of the EPBD or chose to adopt directly the Directive. This leads to a complex situation, in which definitions, algorithms and accuracy of the EPBD implementation can greatly vary locally. Currently, the national government is working as to increase the uniformity of the procedures but this process will require a long time.

Italy is divided into "climatic zones" according to heating degree days. Temperature and solar radiation values are referred to some cities representative of the different zones, as follows:

- A: not considered because marginal
- B: Palermo
- C: Bari
- D: Firenze
- E: Milano
- F: Belluno

Table IT-5: Climatic zones

	Climatic Zone A	Climatic Zone B	Climatic Zone C	Climatic Zone D	Climatic Zone E	Climatic Zone F
January average outside temperature [°C]:	-	11,1	8,6	5,3	1,7	0,1
August average outside	-	25,4	24,5	24,3	24,1	20,8

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temperature [°C]:						
Average global horizontal radiation [kWh/m² yr]:	-	1785	1735	1476	1307	1272
Annual heating degree days [°Cd/yr]:	≤ 600	601-900	901-1400	1401-2100	2101-3000	> 3000

According to the climatic zone, saving energy requirements are differently defined for thermal transmittance, primary energy need for heating and ideal energy need for cooling:

Table IT-6: Thermal transmittance

Thermal transmittance U [W/m²K]	Climatic Zone A	Climatic Zone B	Climatic Zone C	Climatic Zone D	Climatic Zone E	Climatic Zone F
Façade/wall	0,62	0,48	0,40	0,36	0,34	0,33
Roof	0,38	0,38	0,38	0,32	0,30	0,29
Ground floor	0,65	0,49	0,42	0,36	0,33	0,32
Glazing	3,70	2,70	2,10	1,90	1,70	1,30
Window	4,60	3,00	2,60	2,40	2,20	2,00
Curtain wall	4,60	3,00	2,60	2,40	2,20	2,00
Gate	4,60	3,00	2,60	2,40	2,20	2,00
Door	4,60	3,00	2,60	2,40	2,20	2,00
Slab above basement	0,65	0,49	0,42	0,36	0,33	0,32
Interbuilding wall	0,80	0,80	0,80	0,80	0,80	0,80

Table IT-7: Primary energy need for heating

Primary energy need for heating [kWh/m³yr]	Climatic Zone A	Climatic Zone B	Climatic Zone C	Climatic Zone D	Climatic Zone E	Climatic Zone F
Compactness ratio ≤ 0,2	extrapolation	2,0-3,6	3,6-6,0	6-9,6,0	9,6-12,7	extrapolation
Compactness ratio ≥ 0,9	extrapolation	8,2-12,8	12,8-17,3	17,3-22,5	22,5-31,0	extrapolation

Table IT-8: Ideal energy need for cooling

	Climatic Zone A	Climatic Zone B	Climatic Zone C	Climatic Zone D	Climatic Zone E	Climatic Zone F
Ideal energy need for cooling [kWh/m³yr]	14	14	10	10	10	10

The final thermal and primary energy consumption values for the different end uses are provided in kWh/m² year for residential buildings and in kWh/m³ year for the non residential buildings.

Law 90/2013 states the national regulations and requirements are only in force if Regions do not directly adopt the EU Directives. This disposition, as mentioned before, has involved different energy regulations through the country and several different energy efficiency policies as local administrations are able to change (only in a more restrictive way) the above mentioned limit values, or to decide using different performance indicators (i.e. ideal energy need for heating instead of primary energy need).

In Italy the annual global non-renewable primary energy is defined as the sum of the primary energy for each service (heating, ventilation, cooling, DHW, lighting only for non-residential), where:

- the delivered energy is the energy expressed for final energy carrier, supplied to technical systems at the boundaries to produce heat or electricity for energy building services;
- the delivered and exported electricity is evaluated separately;
- the onsite produced renewable thermal energy (e.g. solar collectors) is evaluated as a reduction of the energy need for heating/DHW.

Concerning the building boundaries, just the single building is considered including eventual external plants (i.e.: geothermal wells). Thus, the following definitions are expressed:

- Building: system consists of the external building structures delimiting the volume, the internal structures and all the plants and technological devices that are permanently inside; the surface delimiting the building can confine with all or some of these elements: the external, the land, other buildings. The term can refer to an entire building and its systems or parts of buildings and related facilities designed or restored to be used as stand-alone units.
- System boundary: it includes all areas associated with the building (both inside and outside the building) where the energy is consumed or produced.

In Italy the concept of “nearby” is not definitely specified yet; by now FprEN 15603 is applied, in which “nearby the building site” is defined as the energy source which can be used only at local or district level having a dedicate connection, requiring specific equipment for the assessed building or building unit to be connected to it.

Some additional information is needed as follows:

- the energy prices for non-residential buildings:

In Italy the energy market is liberalized, thus the prices are deeply influenced by the energy amount required. Concerning the thermal energy provision, the following two scenarios are generally identified:

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- the public administrations acquire the fuel, usually natural gas (through collective agreement, and the delivered energy price should be around 0,06 €/kWh) or district heating (price around 0,07/0,012 €/kWh of energy delivered to the distribution subsystem, according to the supply zone) ;
- the public administrations define comprehensive services contracts with providers, usually based on the energy amount required; in these cases the prices are not easily defined.

Concerning the electrical energy provision, there could be several different scenarios; generally the delivered energy price could be defined around 0,18 €/kWh.

- the primary energy factors in Italy,
According to the draft copy of the expected regulation implementing the nZEB concept, the following primary energy factors are defined:

Table IT-9: Primary energy factors

Energy carrier	$f_{p,nren}$	$f_{p,ren}$	$f_{p,tot}$
Natural gas	1,05	0	1,05
GLP	1,05	0	1,05
Gas oil	1,05	0	1,05
Coal	1,10	0	1,10
Solid biomass	0,20	0,80	1,00
Liquid or gaseous biomass	0,40	0,60	1,00
Electricity	1,95	0,47	2,42
District heating	1,5	0	1,5
Waste refuse	0,2	0	0,2
District cooling	0,5	0	0,5
Thermal energy by solar collectors	0	1	1
Electricity by PV panels	0	1	1
Free cooling	0	1	1
Heat pumps	0	1	1

- the main energy sources in public buildings based on deliverable D2.1

In 2011, the final energy consumption in the residential building sector was about 30.7 Mtoe, that corresponds to an increase of 9% respect to 2010. The main energy source used in the residential building sector in Italy is the natural gas, that rose in the last years of about 9%; the increase is also recorded for wood (+52%) and electricity (+0.9%). On the other hand, the consumption of all the other energy sources decreased. The Italian electrical consumption in the residential building sector has increased of about 1% while the European average is of 6%: the value is linked to the use by consumers of more effective electrical equipment. The energy consumption for heating for building unit is also decreased, but less markedly than in most other European countries.

The non-residential sector (services and commercial sectors, public authorities) energy consumption is continuously growing, from less than 9.5 Mtoe in 1995 to more than 15.5

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Mtoe in 2011. The commercial and services sector differs from the residential sector, as the almost exclusive sources are gas (50.4%) and electricity (45.4%).

- best practices related to refurbishments towards nZEB level

A number of Regions are currently promoting initiatives targeting nearly-zero energy buildings, via dedicated regional calls and efficient building construction initiatives in the social housing and non residential (schools, offices etc.) sectors. For example, the Lombardy Region has already issued a regional law requiring all (new) buildings, public and private, to be nearly zero-energy from 1 January 2016. The Region has already implemented a number of energy upgrading projects in public and private buildings including several schools and healthcare centres. A showcase example is the laboratory at the Bovisa campus of the Milan Polytechnic University. This is a nearly zero-energy new university pavilion hosting a cutting-edge laboratory for the development of energy efficiency technologies.

The main national incentives promoting the energy efficiency in buildings as well as the use of renewable sources are summarized as follows:

- Tax deduction for energy efficiency improvement actions
- The Thermal Account
- White certificates
- Guarantee funds and promotion of TPF (Third-Party Financing) models

3.7 PORTUGAL

3.7.1 State-of-the-art of the EPBD implementation

The first Portuguese legislation regarding the energy performance of buildings was established by Decree Law 40/90 of 1990, with the first requirements related to the implementation of energy efficiency measures in buildings. It was limited to heating and cooling energy needs, as well as the heat transfer coefficient (U) of the envelope walls and the solar heating gain coefficient of the glazing solutions. However, the requirements of this regulation were not very demanding. Since this year the first building regulation was applied for new residential buildings (RCCTE - Regulation of thermal performance characteristics of buildings Degree-Law 40/90). Eight years later, in 1998, the regulation was extended for the non-residential buildings with the publication of Degree-Law 119/98, RSECE-Regulation of climatization systems (HVAC) in buildings. With the increasing of the energy consumption in building sectors, one of the main goals of the European Union (EU) was to respond to this challenge by providing support for improving energy efficiency that prove decisive for competitiveness, security of supply and for meeting the commitments on climate change made under the Kyoto protocol. In this manner the EU has introduced legislation to ensure that the reducing buildings energy consumption. One of the key part of this legislation is the Energy Performance of Buildings Directive (Directive 2002/91/EC, EPBD), first published in 2002, which required all EU countries (Member States-MS) to adapt and enhance their building regulations and to introduce energy certification schemes for buildings. Besides this, all MS were also required to have inspections of boilers and air-conditioners. As EU requirements were very challenging to be adapted and applied in the MS national laws, EU launched some actions to support EU countries in this task. One of these actions was the project Concerted Action (CA) EPBD with the main objective to promote dialogue and exchange of best practice between them, to enhance the sharing of information and experiences from national adoption and implementation of the European legislation.

In Portugal, the transposition of the EPBD requirements was published on 4 April 2006 by three diplomas:

- Decree 78/2006, with the definition of the operational rules for the System for Energy and Indoor Air quality Certification of Buildings;
- Decree 79/2006 (RSECE) setting the thermal regulation for service buildings (Regulation of HVAC Energy Systems in Buildings) including inspection of boilers and air conditioners and indoor air quality. So from 2006, maximum primary energy consumption per sqm of floor area; maximum U-values; minimum requirements for thermal bridges; minimum shading requirements for all windows, (excluding north orientation); minimum efficiency and quality requirements for heating Minimum efficiency and quality requirements for heating and cooling components for non-residential buildings.
- Decree 80/2006 (Regulation of the Characteristics of the Thermal Behaviour of Building - RCCTE) - which sets the thermal regulation for residential buildings increasing the minimal thermal requirements of buildings and promoting the use of renewable energy and supports the use of certified materials. It is mandatory the use of solar collector for DHW for new residential building or when subject to major renovation and if sun exposure is appropriate (which simply means the existence of an orientation in a range of azimuths of 90 ° between the southeast and southwest, not shaded by significant obstacles during the daytime). The solar collectors can be replaced by other systems using renewable energies ensuring, on an annual basis, the energy equivalent to the solar thermal system. According to the energy classification adopted by the SCE, the most efficient building (class A+) may consume less than 1/4 of the energy consumed by

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a reference building (new buildings and buildings under major renovation), while the least efficient (class G) can consume over 300% more (only possible for existing buildings). So from 2006, for the residential buildings exists maximum cooling and heating energy needs (kWh/m².year) heating and cooling needs; maximum U-values; minimum requirements for thermal bridges; minimum shading requirements for all windows, (excluding north orientation); mandatory installation of solar water heaters;

Result of the implementation of the aforementioned legislation has been observed an improvement of the energy performance of the national building stock over the past 25 years, since the publication of the first rules in 1990, according to the report:

[29]

The transposition of Directive 2010/31/EU - Energy Performance of Buildings Directive (EPBD - recast) was published 14 August 2013 by the Decree-Law No. 118/2013 of August 2013. Regarding the rules for determining the energy class it depends on the type of building: residential and non-residential.

For residential buildings the Energy Pre-Certificate and Certificate, the energy class is determined by the energy class ratio (R_{NT}), according to the expression

$$R_{NT} = \frac{N_{tc}}{N_t}$$

where N_{tc} is the value of the annual nominal primary energy needs and N_t corresponds to the regulatory threshold for annual nominal energy needs primary, both calculated in accordance with the provisions of Energy Performance Residential Buildings Regulation (REH).

Table PT-1: Residential Building Energy Performance Level.

Building energy performance level	Value of R_{NT}
A +	$R_{NT} \leq 0,25$
A	$0,26 \leq R_{NT} \leq 0,50$
B	$0,51 \leq R_{NT} \leq 0,75$
B -	$0,76 \leq R_{NT} \leq 1,00$
C	$1,01 \leq R_{NT} \leq 1,50$
D	$1,51 \leq R_{NT} \leq 2,00$
E	$2,01 \leq R_{NT} \leq 2,50$
F	$R_{NT} \geq 2,51$

Remarks: new building \geq B-; major renovation \geq C; existing building all levels

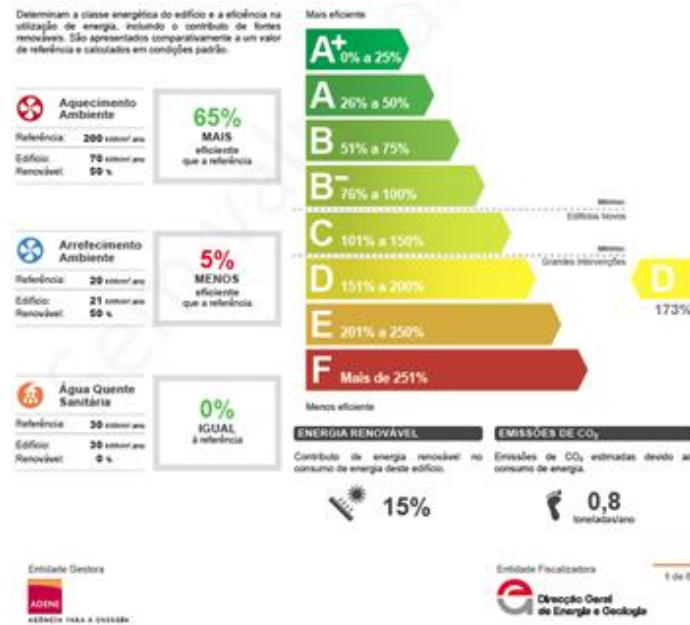


Figure PT-1 - Energy Certificate Model - Residential Buildings [30]

Concerning non-residential buildings (trade and service) the energy class is determined by the energy class ratio R_{IEE} ,

$$R_{IEE} = \frac{IEE_S - IEE_{REN}}{IEE_{ref,S}}$$

IEE_S - Energy Efficiency Indicator for the consumption of type S, depending on the type of building and whether it is new, existing or subject to large intervention, which includes: heating and space cooling, humidification and dehumidification, ventilation and pumping systems in air conditioning, domestic hot water and swimming pools, indoor Lighting, from January 2016 elevators, escalators and moving walks, outdoor lighting

$IEE_{ref,S}$ Reference Energy Efficiency Indicator associated with the reference consumption annual energy type S;

IEE_{REN} - Renewable Energy Efficiency Indicator associated with the production of electrical and thermal energy from renewable energy sources

Those indicators area calculated in accordance with the provisions of Energy Performance of Trade and Service Buildings Regulation (RECS).

Table PT-2: Trade and Service Building Energy Performance Level.

Building energy performance level	Value of R_{IEE}
A +	$R_{IEE} \leq 0,25$
A	$0,26 \leq R_{IEE} \leq 0,50$
B	$0,51 \leq R_{IEE} \leq 0,75$
B -	$0,76 \leq R_{IEE} \leq 1,00$

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C	$1,01 \leq R_{IEE} \leq 1,50$
D	$1,51 \leq R_{IEE} \leq 2,00$
E	$2,01 \leq R_{IEE} \leq 2,50$
F	$R_{IEE} \geq 2,51$

Remarks: new building \geq B-; major renovation \geq C; rationalization energy plan (PRE) \geq D

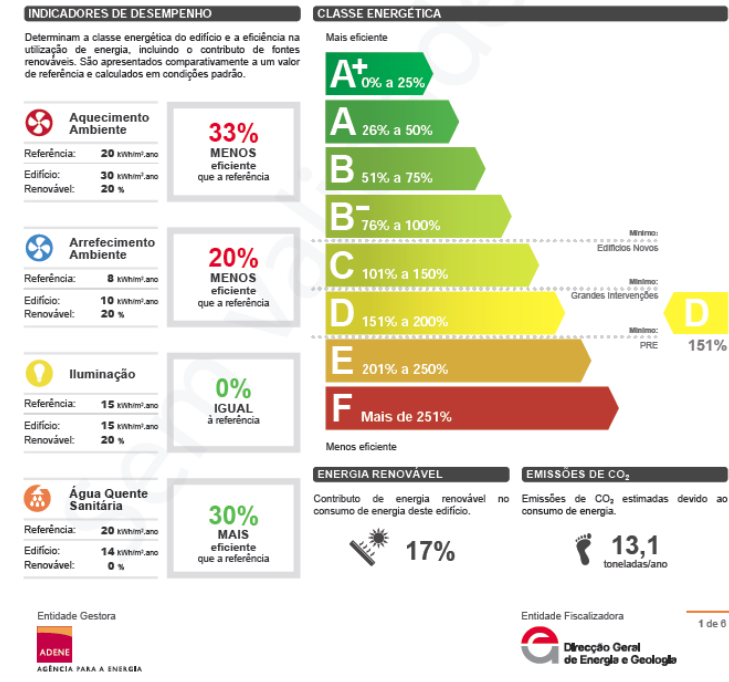


Figure PT-2: Energy Certificate Model - Trade and Service Buildings [31]

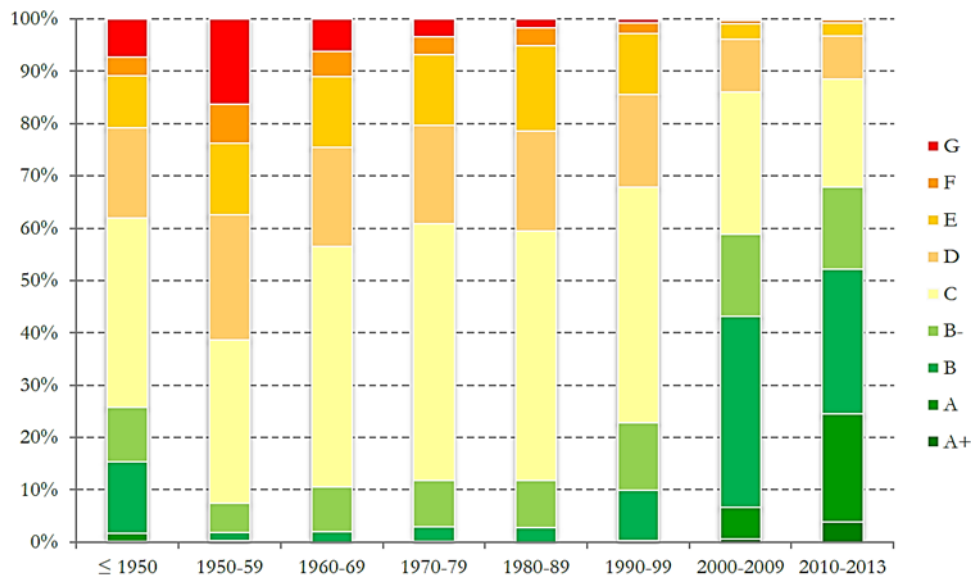


Figure PT-3: Evolution of Building Energy Performance (DGEG, National plan for increasing the number of nearly zero-energy buildings in Portugal)

3.7.2 EPBD implementation until 2020

The Decree-Law No. 118/2013 of August 2013 took effect on December 1, 2013 and repeals the 2006 legislation and embodies improvements on the energy performance level through the Energy Certification (SCE) system, which integrates the Regulation of Energy Performance of Buildings Housing (REH) and the Regulation of Energy Performance of Buildings Trade and Services (RECS). In order to increase the energy performance the existing building must converge to an energetic performance of the new buildings, according to feasibility criteria technical, architectural, functional and economic aspects.

The new regulatory framework established by Decree-Law No. 118/2013 of 20 August, as mentioned above, states using the methodology of calculation associated with the Regulation of Energy Performance of Buildings Housing (REH) and the Regulation of Energy Performance of Buildings on Trade in Services (RECS) the existence of a minimum set of conditions referring to the buildings must comply and that, compared with conditions typified reference, allow the determination of the energy efficiency class.

Thus, for residential buildings and buildings for trade and services, is presented, as example, some of the aspects that were taken into account:

Envelope elements

New buildings; maximum U-values, depending on the winter climate zone, and opaque envelope element (horizontal and vertical), maximum window g values (depending on summer climate zone). Requirements also on flow air renovation rates.

Buildings under major renovation: equal to new buildings unless there is technical incompatibility and be shown that with the alternative solutions the building energy performance is not negatively affected.

Equipment

Concerning the equipment's can be pointed out: Minimum energy efficiency of boilers used for space heating where the class minimum efficiency after depending on the year according to the next 2 tables:

Table PT-3: Minimum energy efficiency of boilers

Equipment	Minimum efficiency class after...	
	Entry into force	31 Dec 2015
Boiler	B	A

(1) - Class A, where operating temperatures do not permit installation of harnessing the energy released by the condensation of flue gas.

Table PT-4: Trade and Service Building Energy Performance Level. Boilers energy efficiency classes, for space heating, in terms of the nominal efficiency

Energy efficiency class	Nominal efficiency (η)
A+ +	$\eta \geq 96\%$
A +	$96\% \geq \eta > 92\%$
A	$92\% \geq \eta > 89\%$

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B	$89 \% \geq \eta > 86\%$
C	$86 \% \geq \eta > 83\%$
D	$83 \% \geq \eta > 80\%$
E	$89 \% \geq \eta > 77\%$
F	$\eta \leq 77$

Cooling systems: minimum efficiency requirements depending on their classification for certification (www.eurovent-certification.com) or performance evaluated by the same reference standard, with the requirement equivalent in terms of COP and EER and the tests should be performed by accredited entity.

Air conditioning systems: minimum efficiency requirements depending on their classification for certification (www.eurovent-certification.com) or performance evaluated by the same reference standard, with the requirement equivalent in terms of COP and EER and the tests should be performed by accredited entity

The **lighting system** is taken into account only for non-residential buildings (Trade and Service Buildings) and should accomplish the requirements of EN 12464-1 and EN 1519 and according to the 2009/1225/EC Directive.

Concerning the **renewable energy systems** the building code includes guidelines for solar thermal systems, solar photovoltaic systems, micro wind systems, biomass boilers and geothermal systems.

3.7.2.1 nZEB definition

Concerning the nZEB definition the Decree-Law N^o. 118/2013 of 20 August, which transposes the EPBD recast in Portugal, as mentioned before, established in general terms the concept of nearly zero energy building, for new construction from 2020 or 2018, in the case of new buildings owned or occupied by public entities and for major renovations in the existing building. This pattern combines reducing, to the greatest extent possible and supported on cost-benefit analysis; the energy needs of the building and use energy from renewable sources. Concerning the specific features of the social sector, it is still analyzed the feasibility of the cost of certification energy social housing be financed through funds or other instruments to finance energy efficiency measures.

In the article 16 of the Decree-Law No. 118/2013 is stated that the building stock should gradually be composed of nearly zero-energy buildings, those with a high energy performance and with energy needs supplied largely from renewable energy sources, produced in the building or nearby - new building after December 31, 2020, and after 31 December 2018 for new buildings property of a public body and occupied by a public entity.

The Government members responsible for the areas energy, spatial planning and finance approve by ordinance the national rehabilitation plan for existing buildings to meet the requirements nZEB. The nZEB will be equipped with: efficient systems, renewable energy covering a large part of the remaining needs, installed in the building or nearby.

It can be pointed out that Portugal has prepared the National plan for increasing the number of nearly zero-energy buildings which enforces the Decree-Law no 118/2013 of 20 August, in

what concerns the building rehabilitation, recommending that it must converge, following technical feasibility criteria, architectural, functional and economic, for an energy performance close to that which applies to new buildings thus signaling the purpose of obtaining buildings with nearly zero-energy.

The plan also refers that the nZEB definition should take into appropriate metrics for new and existing buildings undergoing major intervention, and in this particular feature the analysis of the technical feasibility and economic play a key role, it marks the limits that will frame these buildings, providing the definition and the flexibility plan to cover two dimensions, but also in the future requirement that prospective for nZEB.

In Portugal has not yet defined in a quantitative manner the requirements related to nZEB for annual primary energy consumption, share of RES. The above mentioned report refers that nZEB appear most likely from the proposed regulatory nature, as are the Energy Performance Regulations for Residential Buildings (REH) and the Energy Performance of Trade and Services Buildings Regulation (RECS), based on the generality of the requirements for 2015, projecting subsequently, energy efficiency requirements that will minimize energy requirements for residential buildings and commercial and service making these can be classified as NZEB.

3.7.2.2 Cost-optimal level requirement

It has already been performed the comparative methodology framework for calculating the optimum levels of profitability of minimum energy performance requirements for residential buildings according to Regulation Delegate (EU) No 244/2012 of the Commission of 16 January 2012, supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings. The structure of the report generally followed the proposed notification model in Regulation 244/2012 delegate, presenting the information and results achieved in the determination of optimal levels of profitability for the energy performance residential of buildings in Portugal. Concerning the non-residential buildings the first results will be presented in December 2014.

3.7.3 Overview of existing national plan

In Portugal there exists the National Energy Efficiency Plans (NEEAPs) according to Article 14 of Directive 2006/32/EC on energy end-use efficiency and energy services (ESD) and the National Renewable Energy Plans (NREAPs) of all countries, which includes versatile energy efficiency in parallel with measures for promoting renewable energy use. Since 2014 the National Plan for increasing nearly Zero Energy Buildings was published as well.

National Energy Efficiency Action Plan - PNAEE2016

The recently published National Energy Efficiency Action Plan (PNAEE2016, 2013) presents six main areas of intervention:

- i) Transportation
- ii) Residential and service buildings
- iii) Industry
- iv) Government energy efficiency
- v) Behaviour and agriculture

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These areas add a total of 10 programs, with a range of measures to improve energy efficiency, targeted in a quantifiable way the energy demand with the aim to achieve the proposed objectives.

In which regard the building energy efficiency a list of programs and sub-programs that integrate targets and measures to improve the buildings energy performance including the new buildings, public buildings. These programs and the corresponding targets are listed in Table PT-5.

Table PT-5: PNAEE2016 targets

Program	Accumulated Energy savings (tep)		CO ₂ emissions reduction (tCO ₂)	
	2016	2020	2016	2020
Residential and service Buildings	320.932	582.727	1.400.941	2.543.735
Government Energy Efficiency in Public Buildings	112.170	253.988	489.647	1.108.715
Behaviour - Information and communication of energy efficiency	-	-	-	-

The Portuguese National Action Plan for Energy Efficiency (PNAEE2016) integrates some other instruments and tools towards accomplishments of the proposed programs, as:

Economic incentives and financing instruments

According with PNAEE 2020 the following incentives and financial instruments will be offered: Energy Efficiency Fund (FEE), Innovation Support Fund (FAI), Strategic Energy Efficiency Plan for promoting energy efficiency in the industrial, retail, residential and services sectors (PPEC), Portuguese Carbon Fund (FPC), National Strategic Framework (QREN), Joint European Support for Sustainable Investment in City Areas (JESSICA).

Supervision (energy advice and audits)

One of the objectives of the PNAEE 2016 for 2020 is to certificate a total of 2225 public buildings. 550 of these buildings will be covered by Eco-innovation Action Plan – EcoAP, that has as principal objective to improve of energy efficiency in public buildings by means of monitoring and audits and is expected an energy savings of these buildings in about 30%.

Information and Demonstration

The program EcoAP is assisted by the initiative Barometer of Energy Efficiency in Public Buildings (Barómetro da Eficiência Energética na Administração Pública) which has as objective a continuous divulgation of the energy efficiency and audits results. Later on will be promoted a Guide of Energy Efficiency of Public Buildings (Guia da Eficiência Energética na Administração Pública).

National Renewable Energy Action Plan - PNAER2020

Although, The National Renewable Energy Action Plan (PNAER 2020) compared to the PNAER of 2010 forecasts a reduction of 18% in the installed capacity in technologies based

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on renewable energy, the renewable electricity share in the new PNAER is higher (60% vs. 55%), as the global target to achieve, which is expected to stand at around 35% (compared to the 31% target). PNAER down for this, with trajectories of introduction of RES in three major sectors:

- i) Heating and cooling
- ii) Electricity
- iii) Transport

The establishment of this 2020 time frame for the monitoring of estimated impact on primary energy consumption allows forecasting, comply with the new targets set by the EU, 20% reduction of primary energy consumption by 2020 and the overall goal, above, reduction in primary energy consumption by 25% and the specific purpose for Public Administration 30% and it is expected to continue to see a favorable evolution of the global goal of using that RES horizon 2013 -2020.

Regarding the National Renewable Energy Action Plan (PNAER2020, 2013), the program of the use of renewables for heating and cooling sets for 2020 an increasing of 9% compared with 2010 taken as reference; with the major contribute of solar thermal and biomass. The total renewable energy use for heating, cooling and transport predicted for 2016 and 2020 is 5.259ktep and 5.737ktep, respectively.

National Plan for increasing the number of nZEB

According to EPBD Article 9 Paragraph 3(a) the MS are asked to provide national plans for increasing the number of nearly zero-energy buildings. A first version of the Portuguese national plan has been published in 2014. This plan presents:

a). Intermediate targets for improving energy performance of new buildings in order to ensure that by December 2020 all new buildings are nearly zero energy buildings including: i). Qualitative 2015 targets: Interim energy related requirements for new residential and non-residential buildings and ii). Quantitative 2015 targets: Share of nZEB according to official nZEB definition on all newly constructed buildings (define reference parameter e.g. number of buildings, floor area, volume etc.):

b). Intermediate targets for improving the energy performance of new buildings in order to assure that by December 2018, new buildings occupied and owned by public authorities are nearly zero energy buildings including: i). Qualitative 2015 targets: Interim energy related requirements for new public buildings and ii). Quantitative 2015 targets: Share of public nZEB according to official nZEB definition on all newly constructed public buildings (define reference parameter e.g. number of buildings, floor area, volume etc.).

c). Identified policies and measures for the promotion of all new buildings being nearly zero energy after December 2020 for residential and non-residential buildings and including: relevant regulation, relevant economic incentives and financing instruments, energy performance certificates and the layout regarding nZEB, supervision (audits and energy advice), information tools, demonstration, education and training.

d). Identified policies and measures for the promotion of all new buildings occupied and owned by public authorities nearly zero energy after December 2018 and including: relevant regulation, relevant economic incentives and financing instruments, energy performance certificates and the layout regarding nZEB, supervision (audits and energy advice), information tools, demonstration, education and training.

e). Identified policies and measures for the promotion of existing buildings under major renovation residential and non-residential being transformed into nearly zero energy and including: relevant regulation, relevant economic incentives and financing instruments, energy performance certificates and the layout regarding nZEB, supervision (audits and energy advice), information tools, demonstration, education and training.

3.7.4 Identification of aspects on refurbishment of public buildings into nZEB level

Some non-financial deployment barriers are pointed out here. Regarding the on-site renewable electricity generation:

The "Renewables on Time" Program intended to promote the substitution of fossil energy consumption by renewable energy sources through an easier access to electricity microgeneration technologies and solar heating for domestic hot water (DHW). With the "Renewables on Time" residential dwellings, service buildings and others could become small producers of electricity in a simple and easy way with the facilitation of the electricity-generating stations licensing. The program showed a strong momentum in both measures defined for micro for electrical purposes as well as incentives for the installation of new solar thermal systems. Microproduction is now discontinued under this plan taking into account the absence of impact in the final energy. In the first three years, there was an adherence of around twelve thousand micro producers.

Due to climatic conditions in Portugal, a temperate Mediterranean climate with high temperatures in summer and mild in winter, investment in infrastructure, heating and cooling has not be considered to have great significance, given its weak profitability by low levels of use. For this reason, the targets relating to the portion of energy consumption heating and cooling based on renewable, does not include relevant building infrastructures for heating and cooling.

Regarding the financial deployment barriers related as well with on-site RES generation:

- Tariff reduction for the mini and micro generation program;
- End of the fiscal benefits for the installation of renewable energy equipment;
- VAT rate increase from 13% to 23% for the renewable equipment.

Due to new targets for energy consumption and in view of the NEEAP for 2016 several measures in the NREAP of 2020 were reviewed, namely measures related to incentives for installing additional power of RES, especially in technologies still not very competitive:

- Redefinition of support mechanisms associated with emerging technologies or less mature, considered still in the early research / demonstration;
- Concentrated Solar Power (CSP) and Concentrated photovoltaics (CPV): reevaluation of the goals associated due to its high cost in electricity production;
- Incentive the biomass energy use, mainly forests, particularly supporting the equipment for space heating and DHW for the residential sector and public services, wherein the financing should be based on the existing support funds and on the negotiation of the future programming for 2014-2020.

Presently has been launched in the frame work of the energy efficiency fund:

- Residential, aims to support applications for deployment in existing residential buildings (multifamily and single family), solutions for improving energy efficiency. In this first warning, the focus will be on the installation of solar collectors whenever energy certificate for buildings refers to this measure as an opportunity for improvement. This announcement is open to Energy Services Companies (ESCOs), which will interface with the owners of the buildings and condominiums.
- Industry, "Management System of Intensive Energy Consumption (SGCIE) - Encouraging the promotion of Energy Efficiency", which will finance measures included in NEEAP labelled "Program for Competitive Energy Industry" to operators

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of installations covered by the Agreement Consumption Rationalisation of Energy under the SGCIE including support for carrying out energy audits and installation of equipment and systems for the management and monitoring of energy consumption.

- Buildings owned or occupied by Public authorities, with a focus on Energy Efficiency Program for Public Administration - ECO.AP, through Notice "Energy Certification in the Public Sector", in order to make investments aiming the implementation of previous studies, technical analysis and creation of tools and methodologies for the analysis leading to the Energy Certification of buildings and systems integrate the Program ECO.AP or in addition, audits that allow the identification of energy consumption baselines for use in the program ECO.AP.

Climatic conditions

In the Portuguese legislation there are 3 summer climatic zones (V1, V2, V3) defined from the average outside temperature corresponding to the conventional cooling season and 3 winter climatic zones (I1, I2, I3) defined according with heating degree days (HDD) in 18°C base.

In the following tables are presented the criteria for the definition of the climatic zones and the relevant parameters:

Table PT-6: Criteria for winter zone definition

Criteria	HDD ≤ 1000	1000 < HDD ≤ 1500	HDD > 1500
Zone	I1	I2	I3

Table PT-7: Relevant climatic parameters for the heating season (winter)

	z REF m	M		HDD		$\theta_{ext,i}$		G _{Sul} kWh/m ² Per month
		REF month	a month/km	REF °C	a °C/m	REF °C	a °C/km	
Mínho-Lima	270	6,5	1	1420	1,5	7,7	-5	90
Alto Trás-os-Montes	680	7,8	0	2070	1,4	4,3	-4	90
Cávado	170	6,8	1	1160	1,3	8,6	-6	90
Ave	425	7,1	0	1470	1,5	6,9	-6	90
Grande Porto	95	6,9	2	1060	1,6	9,2	-7	95
Tâmega	320	6,9	0	1310	1,6	7,4	-5	90
Douro	580	7,3	0	1880	1,4	5,3	-4	90
Entre Douro e Vouga	300	6,9	1	1250	1,4	7,9	-5	95
Baixo Vouga	50	6,3	2	860	1,1	9,1	-5	110
Baixo Mondego	65	6,2	0	850	1,0	9,2	-5	105
Beira Interior Norte	715	7,8	0	1900	1,0	5,0	-3	90
Beira Interior Sul	330	6,6	1	1030	1,8	8,1	-6	95
Cova da Beira	505	7,3	0	1430	1,4	6,7	-5	90
Serra da Estrela	555	7,7	0	1650	1,6	6,6	-5	90
Dão - Lafões	500	7,4	0	1390	1,9	6,7	-6	95
Pinhal Interior Norte	360	6,6	0	1340	1,6	7,7	-5	90
Pinhal Interior Sul	360	6,3	1	1380	1,5	7,7	-4	90
Pinhal Litoral	125	6,1	0	940	1,9	9,3	-5	95

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Oeste	100	5,8	0	810	2,2	9,8	-8	105
Médio Tejo	170	6,0	0	1130	1,3	8,5	-4	95
Lezíria do Tejo	75	5,7	3	820	2,7	9,4	-7	105
Grande Lisboa	110	5,8	3	700	1,7	10,2	-4	110
Península de Setúbal	50	5,2	0	650	1,5	10,1	-4	110
Alto Alentejo	245	6,2	2	910	1,2	8,8	-3	105
Alentejo Central	220	5,7	2	870	1,1	9,2	-4	110
Alentejo Litoral	90	5,5	2	730	1,1	10,2	-2	110
Baixo Alentejo	180	5,7	0	770	1,0	9,7	-2	110
Algarve	145	5,1	0	610	1,8	10,8	-6	110
R.A. Açores	100	4,0	1	1000	1,0	15	-3	60
R.A. Madeira	300	4,7	1	900	2,0	16	-3	90

HDD - number of heating degree-days, based on 18 ° C, corresponding to the conventional heating station;

M - Duration of the heating season (months);

$\theta_{(ext, i)}$ - Outdoor temperature average of the coldest month of the heating season;

GSul - average monthly solar energy during the season, received a vertical surface facing South, [kWh / m².month]

Table PT-8: Criteria for summer zone definition

Criteria	$\theta_{ext, v} \leq 20^{\circ}\text{C}$	$20^{\circ}\text{C} < \theta_{ext, v} \leq 21^{\circ}\text{C}$	$\theta_{ext, v} > 21^{\circ}\text{C}$
Zone	V1	V2	V3

$\theta_{ext, v}$ – mean temperature during the conventional cooling season (1 June- 30 September)

Table PT-9: Relevant climatic parameters for the cooling season (summer)

	z REF m	$\theta_{ext, v}$		I_{sol}								
		REF °C	a °C/km	kWh/m ² accumulated June-September								
				0°	90° N	90° NE	90° E	90° SE	90° S	90° SW	90° W	90° NW
Minho-Lima	270	20,1	-4	580	165	260	355	355	310	355	355	260
Alto Trás-os-Montes	680	20,4	-7	585	170	260	355	360	310	360	355	260
Cávado	170	20,5	-3	585	165	260	355	355	310	355	355	260
Ave	425	20,2	-3	585	165	260	355	355	305	355	355	260
Grande Porto	95	20,2	-1	590	165	260	360	365	315	365	360	260
Tâmega	320	21,0	-3	590	170	260	355	355	305	355	355	260
Douro	580	21,6	-6	595	170	265	360	360	310	360	360	265
Entre Douro e Vouga	300	20,2	-3	595	170	265	365	365	315	365	365	265
Baixo Vouga	50	20,5	-2	595	170	265	360	360	305	360	360	265
Baixo Mondego	65	20,7	-1	605	170	270	370	365	310	365	370	270
Beira Interior Norte	715	20,6	-5	605	170	265	365	365	310	365	365	265
Beira Interior Sul	330	24,4	-7	615	170	270	370	365	310	365	370	270
Cova da Beira	505	21,9	-6	610	170	270	370	365	310	365	370	270
Serra da Estrela	555	20,7	-4	605	170	265	365	365	310	365	365	265

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Dão - Lafões	500	20,6	-3	600	170	265	365	365	310	365	365	265
Pinhal Interior Norte	360	20,7	-2	610	170	270	365	360	305	360	365	270
Pinhal Interior Sul	360	21,9	-3	615	175	270	370	365	305	365	370	270
Pinhal Litoral	125	19,9	-2	610	170	270	365	360	305	360	365	270
Oeste	100	20,8	+3	615	170	270	370	365	310	365	370	270
Médio Tejo	170	21,5	-7	615	170	270	370	365	310	365	370	270
Lezíria do Tejo	75	22,5	-6	615	170	270	370	360	300	360	370	270
Grande Lisboa	110	21,5	-10	620	170	275	375	365	305	365	375	275
Península de Setúbal	50	22,6	-5	625	175	275	375	365	305	365	375	275
Alto Alentejo	245	23,8	0	620	170	275	375	365	310	365	375	275
Alentejo Central	220	23,6	0	625	170	275	375	370	305	370	375	275
Alentejo Litoral	90	22,0	-7	630	170	280	380	370	305	370	380	280
Baixo Alentejo	180	24,1	-5	635	175	280	380	365	300	365	380	280
Algarve	145	22,9	-1	640	170	280	380	370	300	370	380	280
R.A. Açores	100	20,1	-2	485	140	205	270	275	245	275	265	200
R.A. Madeira	300	20,4	-2	470	150	215	270	255	210	255	270	215

L_v - Duration of the season = 4 months = 2968 hours

$\theta_{ext, v}$ - Outdoor average temperature in cooling season [° C]

$Isol$ - Solar energy accumulated during the cooling season, received horizontal (inclination 0 °) and vertical surfaces (inclination 90 °) [kWh / m²]

The altitude corrections and the values of climatic parameters X associated with a particular location, are obtained based on altitude that location, according to:

$$X = X_{REF} + a (z - z_{REF}) \quad [\text{months or } ^\circ\text{C}]$$

The energy performance of the residential buildings, based on the seasonal method of EN ISO 13790 are beside on tehe previous datas.

Concerning Trade and Service Buildings the energy performance are based on dynamic numerical simulations and LNEG developed syntetic reference meteorological year, for each zone, in 2 formats:: CLIMAS-SCE –".EPW" (ESP-r/EnergyPlus Weather format) for general purpose dynamical simulations; ".DAT" adequate to simplified dynamical simulations (provides hourly temperature, and solar irradiation at the horizontal and at walls oriented at eight directions): [32]

Table PT-10: Primary energy factors

Energy source	Primary energy factor
Electricity	2.50
Electricity (non peak) non-renewable solid, liquid and gaseous combustible	1.0
Thermal energy from renewable sources	1.0

3.8 ROMANIA

3.8.1 State-of-the-art of the EPBD implementation

Romania has started the development of the legal framework regarding the energy savings in buildings in 2000 and continued to build a robust regulatory framework, while transposing EPBD (2003) and EPBD recast (2010) along with other EU legal provisions and policies in the field of energy performance of buildings, energy efficiency and renewable energy. In Romania, the implementation of EPBD is under the responsibility of the Ministry of Regional Development and Public Administration (MDRAP), while the RESD and EED are in the responsibility of the Ministry of Economy (now the Department for Energy within the mentioned Ministry). The regulation of the construction sector, including all aspects related to energy policy in buildings (for all three relevant directives), is the responsibility of MDRAP.

The EPBD has been transposed into the national legal framework by the adoption of Law 372/2005 on Energy Performance of Buildings, which was amended in 2013, in order to be in compliance with the recast EPBD. The energy performance certificate (EPC) is mandatory as provided in the EPBD. For the buildings or building units on sale or rental, the owner/investor/manager of the building is responsible for the EPC elaboration and presentation to the potential buyer or tenant. The selling contracts made without the existence of an EPC may be cancelled according to the provisions of the Civil Code. The general framework for EPC and inspection reports verification and sanctions/penalties for non-compliance were introduced.

The building regulation C107/2005 contains prescriptive element-based criteria for thermal insulation, as well as a global heat transfer coefficient of the heated volume, G-value (W/m^3K), as an overall minimum requirement, depending on the number of the building floors and the external area per volume ratio (A/V). This regulation has been amended in October 2010 (C107/2010 Annex 3) by raising the level required in terms of thermal resistance values for new buildings. Currently there is no minimum energy performance requirement in terms of global indicator, neither for new buildings nor for renovations, except for residential buildings, where the maximum allowed heat demand (per total heated volume) varies from 15 kWh/m³.year to 37.5 kWh/m³.year, depending on the external area per volume ratio (A/V). The maximum indicated heat demand is expressed in terms of final energy, without taking into account the system efficiency. Cooling and Domestic Hot Water (DHW) are also not considered.

The building energy performance is computed and displayed (EPC) based on the calculation methodology (Ministry Order 1057/2007) for the energy performance of buildings (Mc 001/1, 2, 3 - 2006), taking into account the EPBD standards, especially the EN 13790 for heating and cooling, which was available in draft when the methodology was issued. The methodology includes also alternative calculation methods for heating and hot water consumption, based on previous Romanian research activity. The methodology was amended and supplemented with a calculation summary of the energy performance of buildings and EPC template for apartments (2009), by publishing climatic data for EPB calculation methodology application (2012, revised monthly data for 40 cities and reference year for 9 cities), approving procedure for EPC control (2013, State Inspectorate in Constructions), and providing guides for inspection of HVAC and heating systems (2013). The methodology is available both for new and existing buildings, as well as for residential and non-residential buildings.

Regarding the energy certification system, classes in EPC are from A (the most efficient) to G (the most energy consuming). Class A in the energy performance certificate (EPC) ranges from 125 kWh/m².yr (heating, domestic hot water -DHW- and lighting) to 150 kWh/m².yr (all energy uses). EPC covers heating, cooling, ventilation, DHW and lighting (these are the "utilities", i.e. energy uses). For a building which has no cooling system and no mechanical ventilation system, the energy use class A is below 125 kWh/m².yr. These values are not

actually imposed as a minimum requirement for new buildings since there is no requirement for final and primary energy in Romania.

3.8.2 EPBD implementation until 2020

The main changes foreseen for the implementation of EPBD until 2020 relate to the effective implementation of minimum energy requirements according to the cost optimal levels and to the definition of nearly zero energy buildings.

3.8.2.1 nZEB definition

The nZEB general definition is included in the Law 372/2005 on Energy Performance of Buildings, as amended in 2013. According to article 3 of the mentioned legal act, a *nearly zero energy building* is “a building with very high energy performance, in which the energy need from conventional sources is almost equal to zero or is very low and it is covered, in the highest extent possible, by energy from renewable sources, including energy from renewable sources produced on-site or nearby.”

Currently the meaning of “on-site or nearby” is not clearly detailed, however it is generally accepted that it refers to the considered building and corresponding land which is linked with it in terms of property.

The detailed definition of nZEB in Romania, in terms of establishing the levels of main numerical indicators of energy performance, greenhouse gas emissions and use of renewable sources, was performed within the *Plan to increase the number of buildings with nearly zero energy consumption*. The plan (as revised in July 2014, published in September 2014) updates the version notified in October 2013 to the Commission (and posted on its website at: http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm). The definition comprises numerical targets for primary energy use (kWh/m²/y), for specific CO₂ emission (kgCO₂/m²/y) and takes into consideration the share of renewables in a qualitative way.

The plan was reviewed and updated based on completed research results in the field and on recent developments in relevant sustainable development policy at EU and national level, and was completed with the comments received from the DG Energy relating to the detailed application in practice of the definition of nZEB, which includes the non-renewable primary energy indicator, introduces intermediate target (2015) to achieve low energy buildings and presents policies and measures identified for renovation of buildings to achieve nZEB levels.

According to Law no. 372/2005 (republished in 2013):

- New buildings commissioned starting the 31st of December 2020 shall be buildings with nearly zero energy consumption from conventional sources;
- New buildings owned/management by public administration, commissioned starting the 31st of December 2018, shall be buildings with nearly zero energy consumption from conventional sources.

Maximum allowable level of primary energy from conventional sources (fossil fuels) and CO₂ emissions of buildings are fixed as targets by building types and winter climates zones as presented in Table RO-1. Moreover, the total calculated primary energy consumption of a nZEB will be covered by 10% from renewable energy (non-fossil) sources. Renewable energy systems shall be used according to their technical, economic and environmental feasibility and installed on the building or on the corresponding land having the same ownership as the building. In existing buildings undergoing major renovations, the maximum admissible primary energy from conventional sources shall be respected to the extent that

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these investments are technical and economical feasible, based on the return of investment analysis during the normal service lifetime of the building.

The targets set for the nZEB definition are subject to the approval by Ministry Order, which is expected to be issued at the end of 2014 or early in 2015.

Table RO-1: Maximum admissible values of primary energy and CO₂ emissions (building types and winter climate zones)

Climatic Zone	Timeline	OFFICE		EDUCATION		HEALTH		COLLECTIVE RESIDENTIAL		INDIVIDUAL RESIDENTIAL	
		Primary energy [kWh/m ² y]	CO ₂ emissions [kg/m ² y]	Primary energy [kWh/m ² y]	CO ₂ emissions [kg/m ² y]	Primary energy [kWh/m ² y]	CO ₂ emissions [kg/m ² y]	Primary energy [kWh/m ² y]	CO ₂ emissions [kg/m ² y]	Primary energy [kWh/m ² y]	CO ₂ emissions [kg/m ² y]
I	31 Dec. 2015	75	21	115	28	135	37	105	28	131	36
	31 Dec. 2018	50	13	100	25	79	21	100	25	115	31
	31 Dec. 2020	45	12	92	24	76	21	93	25	98	24
II	31 Dec. 2015	93	27	135	37	155	43	112	30	147	42
	31 Dec. 2018	57	15	120	25	97	27	105	28	121	34
	31 Dec. 2020	57	15	115	30	97	26	100	27	111	30
III	31 Dec. 2015	110	28	154	39	171	49	130	36	172	48
	31 Dec. 2018	69	19	136	37	115	32	122	34	155	41
	31 Dec. 2020	69	19	136	37	115	32	111	30	145	40
IV	31 Dec. 2015	107	28	192	56	190	55	152	38	226	57
	31 Dec. 2018	89	24	172	48	149	42	144	40	201	51
	31 Dec. 2020	83	24	170	49	142	41	127	35	189	42
V	31 Dec. 2015	127	29	210	58	214	58	178	48	248	78
	31 Dec. 2018	98	28	192	56	174	49	152	38	229	57
	31 Dec. 2020	89	24	185	53	167	48	135	37	217	54

3.8.2.2 Cost-optimal level requirement

The cost optimal levels of minimum energy performance requirements were analysed based on the methodology provided in the Commission Delegated Regulation (EU) No 244/2012 and the associated Guidelines. The report on the calculation of cost-optimal levels of minimum energy performance requirements for buildings and building elements was issued in November 2013 and sent to the Commission, while an updated report was published in July 2014.

The current requirements concerning the envelope of the building are those according to C107/2010 (currently used for the design of new buildings) and are presented in Table RO-2.

Table RO-2: Maximum thermal transmittances (incl. thermal bridges corr.) – Residential buildings

ENVELOPE COMPONENTS	U' _{max} [W/(m ² K)]	
	Newly built	Existing to be renovated
External walls	0.56	0.71
External windows	1.30	2.50
Terraces	0.20	0.33
Floors of unheated basements	0.35	0.60
Ground floors (no basements)	0.22	0.33
Floors of heated basements	0.21	0.24
External walls of heated basements	0.35	0.50

Source: C107-2005 – amended in 2010

The cost-optimal analysis was performed using dynamic simulations on reference buildings covering the typology included in the EPBD and representative buildings for the existing building stock as well as for new designed and constructed buildings. Cost optimal levels of specific primary energy consumption were defined as a range for each reference building in various climatic conditions representative for Romania and gaps against current requirements for reference buildings were emphasised.

Since no minimum energy performance requirements are currently set in terms of a global indicator (kWh/m²y), the gap was calculated against the primary energy indicators calculated for the reference buildings taking into account the minimum thermal requirements (e.g. maximum transmittances in Table RO-2 for residential buildings) for reference buildings.

The gaps against the optimal range could be eliminated by supplementing existing requirements for building envelope components with minimum requirements for the systems, e.g. by equipping the building with mobile thermo-insulating shutters for the unoccupied hours during winter, by providing it with a mechanical ventilation system with a with efficient heat recovery (min. 72 %), and efficient heating and DHW systems.

Cost-optimal levels will be applied starting 31.12.2015 (see Table RO-1).

Climatic zone II could be considered as representative average for urban area in Romania, while climatic zone IV was used to check the cost optimal levels of the requirements in cold area of Carpathian region.

Table RO-3: Comparison table for both new and existing buildings

Building type	Climatic zone	Reference building (current status) kWh/m ² y	Cost-optimal range/level kWh/m ² y	Current requirements for reference buildings kWh/m ² y	Gap %
Office (exist.)	II	296,50	62 - 100	112,55	12,55
Education (exist.)	II	264,17	67 - 122	154,55	26,38
Health (exist.)	II	552,73	75 - 200	328,12	64,06
Collective residential (exist.)	II	271,07	56 - 112	133,06	18,80
Individual residential (exist.)	II	701,55	155 - 230	317,94	51,27
Collective residential (exist.)	IV	327,96	65 - 135	175,36	66,40
Individual residential (exist.)	IV	941,37	150 - 270	400,05	48,16
Office (new)	II	61,38	45 - 60	61,38	2,38
Education (new)	II	150,31	30 - 78	150,31	92
Health (new)	II	256,18	75 - 200	256,18	28,09
Collective residential (new)	II	132,69	90 - 110	132,69	20,45
Individual residential (new)	II	268,00	95 - 170	268,00	58,00

3.8.3 Overview of existing national plan

Relevant existing national plans in the context of EPBD implementation and towards nZEB public building stock are the National Plan for increasing the number of nZEB, the third Energy Efficiency Action Plan, and the Strategy for mobilising investments in the renovation of residential and commercial building stock.

Furthermore, the second National Action Plan on Energy from Renewable Sources (http://www.minind.ro/pnaer/PNAER_29%20iunie_2010_final_Alx.pdf), the Status Quo Analysis Report, BUILD UP Skills – Romania project (August 2012) and the Roadmap for National Qualification of Building Workforce, BUILD UP Skills – Romania project (April 2013) contain useful information for the substantiation of a nZEB renovation strategy.

National Plan for increasing the number of nZEB

The plan was elaborated during 2013-2014 (published in September 2014) and included for the first time a detailed application in practice of the definition of nZEB in Romania, which includes the non-renewable primary energy indicator, introduces intermediate target (2015) to achieve low energy buildings and presents policies and measures identified for renovation of buildings to achieve nZEB levels (see paragraph on nZEB definition).

The nZEB plan starts from several policies impacting on energy use, as follows:

- The energy roadmap for Romania (GD 890/2003) aiming at a final electricity consumption of 57.59 TWh in 2015;
- The strategy on renewable energy sources (GD 1535/2003) reinforced by the Renewable Energy Action Plan under the RE Directive;
- The national strategy on energy efficiency (GD 163/2004);
- The national strategy on the heating supply of localities through district generation and distribution systems (GD 882/2004);
- The national programme “Heating 2006–2015 heat and comfort” (GD 462/2006) for rehabilitation of the district heating systems and thermal rehabilitation of buildings;
- The National Development Plan 2007–2013, in conjunction with ERDF sectorial programmes and with three major sub-programmes on efficient and sustainable energy, renewable energy sources and interconnection networks;
- Romania’s national energy strategy 2007–2020 (GD 1069/2007) aiming to reach a primary energy intensity of 0.32 in 2015 and 0.26 in 2020;
- The national strategy on the sustainable development of Romania – Horizons 2013-2020-2030 (GD 1460/2008).

Romania’s energy strategy for 2007–2020 includes forecast of the energy consumption made in 2007. However, such forecasts do not consider the influence of the economic crisis.

The main measures of the strategy related to buildings are:

- Intensifying the information campaigns of the population and of the business environment;
- Continuing the “Heating 2006–2015 heat and comfort” programme;
- Continuing the Programme for the improvement of energy efficiency of blocks of flats;
- Expanding the national programme for energy efficiency (retrofitting the heating system, retrofitting public buildings) for 2011–2015;
- The compulsory issuing of the energy performance certificates, starting with 2010, for residential buildings (i.e. single family homes and apartments) that are sold or leased out;
- The enforcement by the central and local public authorities of legislation on energy efficiency and the promotion of the final consumer use of energy from renewable sources.

For an alternative approach, the following range of possible policy measures was identified:

- Establishment of an energy efficiency investment fund to tap into private funds, structural funds, auctioning revenues under EU ETS provisions and possibly the state budget;
- Conducting energy audits and training of energy auditors;
- Consumer awareness-raising and advice campaigns, to raise awareness among households of the benefits of energy audits through energy advisory services in building energy;
- Regulations or voluntary agreements;
- Supporting the development of ESCOs, including developing the regulatory framework for the effective operation of the ESCO, developing the market of these companies and promotion of energy performance contracts by 2016.

These measures are aimed at improving the regulatory framework for building renovation and to mobilise investments in building renovation in order to increase the number of nZEBs.

Third Energy Efficiency Action Plan

According to the provisions of the National Reform 011-2013 (NRP 2011-2013, approved in April 2011), Romania set as targets for 2020 to reduce the consumption of primary energy by 20% compared to the PRIMES 2007 forecasts (estimated at circa 10 Mtoe), a decrease in the greenhouse gas emissions by 19% compared to the reference year 1990 (corresponding to 28.289 thousand CO₂ tons), respectively a weight of 24% of the energy from renewable sources in the gross final energy consumption (corresponding to 7.267 thousand toe). In order to detail the actions considered to achieve these targets, the second National Energy Efficiency Action Plan was published in 2012 and included strategies and measures for primary energy savings (to

produce electricity and heat and for the distribution and transport), final energy savings in end-use sectors, and measures to increase EE in domestic, industrial, transport, service sectors and as well as the public sector. However, like the National Renewable Energy Action Plan, the second NEEAP did not provide a clear quantification of measures engaged in the buildings sector and the support measures included for the building sector were rather general, based on two National programmes for increasing the energy performance of existing buildings (Government Emergency Order No 18/2009 – for collective buildings and Government Emergency Order No 69/2010 - with funds from bank loans with Government guarantee).

The third National Energy Efficiency Action Plan was elaborated in 2014 and is currently in approval process to be submitted to EC.

According to the updated forecast presented in the Plan, the revised target for 2020 (corresponding to an estimated energy consumption for 2020 of 42.99 million toe) for the reduction of primary energy consumption is 1.15 million toe. In terms of final energy, the reduction target for 2020 is 1.64 million toe (corresponding to an estimated final energy consumption of 30.32 million toe).

For the building sector, the Plan references the Strategy for mobilising investments in the renovation of residential and commercial building stock and the definition of nZEB levels which will be approved for 2015, 2018 and 2020. A substantial reduction in energy consumption in buildings can be considered achievable in stages, only through a combination of energy efficiency measures and implementing the use of renewable energy resources and buildings. The three key successive phases identified and proposed national fund to renovate buildings are:

Phase 1: Determine the conditions in which major renovations can become a target within 5 years;

Phase 2: Technological development for buildings renovation that can provide the means to achieve substantial reduction of energy consumption and achieve the level of nearly zero energy buildings from conventional sources, within about 15 years;

Phase 3: Deep renovation of buildings within 15 years.

For Government Buildings, based on the inventory of public buildings heated and/or cooled with a total useful floor area greater than 500m², owned and occupied by central authorities (6.74 million m²), primary energy savings by renovating 3% each year were estimated at 44,194 GWh / year (3,800 toe), resulting total energy savings of 22,800 toe for 2014-2020.

For building stock under local government (which sums 27 million m² of a total 67.2 million m² of non-residential buildings), total energy savings were estimated at about 11,600 toe by thermal rehabilitation to increase their energy performance.

The Regional Operational Programme for 2014-2020 provides thematic objectives (TO) linked to increasing energy efficiency: TO4 - Supporting the shift towards a low-carbon and TO6 - Protecting the environment and promoting resource efficiency, with specific priority axes for Energy efficiency in public buildings and for Sustainable Development (including The energy efficiency of residential buildings).

Other key actions included in the Plan refer to the implementation of monitoring systems (including smart metering), availability of qualification, accreditation and certification systems (especially for energy managers – EED) and programs for energy awareness of final consumers.

Strategy for mobilising investments in the renovation of residential and commercial building stock

The strategy for mobilizing investments in the renovation of existing residential and commercial building stock, both public and private was developed by MDRAP starting from the BPIE report developed in consultation with Romanian stakeholders and published in April 2014.

The strategy was developed using a five-phase stepwise approach (BPIE): (1) identify key stakeholders and information sources, (2) building stock characterization, economic appraisal of renovation potential and quantification of investment requirements, (3) comprehensive appraisal of barriers and development of holistic policy package, (4) draft renovation strategy and consultation, and (5) publish final strategy, commence policy implementation process, establish monitoring and evaluation process and review and update strategy every three years.

Renovation is considered in the strategy as a major opportunity for sustainable modernization of existing buildings, which bring multiple benefits to households, businesses and public sector, while a strategic approach is crucial to stimulate the market which was currently supported only by fragmented initiatives. Funding renovation of buildings is considered the key to success. There are many sources of funding to be exploited and Energy Efficiency Investment Fund should be designed to facilitate investments in renovation of buildings.

A set of policy measures to underpin the renovation strategy was identified, structured by categories: strategic, legal and regulatory, technical, fiscal/financial, capacity building and research & development.

Among the defined most important policies during the next three years, providing support for a national program to renovate the building stock and for renewable energy use in buildings (also improving the utilization of Cohesion and EU Structural Funds), ensuring the achievement of the renovation rate of 3% for central government buildings, developing stimulative regulatory framework for ESCOs and developing a scheme for energy efficiency obligations (EEO) to support extensive renovations after 2017 are crucial for the successful implementation of the renovation strategy. Other measures refer to further improvement of the effectiveness and public acceptability of existing centralized heating systems, to encourage the development of an internal industry of local supply chain to ensure the implementation of renovation measures, to develop promotion and dissemination activities to raise awareness building owners about the opportunities of extensive renovation and to provide a step by step support throughout the rehabilitation process. Creating a stakeholder forum is needed to assist in the implementation and continuous updating of the strategy.

3.8.4 Identification of aspects on refurbishment of public buildings into nZEB level

In Romania the definition and the requirements concerning the nZEB are quite clear and will be introduced in the relevant legislation in short time to ensure the implementation of EPBD obligations for newly built nZEB starting 31.12.2018 (public buildings) and from 31.12.2020 (all buildings), with intermediate targets for 31.12.2015.

Relevant strategies to support building renovations and nZEB concept implementation are defined and financing sources are included in the Regional Operational Programme 2014-2020. However, the concept of “nearly zero energy building” is very new and the market is not getting prepared to embrace it. There is no currently best practice available which could prove the realistic achievement of nZEB definition.

Although many residential collective buildings have been refurbished with national or EU funding grants, which proves the value of energy efficiency, the levels achieved are far from nZEB ones. It is anticipated that best practices and a well-developed raising awareness campaign would increase the leverage effect of Public Rehabilitation Programs by increasing (up to 100%) the private contribution (from building owners) and accelerate the refurbishment of buildings towards nZEB level. An additional condition for the successful change towards high energy performance building stock is the implementation of monitoring systems (equipment and procedures) in order to assess the effect of rehabilitation programs. This is valid for the public building stock as well, which could serve as example for the market.

The low energy prices (ones of the lowest priced for electricity and gas for households in Europe – *Source: Eurostat*) could hinder the implementation of energy efficiency projects (perceived as non-attractive investments). The electricity and gas price regulations, which continue to exist for both household and industrial customers, are subject to future modifications to achieve the provisions of the governmental assumed roadmap to phase out regulated prices for non-household and household customers (approximate to the European average to 2018, influenced by high share of network costs).

Climatic conditions

Romania has a temperate-continental climate with moderate features which is characteristic for Central Europe, with hot summers, long, cold winters and very distinct seasons. Abundant snowfalls may occur throughout the country from December to mid-March, especially in the mountainous areas of Romania.

The annual average temperature depends on latitude and ranges from 8°C in the North and 11°C in the South, with temperatures of 2.6°C in the mountains and 12°C in the plains. In general, the warmest areas are in the southern counties of Romania.

Table RO-4: Climatic data

Climatic zone:	I	II	III	IV	V
Winter design temperature [°C]	-12	-15	-18	-21	-25
Average Tmin [°C]:	1,3	-1,4	-2,9	-3,8	-6,5
Average Tmax [°C]:	23,2	22,6	19,4	18,5	17
Average T year [°C]:	12,1	10,7	8,7	7,8	5,7
Average total horiz. [kWh/m ² yr] - 8760h	1300	1230	1200	1100	1000
Average HDD	2670	3145	3530	3870	4560

The number of hours of sunshine is between 1600-2300 per year, with highest values on the Black Sea coast and lowest values at altitudes over 2500 m.

Heating sources: According to the statistic data presented in D2.1, the main energy sources in public buildings are natural gas and district heating. Natural gas is the heating source in approximately 63% of the public buildings, while district heating in 23% of the buildings.

Primary energy factors:

Table RO-5: Primary energy factors

Energy source / fuel	Primary energy conversion factor
Electricity	2,62
Natural gas	1,17
District heating (cogeneration)	0,92
High efficiency cogeneration	0,30
Biomass (pellets)	1,08

Renewable Energy Ratio (RER) requirement: in the current status, the usage of RES is not yet mandatory, but the requirement for primary energy use can be fulfilled easier if use of RES is considered. The RER is expected to be approved early in 2015 at the value of 10% (share of RES in the total primary energy consumption) for new, nearly zero energy buildings.

Grants: Regional Operational Programme 2014-2020 EU funding financial source will be available, with more than 300 million EUR for public buildings. The implementation guides have not been published, therefore the details are not known yet.

3.9 SLOVENIA

3.9.1 State-of-the-art of the EPBD implementation

National:	Energetski zakon
English:	Energy Act
Acronym:	EZ-1
Act:	Uradni list RS, št. 17/2014
Year of implementation:	2014
Source:	http://www.uradni-list.si/1/content?id=116549

The new Energy Act is transposing in Slovenian legislation a number of European Directives and Regulations concerning market in natural gas and electricity as well as energy efficiency and renewable energy sources. Act in addition to the transposition of European legislation into national law also regulates other areas of energy policy, e.g. energy infrastructure and supply of heat. Slovenia needed the new Energy Act for greater transparency regulation in the energy sector, since the existing law from 1999 was amended already five times and was becoming increasingly opaque.

Key changes in the EZ-1:

In the area of planning and key decision-making by country:

- The energy concept of Slovenia, which will replace the current National Energy Programme, will be shorter strategic document with key development directions for 40 years;
- Local energy concept will be a key document in the field of local development of energy and will need to be coordinated with the spatial plan of the municipality. Thus, the spatial placement of new energy production from renewable energy sources faster.

In the field of electricity and gas:

- Introducing the high standards of consumer protection;
- Changing electricity supplier or natural gas will be possible within 21 days;
- Change of supplier will be possible without penalty before the expiry of the period for which the contract was concluded, if the conclusion of the contract's been one year;
- It also introduces protection of vulnerable customers. The disconnection of vulnerable customers will not occur, as far as the circumstances are such that threaten the life or health.

In the field of heat supply:

- Simplify the rules for the creation of smaller, local district heating systems. Rates of heat in the case when it comes to care for more than 100 households, remain regulated in the future.

In the field of energy efficiency:

- Each year it will be necessary to renovate 3% of public buildings, which will encourage new jobs, but bring savings in public expenditure.

In the field of renewable energy sources:

- Support scheme for electricity production from renewable energy sources remains a fundamental instrument for the promotion of renewable energy sources, but it varies so that the incentives only benefit from the new plant, which will produce energy at the lowest cost. Thus preventing the uncontrolled growth than we previously saw in the case of photovoltaic power plants. The Government will determine which technologies will be encouraged, and to what extent.

In the field of energy infrastructure:

- Simplifies the procedures for obtaining all necessary permits for the construction of energy infrastructure, which will make an investment cheaper.

In the area of market regulation in electricity and natural gas:

- Energy Agency of the Republic of Slovenia will continue to perform the work as a market regulator;
- Provides the legal separation of the national regulatory body from all public and private entities;
- Provides independently and autonomously functioning of the regulatory body, independent of any political body.

National:	Pravilnik o učinkoviti rabi energije v stavbah
English:	Regulations on Energy Efficiency in Buildings
Acronym:	PURES 2010
Act:	Uradni list RS, št. 52/2010
Year of implementation:	2010
Source:	http://www.uradni-list.si/1/content?id=98727

Since the first thermal regulation was accepted in 1970, several strengthening and changes of the minimum requirements for new buildings took place. The latest regulation on energy efficiency in buildings (PURES 2010) came into force in 2010. It incorporates the elements harmonised with the requirement of the EPBD Recast in detail. As a next step towards nearly zero-energy buildings, it includes a tightening of the requirements already in 2015 for new buildings.

In Slovenia, the implementation of the Energy Performance of Buildings Directive (EPBD) is the overall responsibility of the Ministry of Infrastructure and Spatial Planning. The EPBD was transposed into the national legislation by the Building Construction Act, the Environmental Protection Act, and the amended Energy Act (on the 17th of November 2006). The secondary regulation on new minimum requirements, calculation methodology, feasibility studies and regular inspection of air-conditioning (AC) systems was promulgated in 2008, while the regulation on Energy Performance (EP) certification was accepted in 2009. The training and licensing of independent experts working on the building EP certification and AC systems inspection, as well as the protocols related to the certificates registry, were defined in detail in the 2010 Regulation. The regular inspection of boilers was implemented by an existing scheme, upgraded in November 2007. Since 2013, the revision of the current legislation has been in progress, in order to comply with the requirements of the recast EPBD in 2010. Slovenia is also in the process of establishing and improving the certification process.

Based on the EPBD Recast Slovenia adopted the Regulations on Energy Efficiency in Buildings (PURES 2010) June 2010, which introduces a methodology for the calculation of indicators of the energy performance of the building in accordance with the EPBD CEN standards or SIST EN ISO 13790. It provides minimum requirements for the energy performance of new buildings and major renovation of existing buildings, lays down minimum requirements in the event of maintenance and technical improvements (before the end of the life of each individual element of the system and subsystem building).

Performance-based minimum requirements 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 the recast EPBD, 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. Mechanical ventilation with heat recovery is not a mandatory technology (natural ventilation is also allowed) but, in practice, it is needed for buildings with Energy Class B or higher, as the reduction of ventilation heat losses by heat recovery systems leads to correspondingly low energy need for heating, which is required for Class B and higher. If mechanical ventilation is used, then heat recovery is mandatory.

Compliance with the PURES 2010 Regulation must be demonstrated by fulfilling the following energy-related minimum requirements: 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}), as well as maximum primary energy for the energy systems operation (HVAC and lighting). Maximum U-values of the envelope elements are prescribed for all buildings. Public buildings must comply with 10% more strict 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 beyond Dec. 31, 2014.

An important novelty is the requirement of at least 25 % share of renewable sources in total delivered energy for the operation of (all) systems in the building. However, if the latter requirement is not met, the RES requirement is considered as fulfilled in the following cases:

- if the share of delivered energy for heating and cooling of the buildings and hot water is obtained in one of the following ways:
 - at least 25 percent of solar radiation,
 - at least 30 percent of the gaseous biomass,
 - at least 50 percent of solid biomass,
 - at least 70 percent from geothermal energy,
 - at least 50 percent of ambient heat,
 - at least 50 percent of CHP plants with high efficiency in accordance with the regulations, which regulates the supporting electricity produced by cogeneration of heat and electricity with high efficiency,
 - the building is at least 50 percent supplied from the energy-efficient district heating and cooling.
- if a necessary energy need for heating is at least 30 percent lower than allowed minimum requirements,
- buildings or dwellings that have installed at least 6 m² (bright areas) solar panels with an annual yield of 500 kWh / (m²a).

PURES 2010 sets strict minimum requirements for thermal protection of the building envelope and for the minimum energy need for heating of the buildings. Together with the prescribed 25 % share of renewable energy sources in total delivered energy consumption for the operation of the building and technical requirements for systems is a key part of the minimum requirements for energy efficient buildings.

The additional minimum requirements refer to the maximum U-values of building envelope and windows, and to the airtightness of the envelope ($n_{50} < 3$ for natural ventilated buildings, and $n_{50} < 2$ for buildings with mechanical ventilation, with obligatory heat recovery).

A comprehensive list of requirements refers to energy efficiency characteristics of installations. Heat recovery in ventilation must be used due to the strict requirements for maximum allowed ventilation heat losses. 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 °C), as well as condensing gas boilers, are obligatory in new buildings. 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 of a separate regulation. Additional requirements for cooling refer to obligatory shading of the envelope, and to efficiency requirements for cooling systems. The total shading factor resulting from the positioning of natural or artificial objects, as well from the position and type of the shading device on the window, with consideration to glazing characteristics, must be lower than 0.5 ($g < 0.5$). Internal shading devices are not considered as solar protection.

The minimum requirement for lighting defines the maximum allowed specific power of lighting devices per building category. Energy-saving lamps are obligatory; at maximum, only 20% of lighting may be covered by incandescent light bulbs.

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 CO₂ indicators are given. After the building is completed, the calculation and the summary have to be repeated (by the designer, for the building as 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 the use permit. Fulfillment of the minimum requirements has to be demonstrated in the design 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 Energy Performance Certificate (EPC).

Minimum requirements apply to all new buildings, as well as to major renovations, i.e., if at least 25% of the surface of the building envelope is subject to renovation. The minimum requirements for major renovations must be implemented regardless of the building size. If a renovation (i.e., when a building permit is needed) is limited to less than 25% of the thermal envelope surface, in case of maintenance works on the building envelope, and in case of buildings with a floor area smaller than 50 m², only the minimum requirements for the U-values of the envelope must be considered (i.e., an additional insulation layer will be mandatory). In case of major renovation of the heating system, and in case of maintenance and replacement works, minimum requirements for the systems, subsystems and elements of the same level as that required for new buildings are to be implemented.

3.9.2 EPBD implementation until 2020

National:	Pravilnik o učinkoviti rabi energije v stavbah
English:	Regulation on Energy Efficiency in Buildings
Acronym:	PURES 2010
Act:	Uradni list RS, št. 52/2010
Year of implementation:	2015
Source:	http://www.uradni-list.si/1/content?id=98727

As a next step towards nearly zero-energy buildings, current national regulation provides strengthening of minimum requirements for the energy performance of new buildings and major renovation of existing buildings, including minimum requirements in the event of maintenance and technical improvements. The regulation indicates strengthening of minimum requirements of:

- specific heat transfer coefficient by transmission,
- energy need for heating, separately for residential, non-residential and public buildings,
- energy need for cooling for residential buildings and
- primary energy for residential buildings.

Figure SI-1 shows gradual reduction of minimum requirements over time between minimum requirements that apply today in comparison with the new regulation in 2015 for energy need for heating regarding to the shape factor. For public building with shape factor 0.6, the current minimum requirement for energy need for heating is 14 kWh/ (m(3)a). Regulation applied with 2015 envisages strengthening of that condition on 11.2 kWh/ (m(3)a), which is 20% stricter requirement.

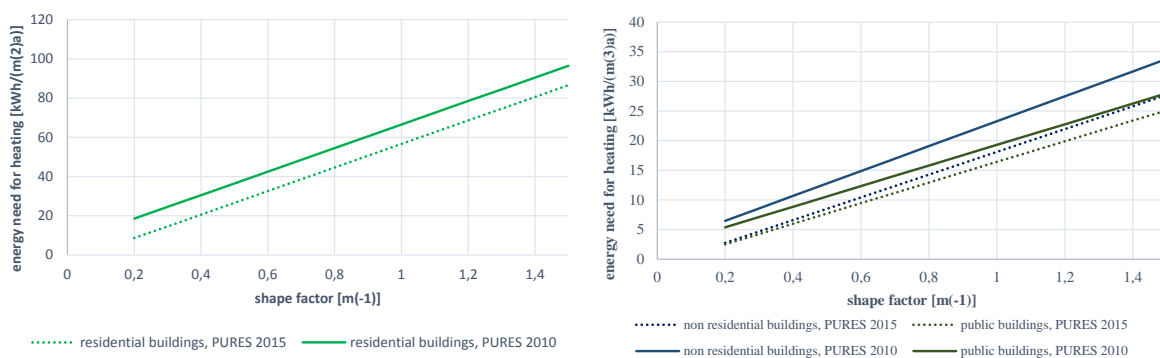


Figure SI-1: Strengthening of minimum requirements of energy need for heating

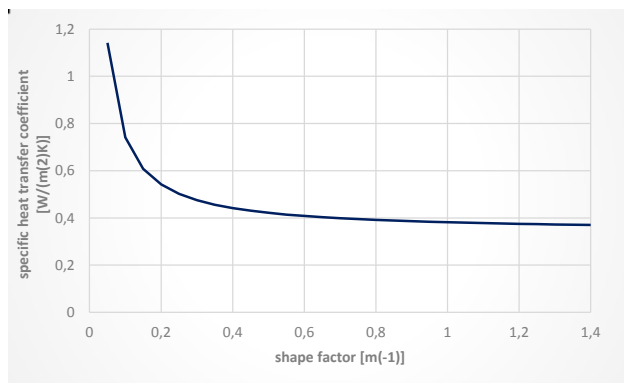


Figure SI-2: Maximum allowed specific heat transfer coefficient by transmission

3.9.2.1 nZEB definition

nZEB definition

The main changes related to nearly zero energy buildings and requirements are corresponding to the national report on cost optimal levels. In Slovenia, the definition of nearly energy zero building is being added through the National plan for nearly zero energy building [37] (to be confirmed in December 2014 or January 2015):

Nearly zero energy building is a building with a very high-energy efficiency or a building with a very low required energy for operation, wherein the required energy is in a large extent produced from renewable energy sources on site or nearby.

The definition foresees the minimal annual energy need for heating of 25 kWh/(m²a), minimal level of primary energy according to the building category and at least 50% share of RES in respect to the total delivered energy. The table below presents the values that are not yet confirmed/official, since the document only finished with the public hearing and is going through the procedures of being accepted. It is important to point out that this may not be the final figures.

Table SI-1: Minimal level of primary energy consumption

Type of building	Minimal level of primary energy according to the building category (kWh/m ² a)		Share of RES [%]
	New building	Major renovation	RER
Single family building	85	105	50
Multi family building	80	90	50
Non-residential (office) building	55	80	50

3.9.2.2 Cost-optimal level requirement

The cost optimal levels of minimum energy performance requirements were analysed based on the methodology provided in the Commission Delegated Regulation (EU) No 244/2012 and the associated Guidelines. The report on the calculation of cost-optimal levels of minimum energy performance requirements for buildings and building elements was issued in March 2014 and sent to the Commission, while an updated report was sent in December 2014.

The cost-optimal analysis was performed using dynamic simulations on reference buildings covering the typology included in the EPBD and representative buildings for the existing building stock as well as for new buildings. The analysis focused on four building categories: single family houses, multifamily houses, public buildings and non-residential (office) buildings.

Cost optimal levels of specific primary energy consumption were defined as a level for each reference building and gaps against current requirements for reference buildings were emphasised.

Table SI-2: The gap between the current requirements and the cost optimal levels for new buildings (Source: Cost optimal calculations: SI report to European Commission)

		Cost optimal level	Current requirements for reference buildings	Gap
Calculation	Reference building	Primary energy [kWh/(m ² a)]	Primary energy [kWh/(m ² a)]	[%]
Financial level	Single family house ESS1	75	89	-14%
	Single family house ESS2	85	93	
	Multifamily house VSS1	84	96	
	Public building JSS1	66	69	
	Non-residential building NSS1	56	69	
	Non-residential building NSS2	68	80	
Macroeconomic level	Single family house ESS1	75	89	-17%
	Single family house ESS2	85	93	
	Multifamily house VSS1	84	96	
	Public building JSS1	58	69	
	Non-residential building NSS1	58	69	
	Non-residential building NSS2	63	80	

Table SI-3: The gap between the current requirements and the cost optimal levels for existing buildings (Source: Cost optimal calculations: SI report to European Commission)

		Cost optimal level	Current requirements for reference buildings	Gap
Calculation	Reference building	Primary energy [kWh/(m ² a)]	Primary energy [kWh/(m ² a)]	[%]
Financial level	Single family house ESS1 - 1960	93	97	13%
	Single family house ESS1 - 1980	93	97	
	Single family house ESS2 - 1960	100	117	
	Single family house ESS2 - 1980	85	117	
	Multifamily house VSS1 - 1960	86	102	
	Multifamily house VSS1 - 1980	86	102	
	Public building JSS1 - 1960	119	72	
	Public building JSS1 - 1980	105	72	
	Non-residential building NSS1 - 1960	119	72	
	Non-residential building NSS1 - 1980	105	72	
	Non-residential building NSS1 - 1960	134	79	
	Non-residential building NSS2 - 1980	119	79	
	Macroeconomic level	Single family house ESS1 - 1960	93	
Single family house ESS1 - 1980		93	97	
Single family house ESS2 - 1960		100	117	
Single family house ESS2 - 1980		85	117	
Multifamily house VSS1 - 1960		31	102	
Multifamily house VSS1 - 1980		31	102	
Public building JSS1 - 1960		87	72	
Public building JSS1 - 1980		77	72	
Non-residential building NSS1 - 1960		49	72	
Non-residential building NSS1 - 1980		77	72	
Non-residential building NSS1 - 1960		61	79	
Non-residential building NSS2 - 1980		104	79	

The gap was calculated for financial and macroeconomic level from which the financial is to become the national benchmark. In accordance with article 14 of Directive 2010/31/EU, there is a large gap between the result of the calculation of cost-optimal levels and the minimum energy efficiency requirements in the country, if the requirements are lower by more than 15% than the cost optimum.

The results of the analyses on new buildings show that the gap in macro-economic calculation of the applicable requirements and cost-optimal level does not exceed -17%. In financial calculations, which is selected as a national benchmark, this gap does not exceed -14%, which is within the allowable gap between the current minimum requirements for the energy performance of the building and the cost-optimal levels. The results for existing buildings show that the gap in macro-

economic calculation of the current requirements and cost-optimal level does not exceed -21%. In financial calculations, which is selected as a national benchmark, this gap does not exceed + 13%, which is within the allowable gap between the current minimum requirements for the energy performance of the building and the cost-optimal levels.

3.9.3 Overview of existing national plan

Valid national plans and national plans in public hearing are as follows:

- **National Action plan for energy efficiency for the period 2014-2020 (AN URE 2020)** [38]

Slovenia poses a national objective with The Action Plan for Energy Efficiency for the period 2014 - 2020, in accordance with the requirements of the Directive on Energy Efficiency (2012/27 / EU) of improving the energy efficiency of energy use by 20% by 2020. This objective is that primary energy consumption in 2020 will not exceed 7.125 million toe (82.86 TWh). This means that, depending on the year 2012 it will not increase by more than 2%. The measures in the AN URE 2020 are planned in the household sector, public sector, economy and transport. Most of the measures constitutes already existing measures that are being implemented and with which the intermediate objectives have so far been achieved. The new action plan brings in the public sector of measures, since it is necessary to fulfil an obligation of 3% renovation of public central buildings per year. Objective is to ensure that all new buildings owned and occupied by public authorities are nearly zero energy from 2018, and in other sectors from the 2020. Additional measures are provided in the economy since energy efficiency is becoming increasingly important factor for improving the competitiveness of the economy.

- **National Action plan for Renewable Energy Sources** [39]

On the basis of Directive 2009/28/EC of the European parliament and of the council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC and Commission of the European Communities, no. C (2009) 5174 is up to each Member State to adopt a national action plan for renewable energy sources for 2010-2020 and to the European Commission by 30 June 2010. For Slovenia it is determined that by 2020 at least 25% share of RES in gross final energy use. By contrast, the criteria for appropriate distribution and take into account the different starting points and potentials of the Member States, Directive 2009/28 / EC provides that at least 10 per cent target for renewables in transport to be set at the same level for each Member State.

- **National Action plan for nZEB buildings (AN sNES)** (to be confirmed)

The definition of nearly zero-energy buildings is a set of minimum requirements for the largest permitted energy needs for heating, cooling or air conditioning, hot water and lighting building under construction with technical legislation (PURES 2010), establishing the maximum primary energy use in the building and determine the minimum allowable share of renewable energy in the total delivered energy for the operation of the building. The scientific bases of the technical definition of nearly zero energy buildings includes both new construction and complete renovation of an existing type of buildings. The Action Plan envisages that by 2018 a comprehensive energy renovated 123,000 m² of public buildings, 84,126 m² of new public buildings will be nearly zero-energy new buildings. By 2020, a nearly zero-energy renovation of 2.257 million m² of dwelling buildings is foreseen, as well as 649.000 m² of apartment buildings and 267,500 m² of new construction dwelling buildings and 649.000 m² of new construction of apartment buildings. The Action Plan also includes interim targets for 2015 and 2018, respectively. AN sNES also sets targets for public buildings of central government, which has since 2014 required to provide an annual 3% renovation of the total floor surfaces of buildings that are owned and used by the central government.

- **Long-term energy balance of the Republic of Slovenia for the period 2010 to 2030**

- **Long-term energy balance of the Republic of Slovenia to 2030 and technical basis for setting national energy goals** (to be confirmed)

3.9.4 Identification of aspects on refurbishment of public buildings into nZEB level

Aspect of measures for increasing energy efficiency in public buildings

In the implementation of measures to increase energy efficiency, the priority will be given to buildings of the central government with the lowest energy performance. Accelerated funding for renovations is necessary since the renovation of buildings is also an important measure to promote economic growth and because the State is obligated under Directive 2012/27/EU to 3% annual renovation of the total floor area of buildings owned and used by the central government body. Priority list, which determines which buildings are going to have priority in terms of providing greater savings, the ministry prepares based on constructed *Long-term strategy for investment promotion renovation of buildings*. Based on until then produced energy performance certificates of buildings, energy audits and collection of data on energy consumption, the strategy will set priorities of renovations in individual buildings of central government and technical bases. Given that the proportion of buildings protected under the regulations governing the protection of cultural heritage in the segment of public buildings is very large and that this segment requires special treatment.

In order for projects to be appropriately chosen and implemented, it is necessary to establish a technical office. The latter would prepare relevant professional basis and starting points for the preparation of projects and selection of the appropriate contractors. Furthermore, such office is going to monitor, analyse, and evaluate projects savings and the effects of implemented projects, which is especially important in energy contracting projects, such as new forms of financing renovation of buildings.

Duties of employees in this area would be preparation of appropriate of expert documents/bases for the preparation of projects documentation, cooperation with the drafters of applications and enterprises for the provision of energy services (coordination between the client and contractors-country projects). The offices would offer legal, professional and technical assistance for the implementation of energy contracting projects both at national and local level, implemented and trained public purchasers (workshops, seminars, conferences) and to cooperate with relevant ministries. Priority list of facilities and detailed criteria for the design calls for the preparation of project documentation (concept) for the rehabilitation of buildings and to finance energy efficiency renovations will also become an integral part of the Strategy renovation of buildings. With the introduction of energy bookkeeping and higher quality data on energy use in buildings of central government on the basis of data sources (energy performance certificates for all buildings, energy audits, management systems and energy) the list will be periodically updated.

Table SI-4: New measures of efficient energy use in public building sector

<i>Measure</i>	<i>Program/Upgrade</i>	<i>Type of measure/Jurisdiction</i>	<i>Target Group</i>	<i>Deadline</i>
Establishment of technical office	AN URE 2020 The implementation of projects of national energy renovation of buildings within the energy contracting.	The ministry responsible for physical assets	National authorities	2014-2020
Support scheme for the	AN URE 2020 Preparation and	Set of instruments / The ministry responsible for	The buildings of cultural heritage and	2014-2020

<p>renovation of heritage buildings and other specific groups of buildings</p>	<p>implementation of a new instrument for the renovation of heritage buildings and other specific groups of buildings: the development of criteria renovation, demonstration projects, development and deployment of technologies, financial support schemes, provision of funds for the 2014-2020 period.</p>	<p>construction and ministry responsible for culture and ministry responsible for energy</p>	<p>other special groups of buildings</p>
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Climatic aspect

Figure SI-3 which shows the distribution of degree-days on a map, the estimate for the distribution of energy consumption for heating. Degree-days and the duration of the heating season are increasing with altitude (Figure SI-3). For 108 places, degree-days and the duration of the heating season were calculated.

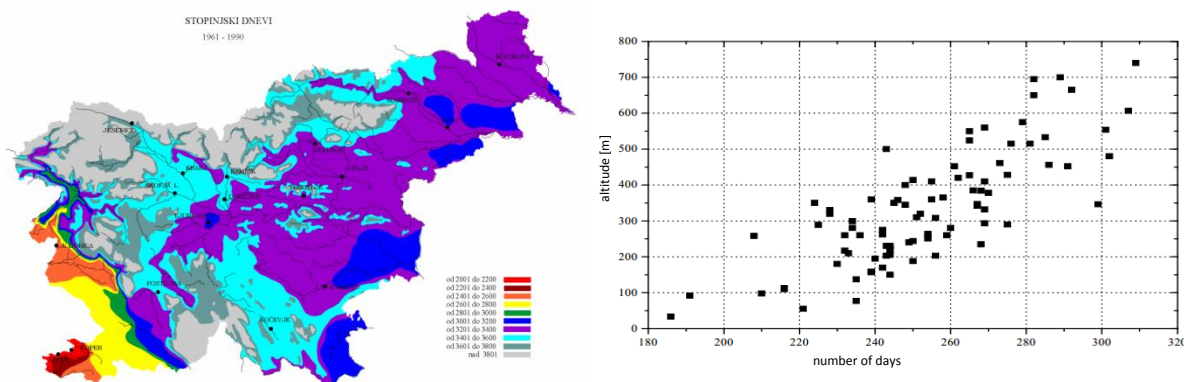


Figure SI-3: Spatial distribution of degree-days (right) and duration of the heating season, depending on the altitude (left) (ARSO)

Climate in Slovenia is determined by many factors, the most important are its geographic location, diverse terrain, the orientation of mountain ridges and proximity to the sea. The result of many intertwined factors is a very diverse climate. Thus, there are three predominant types of climate in certain areas but their effects are intertwined: in eastern Slovenia has a temperate continental climate in central Slovenia sub-Alpine (Alpine in the mountains) and west of the Dinaric-Alpine barrier sub-Mediterranean climate. Climate diversity of Slovenia is reflected in the differences between the values of climate variables and their daily, seasonal and multi-annual variability.

The lowest average temperature in Ljubljana is -1°C in January, the highest is in July – 20°C (Table SI-). The average yearly temperature is 9.7°C. The design outdoor temperatures for sizing the heating systems is -13°C in the heating season (depends on the location within the country). The number of hours of sunshine for Ljubljana is between 1800 and 1900 hours per year, the global horizontal radiation is 1121 kWh/m²a.

Table SI-5: Monthly climatic data for Ljubljana [41]

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°C	-1	1	6	10	15	18	20	19	15	10	4	1
Relative humidity	%	82	77	72	71	73	72	75	76	80	82	84	85
Radiation	kWh/ m ² a	917	1731	2759	4049	4894	5274	5469	4739	3354	1911	983	698

RES aspect

In 2005 the share of RES in final overall energy consumption in Slovenia was 16.2 percent. Slovenia must achieve at least a 25-percent share in the balance of final energy by 2020. Considering the natural resources in Slovenia and the current stage of the development of RES technologies, the most appropriate RES for power production seem to be wood biomass and hydropower. The sun is a free and evenly distributed energy source; however, the exponential increase of installed capacity of the solar power plants in Slovenia, exceeding 6% of all RES capacity in 2011, with high subsidy rates of more than 10%, did not provide more than 1.4% of all the electricity produced by RES. The use of municipal waste is also very promising, with a large supply, but requires complex and interrelated systems, which inhibits its faster deployment. On the other hand, anaerobic fermentation of organic matter for biogas production has great potential, well-developed technology and all prerequisites to be a key technology for the self-supply of sustainable energy.

Hydropower is already well utilised in Slovenia; actually, there are only a few opportunities left for further increasing the capacity of hydropower plants without coming into conflict with the sustainable conservation of nature. In contrast, there is an abundance of wood, which has a great development potential. Wood is already recognised as a strategic resource, which should be principally used in wood industry for products with high benefit, as well as a by-product for energy production. In one way or another, a rational synergy between the still largely unexploited potential of some RES, and the cost-effective energy optimisation, could become one of the cornerstones for sustainable buildings, as well as for the successful development of Slovenia.

The objectives of Slovenia's energy policy for renewable energy sources are:

- Ensuring a 25% share of renewable energy sources in final energy consumption and a 10% share of renewables in transport by 2020, which under current predictions will involve a doubling of energy generated from renewable sources relative to the baseline year of 2005;
- Halting the growth of final energy consumption,
- Implementing efficient energy use and renewable energy sources as economic development priorities,
- In the long term, increasing the share of renewable energy sources in final energy consumption up to 2030 and beyond.

In primary energy consumption, the main role for reference and intensive strategies will continue to have hydropower and biomass. The most intensive growth in the use of biofuels in transport and direct use of geothermal energy, which in both strategies followed by solar energy. The structure of primary energy from renewable sources and a comparison between the reference and intensive strategy shown in Figure SI-4.

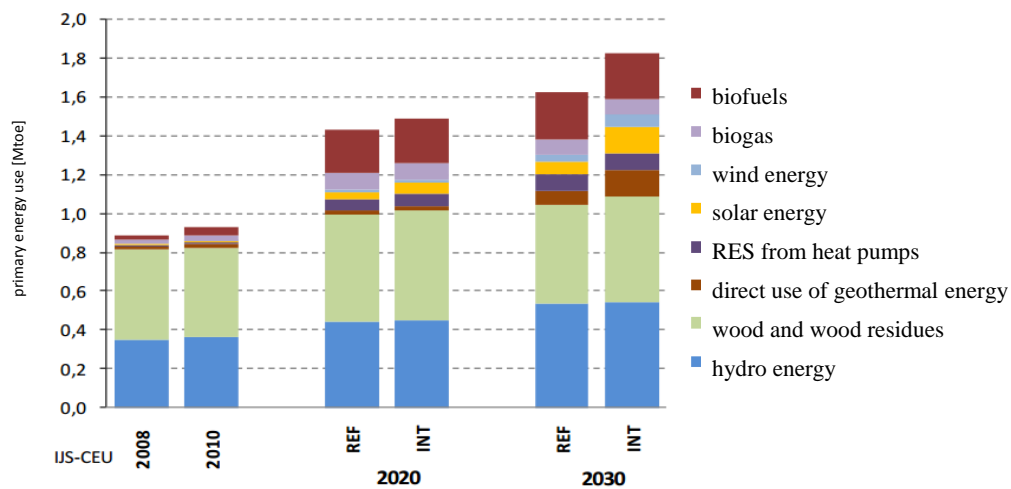


Figure SI-4: Primary energy use from renewable energy sources (reference(REF) and intensive(INT) prognosis)

Energy prices

For industrial user (not household) the national average energy prices are displayed in Table SI-6: Energy prices for electricity and gas [40], where H1 and H2 indicate the first and second half of the year.

Table SI-6: Energy prices for electricity and gas [40]

<i>Gas prices [EUR/kWh]</i>	2013 H1	2013 H2	2014 H1
No taxes	0,0397	0,0377	0,0348
No VAT	0,0445	0,0425	0,0396
With taxes and VAT	0,0534	0,0519	0,0483

<i>Electricity prices [EUR/kWh]</i>	2013 H1	2013 H2	2014 H1
No taxes	0,0860	0,0819	0,0760
No VAT	0,0987	0,0938	0,0871
With taxes and VAT	0,1184	0,1145	0,1063

Heating sources:

According to the statistic data presented in D2.1, natural gas, district heating and oil are the most common used energy carries for the system heating and the preparation of DHW.

Primary energy factors

Table SI-7: Primary energy factors for Slovenia

Label / type of factor	Primary Energy Factors Slovenia
<i>Used for EPC rating</i>	✓
<i>Used for building regulations requirements</i>	✓
<i>Label (national language)</i>	PURES 2010 Tehnična smernica za graditev TSG-1-004:2010 Učinkovita raba energije
<i>Description / type of weighting factor</i>	non-renewable energy amounts, includes upstream energy expenditures (transportation, transformation) beyond national boundary
<i>Factor is multiplied by delivered energy based on the</i>	net calorific value
<i>Reference</i>	[TSG-01-004:2010]
<i>Natural gas</i>	1.1
<i>Heating oil</i>	1.1
<i>Biomass</i>	0.1
<i>Electricity</i>	2.5
<i>District heating with CHP</i>	1.0
<i>District heating without CHP</i>	1.2

Renewable Energy Ratio (RER) requirement

In the current status the usage of RES is mandatory as set forth in PURES 2010. Later, from 2019 (public buildings), and 2021 (all buildings), 50% share of RES will be mandatory for new, nearly zero energy buildings.

Drivers and barriers

The following activities can be treated as examples of best practise on the EPBD implementation field in the last years in Slovenia:

- Introduction of energy performance certificates;
- Improved inspection schemes for heating and air-conditioning systems;
- investigation of cost-optimality of the minimum requirements in the Slovenian Building code;
- National Action plan for nZEB buildings with national definition of nZEB;
- Further intensive training of independent experts for Energy Performance (EP) certification and regular inspection of air-conditioning (AC) systems;
- Development of the electronic database of EPCs and software support.

The following activities are planned for the short and medium term:

- Establishment of the database of energy indicators and, based on that, provision of feedback regarding the energy indicators, for ranking per different building types (as needed in case of complex and mixed-use buildings);
- Validation of calculation tools.
- Establishment of a quality control system.

Existing barriers of the EPBD implementation in Slovenia:

- Organisational barriers for major renovation with nZEB targets;
- The lack of innovative financing instruments for nZEB buildings and major renovation;
- Phased implementation of technical aspects of nZEB regulation (e.g. lack of hourly simulation tools);
- Lack of properly trained staff for demanding nZEB planning and construction process;
- Lack of demo projects in public buildings (e.g. exemplary public buildings).

3.10 SPAIN (Catalonia Region)

3.10.1 State-of-the-art of the EPBD implementation

The directive EPBD is implemented in the Spanish legislation via the following national regulations:

- a) Royal Decree 235/2013, from 5 of April, regarding the basic procedure for the energy efficiency certification

Establishes the energy efficiency certification of existing and new buildings. A compulsory energy efficiency certificate should be available for buyers and tenants from 1st June 2013. It transposes the obligation that all the new buildings as per 31 december 2020 (2018 for public buildings) will be nZEB, being the minimum requirements established in the Technical Building Code (CTE) which will be in force by then. Available at: <http://www.boe.es/boe/dias/2013/04/13/pdfs/BOE-A-2013-3904.pdf>

Table ES-1: Residential Building Energy Performance Level

Building energy performance level	Building energy performance
A	$C1 < 0,15$
B	$0,15 \leq C1 < 0,50$
C	$0,50 \leq C1 < 1,00$
D	$1,00 \leq C1 < 1,75$
E	$C1 > 1,75$ & $C2 < 1,00$
F	$C1 > 1,75$ & $1,00 \leq C2 < 1,5$
G	$C1 > 1,75$ & $1,50 \leq C2$

C1 and C2 are two factors calculated with a formula with different parameters as the CO₂ emissions or the Non renewable primary energy consumption of the building under study compared to a mean value of new buildings or existing buildings, depending on the case. The calculations include heating, cooling and DHW

Table ES-2: Non Residential Building Energy Performance Level

Building energy performance level	Building energy performance
A	$C < 0,40$
B	$0,4 \leq C < 0,65$
C	$0,65 \leq C < 1,00$
D	$1,00 \leq C < 1,30$

E	$1,30 \leq C < 1,60$
F	$1,60 \leq C < 2,00$
G	$2,00 \leq C$

C is the quotient between the annual CO₂ emissions or the primary energy (non renew.) consumption of the building under consideration and the annual CO₂ emissions or primary energy (non renew.) consumption of the reference building. The calculations include heating, cooling, DHW and lightening.

- b) Royal Decree 314/2006, approbation of the Technical Building Code (CTE). The Basic Document DB-HE “Energy Savings” was updated by the Order FOM/1635/2013, 10 September 2013

The Technical Building Code (CTE), entered in force in 2006 for new buildings. In 2013 there was an update of the Technical Building Code to adapt the Spanish Legislation to the EPBD requirements. This update applies to new buildings, enlargements and renovations of buildings. The update of the building technical code entered in force on the 13th March 2014.

This building regulation code limits the primary energy consumption in function of climatic zone and building use for new or enlargement of buildings. The consumption accounts for heating and cooling, DHW and lighting (tertiary buildings only) (HE0). There is a limit for the heating and cooling energy demand for new or renovated buildings, also depending of climatic zone and building use (HE1). Moreover it regulates for new and renovated buildings the energy efficiency in lighting (HE3), the minimum solar contribution for DHW (30 to 70% in function of climatic zone and the DHW demand) (HE4) and the contribution of photovoltaics depending on the climatic zone and the building’s surface (tertiary buildings only) (HE5). It regulates the efficiency of thermal equipment via the “Regulation on Building Heating Installations”

HE 0 – Minimum energy requirements for energy use

- New buildings and enlargements of existing buildings.
- The primary energy consumption non-renewable is limited to: 40 kWh/m²a up to 70 kWh/m²a depending of the climatic zone. A correction factor according the surface is applied over these values.
- In non-residential buildings, the efficiency of the buildings should be equal or higher than category B ($0,4 \leq C < 0,65$), where C is the quotient between the primary energy non-renewable consumption of the building under consideration and primary energy non-renewable consumption of the reference building.

HE 1 – Minimum energy requirements for energy need

- For new buildings and refurbishment and/or enlargement of existing buildings. The requirements are different for new and existing buildings.

New buildings

- Private residential use:
 - Maximum energy demand heating: 15 kWh/m²a to 40 kWh/m²a in function of the climatic zone, a correction factor according the surface is applied over these values

- Maximum energy demand cooling: 15 kWh/m²a for 3 climatic zones and 20 kWh/m²a for the hottest summer climatic zone
- Other uses:
 - Cooling and heating demand as a % of savings in comparison to a reference building, in function of the climatic zone and the internal heat gains

Existing buildings

- Renovations of more than 25% of the building envelope
 - Energy demand should be less than the reference building
- Renovation of less than 25% of the building envelope
 - The replaced elements should fulfill the characteristics required in the above mentioned table: Thermal transmittance and air permeability of the building envelope

HE 2 – Minimum requirement for H/C systems

- New buildings and existing buildings when the H/C system is renovated.
- It should fulfill the requirements established in the Royal Decree. 1027/2007, Regulation on Building Heating Installations (Reglamento de instalaciones térmicas en los edificios (RITE)) updated by Royal Decree 238/2013, 5 April 2013.

HE 4 – Minimum contribution of solar thermal for DHW

- New buildings and existing buildings when major renovation occurs or a renovation of heating system is carried out.
- From 30 to 70% in function of the climatic zone and the DHW demand.
- This contribution can be substituted by another installation in the building or via district heating if it is more efficient.

HE 5 – Minimum PV installation

- Only tertiary sector. For new buildings and existing buildings when major renovation is carried out. Moreover, only when the area is more than 5.000m² and for certain building use.
- The minimal power to install depends on the climatic zone and the surface of the building according the formula $P=C \cdot (0,002 \cdot S-5)$, Where P is the minimal power to install, C is a factor (ranging 1-1,4) in function of the climatic zone and S is the surface of the building. This contribution can be substituted by other renewable sources.

Available at:

<http://www.codigotecnico.org/cte/export/sites/default/web/galerias/archivos/BOE-A-2013-9511.pdf>

c) Law 8/2013, from 26 June 2013, about urban retrofitting, regeneration and renovation

This regulation promotes the building refurbishments as well as urban regeneration and renovation. It creates the Evaluation of Building report, for buildings of more than 50 years. The objective is to create a good legal framework and reducing barriers [42]

Available at: <http://www.boe.es/boe/dias/2013/06/27/pdfs/BOE-A-2013-6938.pdf>

d) Royal Decree 1027/2007, Regulation on Building Heating Installations (*Reglamento de instalaciones térmicas en los edificios (RITE)*) updated by Royal Decree 238/2013, 5 April 2013

It regulates the thermal facilities in Buildings and the requirements for maintenance, metering and control.

In its recent modification it establishes improved efficiency in heating and cooling generation equipment and flows-transmission equipment. It requires better insulation for equipment and thermal flows pipes and an improved regulation and control to maintain the design parameters of conditioned areas. The regulation promotes the use of renewable energies available as well as the incorporation of heat recovery subsystems and the use of wasted energy. It establishes compulsory accounting of consumption in collective installations and periodical inspections [43].

Available

at: http://www.minetur.gob.es/energia/desarrollo/EficienciaEnergetica/RITE/Reglamento/Real_Decreto_238_2013_de_5_de_abril.pdf

Regarding the Catalan Region there is some specific regulation:

- **Decree 21/2006, Eco-efficiency in buildings:**

- It is a regional law concerning energy efficiency in the building sector. Named Eco efficiency Decree, it regulates environmental criteria in the areas of energy efficiency, water use, renewable energy use, materials and waste management. As the Technical Building Code (CTE) at State level, this legislation is mandatory for new construction and major refurbishment projects [44].
- Available at:
<http://www.gencat.cat/mediamb/binlegis/20062093e.pdf>

3.10.2 EPBD implementation until 2020

3.10.2.1 nZEB definition

At the moment there is no definition of the nZEB, only the steps foreseen for its implementation have been established.

The first step has been the current update of the Technical Building Code Document DB-HE in 2013 is part of an integrated policy of the public administration to head towards the nZEB implementation, as mentioned in the National Energy Efficiency Action Plan 2014-2020. The main directions towards nZEB implementation are:

- Energy efficiency requirements via global indicators
 - Energy consumption
 - Energy demand
 - Other indicators in future normatives (new update as per 2016)
- Increase of the level of exigency
 - Which will be incremented in a progressive way with new updates of the technical code to attain the objectives of nZEB in 2020 (2018 public buildings).
- Limitation of non-renewable primary energy consumption (for new buildings and extension projects only)

The second step will be an update of the Building Technical Code Document DB-HE "Energy Savings" in 2016 to approximate nZEB, as explained by the Ministry of Public Works from Spain in a Congress on May 2014 [41]. A possible approach for new buildings would be via the indicators of demand and consumption and the introduction of a CO₂ emission-indicator. The limit for the demand and the consumption would be more restrictive for certain climatic zones. For existing buildings, the exigency will depend on the deepness of the intervention. For bigger renovations the limitation of the demand will be on basis of a reference building, and there will be consumption exigencies in certain actions. IDAE (Institute for Energy Diversification and Savings) will support the implementation of nZEB in Spain by coordinating several support mechanisms such as projects subsidies allocated on annual call basis and communication campaigns for promoting selected nZEB [45].

3.10.2.2 Cost-optimal level requirement

The cost optimal methodology used in the report on cost optimal calculations and comparison with the current and future energy performance requirements of buildings in Spain is based on the programs LIDER and CALENER, being the official methods approved by the Spanish Administration to calculate energy demand and energy consumption of buildings respectively. The energy consumption considered in the calculations is the non-renewable primary energy for heating, cooling and domestic hot water, including lighting for non-residential buildings. Six reference existing buildings and ten new buildings were used, combining them with six climatic zones and different orientations, giving an amount of 120 subcategories of buildings. The cost-optimal values for existing and new buildings were reached in most of the cases and it served as a basis for the update of the Building Technical code in 2013.

3.10.3 Overview of existing national plan

1-NATIONAL ENERGY PLANS

National energy efficiency action plan 2014-2020

The national energy efficiency action plan 2014-2020 offers a description of the energy consumption in the building sector. It presents a "Spanish Strategy for Energy Renovation in the Building Sector" and the legislative and economic measures in the building sector. The legislative measures were presented in the previous chapter and the economic measures will be listed below, as well as the "Spanish Strategy for Energy Renovation in the Building Sector". The contribution of the building and equipment sector to the final energy savings target under the energy efficiency obligation scheme is set to 88 ktoe/year, broken down into energy saving and efficiency measures each of them with an assigned indicative target.

The national plan also explains the Energy Efficiency in Public Bodies. It refers first to the recent central government building inventory and renovation under article 5 of the Directive 2012/27/EU. Secondly it refers to buildings of other public bodies, as autonomous communities (for example Catalonia) and local governments. Each Autonomous Community should set up a register of energy certificates of private buildings that will be sold or rented in its territory. Furthermore, public buildings commonly frequented must obtain an energy efficiency certificate if the surface exceeds 500 m². All of Spain's Autonomous Communities are implementing or planning to implement energy efficiency plans in their public buildings. In Catalonia,

the *Energy Saving and Efficiency Plan for buildings of the Generalitat de Catalunya* focus in the reduction of energy expenses in public buildings, via the optimization of the energy procurement and the implementation of energy saving and efficiency measures, mainly through energy service companies.

The plan entered in force in 2011, and since then, some of the main results are: the aggregated auction bidding for electricity and natural gas supplies to the public buildings of the Generalitat de Catalunya, the creation of energy service contract templates and executions of projects following these models. A database of 550 buildings has been created and training programs for energy managers and government workers have been realized.

Available at:

http://ec.europa.eu/energy/efficiency/eed/doc/need/2014_neep_en_spain.pdf

2-REGIONAL ACTION PLANS

The Energy and Climate Change Plan of Catalonia 2020

It details the strategic energy policy for Catalonia for the 2020 and the reduction of the greenhouse gases. The energy sustainability of the building sector is one of the plan singular strategies to attain the established objectives. This strategy bases in the sustainable construction considering the LCA of the building, intelligent buildings, energy management and refurbishment of existing buildings.

Available at:

http://icaen.gencat.cat/web/.content/03_planificacio_energetica/documents/arxiu/20121001_pecac.pdf

3-BUILDING ENERGY STRATEGY

Spanish Strategy for Energy Renovation in the Building Sector

It is a long term strategy to move investments for the renovation of building stock, as required for the article 4 of Directive 27/2012.

It considers different future scenarios and economic profitability of the actions.

It raises the possibility to make big rehabilitations in the building envelope and renovations of heating, cooling and DHW systems [42].

Available

at:

http://ec.europa.eu/energy/efficiency/eed/doc/article4/2014_article4_es_spain.pdf

Catalan strategy for energy refurbishment of buildings

On 25th of February 2014, the Catalan Government decided to endorse the Catalan Strategy for Energy Renovation of Buildings. This strategy had been drawn up as part of the MARIE European Project. This is due to the commitment of the Regions forming part of this project to achieve by December 2014 a long-term strategy to mobilize the renovation of public and private residential and tertiary buildings in accordance with Directive 2012/27/EU. The aim of the strategy is that by 2020 the estimated consumption of energy in buildings and housing has reduced by 14.4 %, with a saving of 800 million €, and the CO₂ emissions have diminished by 22%. The document defines five areas of action, along with a roadmap, and allows complying with European directives that set 2014 as a year for start actions to achieve the targets in terms of energy efficiency in 2020.

Available at:

http://www.agenciahabitatge.cat/wps/portal?WCM_GLOBAL_CONTEXT=ca/ahc/web/serveis/rehabilitacio/estrategiacatalana

4-ECONOMIC SUPPORT

The economic support measures listed in the National Energy Efficiency Action Plan 2014-2020 are:

1. Royal Decree 233/2013, State Plan to promote rental, refurbishment and urban renovation 2013/2016
 - i. Available at : https://www.boe.es/diario_boe/txt.php?id=BOE-A-2013-3780
 - ii. Includes aids related to energy efficiency in buildings, like building envelope, better efficiency of heating, cooling and DHW systems and introduction of renewables. The financing is linked to a demand reduction of at least 30% [1]
2. ICO credit line for the rehabilitation of dwellings and buildings 2013,2014: financing for companies which promote building renovation of private houses and dwellings
3. Tax incentive based on VAT reduction (from 21% to 10%) for major renovation in residential buildings
4. JESSICA-FIDAE: fund for financing the renovation of non-residential buildings, among other measures
5. PAREER: Aid Programme for the Energy Renovation of Existing Buildings used in the residential sector (housing and hotel use) approved by IDAE Resolution of 25 September 2013. Its goal is to encourage and promote the implementation of integral measures which favour energy saving, energy efficiency improvement and the use of renewable energies in existing buildings. Assistance is granted in the form of a monetary provision without compensation or repayable loan, depending on the type of measures (thermal envelope and heating and lighting installations). It has a budget of €125 million.
6. PIMA SOL environmental stimulus plan, aimed at financing the energy renovation of hotels. Promoted by the Ministry of Agriculture, Food and Environment.
7. Proyectos CLIMA (Fondo de Carbono para una Economía Sostenible: FES-CO2), promoted by the Ministry of Agriculture, Food and Environment: In 2014, the Carbon Emission (Greenhouse) Fund for a Sustainable Economy (FES-CO2) launches its third call for "CLIMA Projects" to select projects known as "diffuse sectors" (improve existing facilities or new projects). This approach is intended to support and promote low carbon emission activities. The eligible projects must be located in Spain will be developed in facilities and sectors not included in the emission trading scheme. Available at:<http://www.magrama.gob.es/es/cambio-climatico/temas/fondo-carbono/Convocatoria-2014-proyectos-clima.asp>

3.10.4 Identification of aspects on refurbishment of public buildings into nZEB level

Spain has set a legislative and economic framework for energy efficiency in buildings transposing the EPBD, mainly in 2013. Although Spain has not submitted the national plan in nZEB, the modification of the Technical Building Code is the first step towards the definition of nZEB. However, there is no clear definition yet of what a nZEB is in Spain, which might lead to some confusion in the building sector.

Due to the current economic crisis, there is very little new construction in Spain. The efforts are currently put in retrofitting of buildings as promoted by the law 8/2013 on retrofitting, regeneration and renovation and the State Plan to promote rental, refurbishment and urban renovation 2013/2016. Moreover the potential customers are short in money and face strong financing difficulties. Furthermore, according to the project ENTRANZE [1] there is a lack of awareness concerning the economic benefits from refurbishment measures and there is a lack of technical and administrative advice. Moreover, the quality assurance of the correct application of the technical building code could be improved.

The ENTRANZE project has modeled several policy scenarios for Spain and issued several recommendations towards the implementation of nZEB, deep renovation and renewable energy heating and cooling. It concluded that current regulatory instruments, such the Technical Building Code should be more exigent, especially in energy demand of renovation of existing buildings. They suggested the introduction of a legal obligation for refurbishment and to establish a mandatory RES contribution, to achieve an ambitious target of nZEB penetration. Regarding economic measures they would increase the state budget and establish subsidies programs for staged renovation. ENTRANZE proposes the coaching of building owners during the renovation, and create a market transformation to assure the capacity of the builders and a good quality assurance and control systems.

During the World Sustainable Building Conference 2014 (WSB14) in Barcelona in October, an analysis of the EPBD implementation in Spain was done by several professionals in the construction field and public administration members. The main conclusion is that there is a need to boost the social demand for renovation, raising the awareness of the building owners concerning the benefits of applying energy renovation measures. There are already technologies and economic aid available. However the experts consider that the coordination between the different aid measures should be improved. Another point to remark is that there were despair opinions among the speakers regarding the impact of the energy performance certificates in the market at the moment.

Climate

In the Technical Building Code CTE there are different energy building requirements depending on the climatic zones. The Code climatic zones are defined by a combination of a letter (α 1, A, B, C, D and E, from warmest to coldest) which represents the climate severity of winter and a figure which represents the climate severity of summer (1, 2, 3 and 4). In the official report of the Spanish Government about Cost optimal calculations to the EC, only six climatic zones have been analysed. The climatic zones which have been selected as representative are: α 3, A3, B4, C2, D3 and E1. As we are focusing in the Catalonia Region, the most representative climatic zones are B3,D3,C2,E1.

Energy prices

For residential users the energy prices in 2014 without TVA were the following:

Table ES-3: Energy prices

Electricity	0.1315 €/kWh
Natural gas	0.05274 €/kWh
Oil	0.906 €/l
Biomass chip	85 €/t
Biomass pellet	184 €/t
Electricity fix term	0.112716 €/kWday
Natural gas fix term	0.291945 €/day

Source: MARIE project (<http://www.marie-medstrategic.eu/en.html>)

According to the Eurostat energy statistics, the price for electricity in 2014 for middle size industries was 0.1185 €/kWh and for natural gas was 0.0368 €/kWh.

Heating sources

According to deliverable 2.1 the main energy sources in residential is natural gas, followed by electricity, oil, heat pumps and wood. Regarding the non residential buildings, mainly the energy source used for heating is fuel (not specified) for cold areas and electricity for warm areas.

Primary energy factors

The primary energy consumption has been calculated using the primary energy factors from IDAE (Instituto para la Diversificación y Ahorro de la Energía) 2014 [46].

Table ES-4: Primary energy factors

Energy source	Primary energy factor
Electricity	2.461
Natural gas	1.195
Oil	1.182
Coal	1.084
Biomass	1.037
Dense Biomass (Pellet)	1.113

Renewable Energy Ratio (RER) requirement

The Building technical code requires a minimum solar contribution for DHW (30 to 70% in function of climatic zone and the DHW demand). This applies to new

buildings or renovation of existing buildings or DHW installations. As well to climatizations of covered swimming pools. This contribution can be substituted by other solutions if the primary energy non renew. consumption and the emissions are lower or the same.

For non-residential buildings there is a minimum contribution of electric energy by photovoltaic solar panels for new buildings or integral refurbishment of building or a change of building bigger than 5.000 m². The minimal power to instal depends on the climatic zone and the surface of the building according the formula $P=C.(0,002*S-5)$, Where P is the minimal power to install, C is a factor (ranging 1-1,4) in function of the climatic zone and S is the surface of the building. This contribution can be subsituted by other renewable sources.

3.11 United Kingdom

3.11.1 State-of-the-art of the EPBD implementation

The implementation of the EPBD in the UK is the responsibility of the respective government departments:

- **England & Wales** - Department for Communities and Local Government (CLG)
- **Scotland** - Scottish Building Standards Division (part of the Directorate for Communities and Local Government).
- **Northern Ireland** - Department of Finance and Personnel (DFPNI) (supported by the Department for Social Development, DSDNI)

Transposition of the EPBD in the UK is achieved through different regulations in each of the jurisdictions:

- **England & Wales** – Building Regulations (amendments) Regulations 2012 (SI 2012/3119) and the Energy Performance of Buildings (England & Wales) Regulations (SI 2012/3118). Responsibility for the Welsh Building Regulations was devolved to the Welsh Government in 2011, and new regulations were introduced in 2013 and came into force in April 2014.
- **Scotland** - Building (Scotland) Act 2003, the Building (Scotland) Regulations 2004, the Building (Procedure) (Scotland) Regulations 2007, the Building (Forms) (Scotland) Regulations 2007 and the Energy Performance of Buildings (Scotland) Regulations 2008, as amended. The latter regulations were amended in 2012.
- **Northern Ireland** - Building Regulations (Northern Ireland) 2012 (SRC 2012 No 192), and The Energy Performance of Buildings (Certificates and Inspections) Regulations (Northern Ireland) 2008 (SRC 2008 No 170) (as amended). The Building (Amendment) Regulations (Northern Ireland) 2014, was made which amends the Building Regulations (Northern Ireland) 2012 to comply with the recast EPBD.

Technical guidance

The above regulations have resulted in changes to mandatory requirements and associated guidance, and the publication of new documents. The key documents related to Energy Performance (EP) requirements in the UK are:

- **England** – 2013 Part L1A (New dwellings), Part L2A (New buildings other than dwellings), Part L1B (Existing dwellings) and Part L2B (Existing buildings other than dwellings) [47].
- **Wales** – 2014 Parts L1A, L2A, L1B & L2B [48].
- **Scotland** - 2013 Technical Handbooks: Domestic Section 6 Energy & 2013 Technical Handbooks: Non-Domestic Section 6 Energy [49]
- **Northern Ireland** – Technical Booklet F1 (Dwellings) and Technical Booklet F2 (Buildings other than dwellings) (October 2012) [50]

Although the EP requirements are set out in the above documents these are supported by guidance documents that show how the technical requirements can be met. For example, Approved Document L is supported by Domestic and Non-Domestic Compliance Guides [51].

In existing buildings minimum EP requirements apply whenever 'building work' is undertaken. This is defined in the above documents but includes, for example, replacement of services (heating systems, lighting, ventilation system etc.), work on a thermal element (wall, roof, floor, windows etc.), construction of an extension etc. The performance requirements are defined in terms of minimum efficiency of services, maximum U-values for thermal elements etc.

Public and private buildings are not treated differently by the Building Regulations. However, local authorities and housing associations may require energy performance beyond building regulations as well as high levels of sustainability for their new dwellings. They use a specific form of BREEAM (Code for Sustainable Homes [52]) to achieve this. They have also made energy efficiency improvements to existing dwellings to improve thermal comfort and reduce tenants' fuel bills. This has been driven by the Decent Homes programme [53] and facilitated by energy efficiency obligations on the energy supply companies, i.e. Carbon Emissions Reduction Target (CERT), Community Energy Savings Programme (CESP) and now the Energy Company Obligation (ECO) [54]. These energy efficiency obligations have also generated savings in the owner occupier sector.

Similarly, local authorities might demand better energy performance of their public buildings, and central government has taken steps to benchmark and improve efficiency of their buildings too.

3.11.2 EPBD implementation until 2020

3.11.2.1 nZEB definition

The EP requirements are framed in terms of CO₂ compliance (kgCO₂/m²/yr) for all building types across the UK. Therefore, they are introducing the term 'nearly zero carbon building', instead of nearly zero energy building. Use of renewable technologies is not obligatory, but one requirement that has been introduced in light of the recast EPBD is that proper consideration is given to the use of 'high-efficiency alternative systems', such as renewables, district heating, heat pumps or CHP. This is covered in the EP national calculation methodology to record that this has been done and note where evidence of such an assessment and analysis can be found.

In preparation for the move to zero carbon (discussed in more detail below), England has also introduced a Fabric Energy Efficiency (FEE) requirement for new dwellings which is defined as the energy needed for heating and cooling a dwelling (kWh/m²/yr). In essence it is a minimum performance standard to ensure that a dwelling's structure meets basic energy efficiency requirements, and that low-carbon energy sources cannot be used to 'rescue' a poor fabric design. Approved Document L1A (2013) introduced a new regulation (26A) that requires new dwellings to achieve, or better, a target fabric energy efficiency (TFEE) in addition to the CO₂ requirement. The NHBC (National House Building Council) Foundation has produced two guides for house builders and designers to help them meet the requirements of Part L 2013 with a particular focus on fabric performance [55].

All the jurisdictions in the UK have taken steps towards nZEB through incremental increases in EP requirements. Specifically, the targets for nZEB across the jurisdictions are:

- **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).
- **Wales** - Expects all new homes and non-domestic buildings to be built to zero carbon (and nearly zero-energy) standards at the latest by 2020. This will be subject to review in 2015/16.

- **Scotland** - Shares the ambition for zero carbon buildings, and will review its energy standards to align with the Article 9 requirement for nZEBs from 2019 [56].
- **Northern Ireland** - Proposes to apply the same standards as England by 2017 for all new homes and all new non-residential buildings to be zero carbon from 2020.

Originally, the definition of zero carbon for new homes required that all CO₂ emissions be reduced to zero through on-site means. This included both 'regulated' emissions (i.e. those associated with heating, cooling, ventilation and lighting which are considered within the EP calculation methodology) as well as 'unregulated' emissions (i.e. those from household appliances). Achieving this demanding target proved both costly and impractical on many sites and so an on-site strategy was deemed as inappropriate for mainstream house construction. A major change to the zero carbon definition was introduced in the March 2011 Budget and this was the removal of unregulated emissions.

3.11.2.2 Cost-optimal level requirement

Article 5 of the recast EPBD requires Member States to ensure that minimum EP requirements for buildings are set "with a view to achieving cost-optimal levels". The European Commission established a comparative methodology framework to calculate these cost-optimal levels which Member States are required to use to determine the cost-optimal levels of minimum EP requirements using reference buildings to represent the typical and average building stock in their country. The first report was commissioned for the UK by DCLG in consultation with the Scottish Government, the Welsh Government and the Northern Ireland Executive and was published in May 2013 [59].

For new buildings, two reference dwellings and seven non-domestic reference buildings were considered:

Table UK-1: Cost optimality of new-build dwellings

New-build dwellings	Volume (m ³)	Floor area (m ²)	Primary energy use (kWh/m ² /yr)
Semi-detached house	195	76	117
Mid-floor apartment	160	67	99

Table UK-2: Cost optimality of new non-domestic buildings

New non-domestic building	Floor area (m ²)	Primary energy use (kWh/m ² /yr)
Office (air-con)	30,000	155
Office (nat vent)	4,500	87
Secondary school	11,100	132
Hospital	18,500	246

Hotel (air-con)	15,200	487
Distribution warehouse	4,900	136
Retail warehouse	4,900	232

For simplicity, modelling was undertaken following the requirements in England.

For new dwellings it was noted that the regulations were better than the cost-optimal levels, whereas the requirements for new non-domestic buildings fell just short of the cost-optimal levels. It should be noted that the activity needs to be updated in light of the new, more demanding requirements that came into force in April 2014.

The exercise was repeated for existing buildings using a similar set of reference buildings:

Table UK-3: Cost optimality of existing dwellings

Existing dwellings	Wall type	Floor area (m ²)	Primary energy use (kWh/m ² /yr)
Semi-detached house	Cavity	76	439
	Solid	76	462
Mid-floor apartment	Cavity	67	235
	Solid	67	245

Table UK-4: Cost optimality of existing non-domestic buildings

Existing non-domestic building	Construction type	Energy efficiency level	Primary energy use (kWh/m ² /yr)
Office (nat vent)	Steel frame	EE1	347
		EE2	242
Secondary school	Cavity wall	EE1	302
		EE2	243
Hospital	Steel frame	EE1	604
		EE2	513
Hotel (air-con)	Steel frame	EE1	880
		EE2	741
Retail warehouse	Steel frame	EE1	521
		EE2	475

For existing dwellings, the requirements are either at or better than the cost-optimal levels, and for existing non-domestic the requirements fall just short of the cost-optimal levels. Although new

requirements came into force in April 2014 those relating to existing buildings are largely unchanged.

Conclusion

The UK jurisdictions have adopted various approaches to transpose the requirements of the EPBD and its recast. The English approach has been mirrored in most jurisdictions, or wholly adopted, e.g. EPCs in Wales. In a few instances, the four jurisdictions have adopted a common approach, namely for heating systems and cost-optimal requirements.

3.11.3 Overview of existing national plan

The UK notified the European Commission on 30 April 2013 of its target under Article 3 of the EU Energy Efficiency Directive (2012/27/EU). The UK's target was set at the level of 129.2 million tonnes of oil equivalent (mtoe) for final energy consumption on a net calorific value basis. This represents an 18% reduction in final energy consumption, relative to the 2007 business-as-usual projection. The latest UK NEEAP, published in April 2014 [60], describes the policy instruments (including revisions to the Building Regulations and the drive towards nZEB) intended to achieve this target. It also shows how, under current projections, final energy consumption in the UK in 2020 will be 20% lower than 2007 levels. Total energy savings from the policy measures identified exceed the target by 143 TWh.

The national plan to increase the number of nZEBs (Article 9 of the recast EPBD) covers all four jurisdictions and confirms the UK's legally binding commitment (under the Climate Change Act 2008) to greenhouse gas emission reduction targets 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, e.g. through heat efficiency improvements, lighting and appliances efficiency improvements, behaviour change; and;
- de-carbonising heating and cooling supply, e.g. through building-and network-level technologies.

There has been successive tightening of EP requirements for new buildings through changes to the Building Regulations. For example, the graph below shows the Building Regulation improvements for new buildings in England (including the % reduction for each building type against the previous requirements):

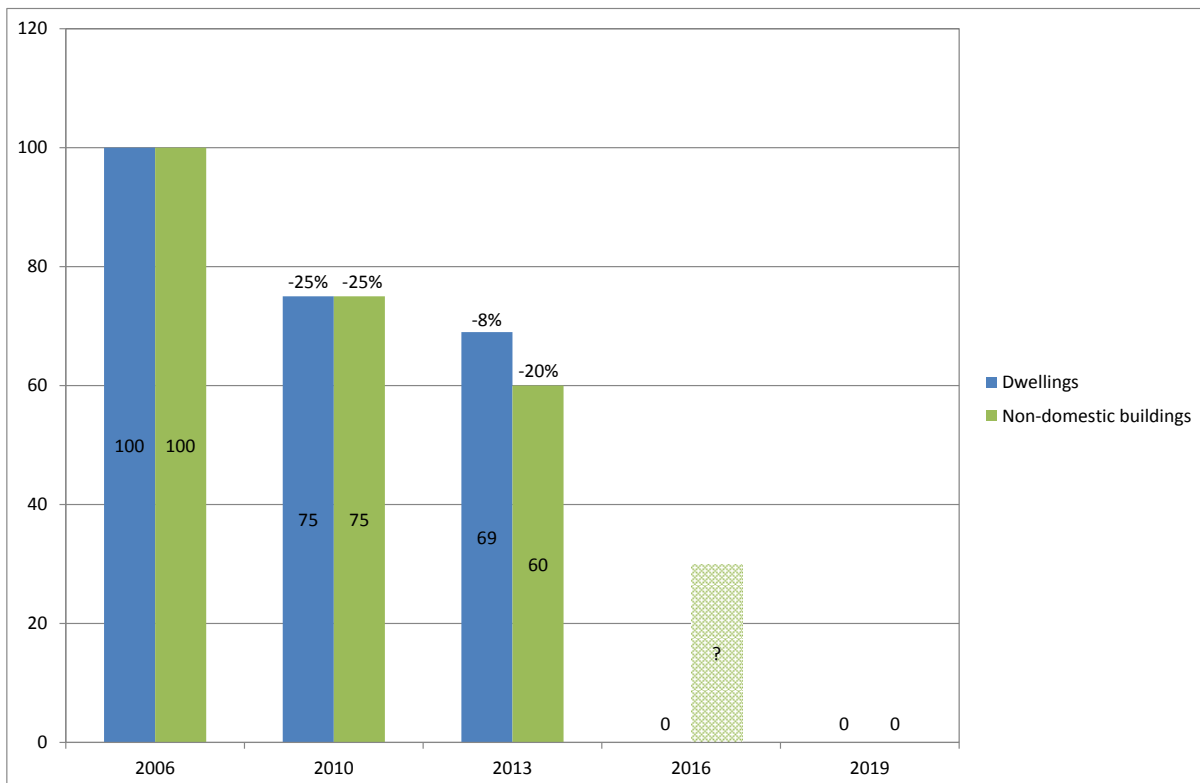


Figure UK-1: Building Regulation improvements for new buildings in England (historic and proposed)

3.11.4 Identification of aspects on refurbishment of public buildings into nZEB level

The UK government’s policy towards zero carbon homes is summarised as a hierarchical triangle:

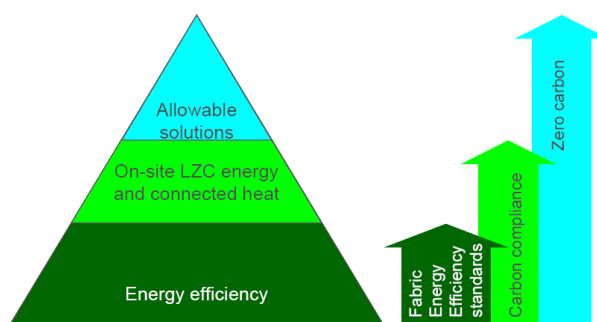


Figure UK-2: Zero carbon homes

Zero carbon is achieved through:

- (i) Good fabric energy efficiency
- (ii) On-site low carbon heat and power technologies
- (iii) **Allowable solutions** to compensate for carbon emissions reduction that are difficult to achieve on site.

Part L 2013 is explicitly linked to this through, in the first instance, the use of the TFE to achieve the energy efficiency target. This reduces the overall energy demand and is locked in, i.e. occupants can turn it off. The current interim targets are unlikely to be sufficient to meet the goal of zero carbon in 2016 and so the ZCH has proposed a **Fabric Energy Efficiency Standard (FEES)** [57]:

- Apartments and mid terrace: 39 kWh/m²/yr;
- Detached, semi-detached and end terrace: 46 kWh/m²/yr

The standards for non-domestic buildings have yet to be resolved.

The Part L 2013 carbon target looks to reduce emissions on site through additional building energy efficiency (where it is cost effective) and the use of low and zero carbon technologies and connected heat networks – this supports the Government’s target of 20% renewables by 2020. Moving forward to 2016 the ZCH has proposed carbon compliance targets for new dwellings:

- Apartments (up to 4 storeys): 14 kgCO₂/m²/yr
- Semi-detached, end terrace and mid terrace: 11 kgCO₂/m²/yr
- Detached: 10 kgCO₂/m²/yr

The final part of the zero carbon compliance process is allowable solutions. The concept was introduced by the UK government in 2009 as a vehicle for house-builders to pay into an allowable solutions fund (to pump-prime carbon-saving projects elsewhere). This would mean that a lower on-site carbon emissions target could be set whilst still achieving zero carbon.

The UK government had a public consultation on how allowable solutions might operate and recently (July 2014) it published the results of this as well as its response [58]. The key aspects of allowable solutions are:

- An on-site EP requirement equivalent to energy Level 4 of the Code for Sustainable Homes which represents an improvement of 20% compared to current Building Regulations.
- Small house builders will be exempt from the zero carbon homes standard as they can be disproportionately impacted by new regulations, but there is still work to be done on how this will operate.
- There will be four possible delivery routes that house builders could adopt (which would be supported by verification and certification arrangements):
 - (i) more or all carbon abatement on site or through connected measures (e.g. a heat network)
 - (ii) meet the remaining carbon abatement requirements through off-site carbon abatement action (e.g. retrofitting existing buildings)
 - (iii) contract a third party to deliver the carbon abatement measures sufficient to meet the zero carbon obligation.
 - (iv) make a payment into a fund which then invests in carbon abatement projects sufficient to meet the zero carbon obligation.
- A national design framework for allowable solutions will be set out, and legislation will provide powers to enable the framework to be established through the Building Regulations which will also enable local authorities to engage, particularly for routes (ii) and (iv).
- A price cap will be introduced for route (iv) to set a benchmark for the costs of allowable solutions but to give maximum flexibility a cap will not be introduced for the other routes – the size of this cap is still to be decided but it will be reviewed every three years.

The UK considers that its approach for zero carbon buildings will meet the definition of nZEB 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 Renewable Energy Sources
- This is expected to encourage the development of heat networks which could eventually be connected to renewable heat sources.
- Low carbon technologies not classified as renewable still have a significant role to play in meeting the aims of the recast EPBD.
- The building regulation standards for zero carbon buildings will take into account all the energy uses covered by Annex I of the recast. 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.

The UK government will publish a definition for nZEB nearer to the 2018/2020 deadlines.

The UK has an average single climatic zone, which is presented in Table UK-5.

Table UK-5: Climatic conditions

January average outside temperature [°C]	4.3
August average outside temperature [°C]	16.4
Average global horizontal radiation [kWh/m ² yr]	1,299
Annual heating degree days [°Cd/yr]	2,200

Annual degree days are based on a base temperature of 15.5°C.

4. EVALUATION OF TARGET COUNTRIES BASED ON VARIOUS CRITERIA RELATED TO nZEB

In this chapter, an overview of national regulatory frameworks for nZEB legislation is presented, providing information especially on nZEB definition and its application in practice, as well as the cost optimal level requirements in the target countries of the RePublic_ZEB project, based on the country reports of Section 4. The policies and measures for the promotion of nearly zero energy buildings according to EPBD recast Article 9 (3) is also presented. Finally, the drivers and barriers to transform existing buildings into nZEB level are described and countries grouped by their national characteristics (climate, heating sources, GDP, primary energy factors, etc.) to highlight those which have similar indicators.

4.1 Overview of national regulatory frameworks for nZEB legislation

In Bulgaria the national definition of nZEB has been formulated, but for the implementation an update of three legislative documents is needed:

1. Regulation No. 7 of 2004 on energy efficiency, heat conservation and energy savings of buildings;
2. Regulation No. RD-16-1058 of 2009 on the parameters for energy consumption and energy performance specifications of buildings;
3. Regulation No. 15/2005 on technical rules and standards for design, construction and exploitation of projects and equipment for production, transportation and distribution of heating energy.

Regulation No. 7 is to be amended in light of the research on improvement of energy performance of buildings in accordance with Directive 2010/31/EC and the standards of its scope, and the requirements of Regulation (EU) No. 305/2011 which lays down the harmonised conditions for marketing of construction products. From a legislative and regulative point of view, there are no obstacles to carry out the nZEB legislation process.

For Croatia, the national definition of nZEB was included in the technical regulation on rational energy use and thermal protection in buildings (OG 97/2014 and 130/14) in August 2014 for single family buildings, and for other building uses in September 2014. Furthermore, according to the EPBD recast, new terms and requirements were added into the national legislations. The changes were in the definition of energy performance rating through primary energy demand, and diversified requirements for different building uses, which are now completely harmonised with Annex I of EPBD recast. The current requirements for each building category was set by a cost optimal calculation and expressed through primary energy requirement including heating, cooling, ventilation, DHW and lighting energy demand.

Another target country of the project is Macedonia, where the Rulebook for Energy Performance of Buildings is partially harmonized with EPBD recast. The Rulebook provides the methodology for determination of the energy performance of buildings, as well as the minimum requirements for energy efficiency of new buildings and existing buildings undergoing major renovations. However, the national nZEB definition has not been formulated in the legislation. Unfortunately no plans for the future implementation of the EPBD are currently foreseen, but there are proposals to review the Rulebook.

In Greece, the nZEB definition has already been introduced in the national legislation, by amendment, in June 2010 and it matches with the precise EPBD definition. The nZEB definition is also included in Law 4122/2013 (recast for the energy efficiency of buildings). The Law specifies

that, after 1/1/2015, every new building of the public sector should be nZEB. This obligation is also applied to all new buildings constructed after 1/1/2020. However, the national application of the nZEB definition has not been made yet.

In Hungary, according to the EPBD recast new terms and requirements were incorporated in the national legislation, Decree 7/2006 TNM. The main changes related to the requirements of nearly zero energy buildings and cost optimal level. As a consequence of this last amendment to the Decree the national nZEB definition has been introduced to the legislation, and ready for implementation in practice.

In Italy the EPBD recast has been transposed into national legislation by Law 90/2013. The law establishes the definition of nZEB, but the energy requirements will be defined in further regulations expected by 2015. According to the draft copy of the proposed regulation implementing the Law 90/2013, many indices will be needed to prove the given building is nZEB (a full list of indices is presented in Section 4.2.1). A building is defined as nZEB if the values of the energy parameters are lower than those defined for the target building, and the use of renewable sources complies with Legislative Decree 28/2011. Consequently the regulatory framework is almost ready to implement the nZEB definition in practice, although the values of the energy parameters of nZEBs have to be set, and it also has to be specified if the renewable energy ratio requirements refer to primary or to delivered energy.

In Portugal, the transposition of EPBD recast was achieved through Law No. 118/2013. This Law established the definition of nearly zero energy building but only in general terms. The numerical requirements of primary energy consumption and share of RES have not been specified yet.

For Romania, the EPBD has been transposed into the national legal framework by the adoption of Law 372/2005 on Energy Performance of Buildings, which was amended in 2013, in order to be compliant with the EPBD recast. It has to be stressed, that currently there is no minimum energy performance requirement in terms of a global indicator, neither for new buildings nor for renovations (except for residential buildings). And it only expresses the final energy demand of heating, without taking into account the system efficiency. The general nZEB definition was included in the last amendment of the Law 372/2005, and the detailed definition of nZEB was included in the National Plan so as to increase the number of buildings with nearly zero energy consumption. The definition comprises numerical targets for maximum allowable level of primary energy use (kWh/m²a) and for specific CO₂ emission (kgCO₂/m²a) by building types and winter climates zones, and it comprises the mandatory value for share of RES. The targets set for the nZEB definition are subject to the approval by Ministry Order, which is expected to be issued early in 2015.

In Slovenia the definition of nZEB is being implemented through the National Plan for Nearly Zero Energy Building. The requirements have been set for primary energy consumption and share of RES, for single family building, multi family buildings, and for non-residential (office) buildings. The values have not been confirmed officially, since the document only recently underwent a public consultation and is also going through the procedures of being adopted.

As regards Spain, there is currently no definition of nZEB in the national legislation, only the proposed steps for its implementation have been established. The first step towards nZEB was the update of the Building Technical Code Document DB-HE "Energy Savings" in 2013. In this update there was an implementation of global indicators of consumption and demand, as well as an increase in the level of requirement and a limit on non-renewable energy primary consumption both in residential and non-residential buildings. The second step is the update of the Building Technical Code Document in 2016 to give the detailed definition of the nZEB via global indicators and increased exigencies in transmittance, energy efficiency in thermal installations and lighting and the share of renewable energy for thermal and electrical use.

Across the United Kingdom the energy performance requirements are framed in terms of CO₂ compliance (kgCO₂/m²a) for all building types. Therefore, they will introduce the term 'nearly zero carbon building' instead of nearly zero energy building. Currently, the set of requirements and the legislation of zero carbon buildings are in progress. The UK government's policy towards zero

carbon homes can be summarised as follows: 1) Good fabric energy efficiency; 2) On-site low carbon heat and power technologies; 3) Allowable solutions to compensate for carbon emissions reduction that are difficult to achieve on site. In preparation for the move to zero carbon homes, England has introduced a Fabric Energy Efficiency (FEE) requirement for new residential buildings, which is defined as the energy need for heating and cooling (kWh/m²a). In essence it is a minimum performance standard to ensure that a dwelling's structure meets basic energy efficiency requirements, and that low-carbon energy sources cannot be used to 'rescue' a poor fabric design. The standards for non-domestic buildings have yet to be resolved. The UK government plans to publish the definition for nZEB nearer to the 2018/2020 deadlines.

4.2 nZEB definition and its application in practice

Article 2 of the EPBD recast introduced the definition of a 'nearly zero energy building', which means a building that has a very high energy performance, and the nearly zero or very low amount of energy required should be addressed to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. Article 9 (3a) of the EPBD recast requires Member States to describe the detailed application in practice of the definition of nearly zero-energy buildings, reflecting the national, regional or local conditions, and including a numerical indicator of primary energy use expressed in kWh/m² per year. All of the target countries, except Macedonia, have transposed the definition of nearly zero energy building into national legislation, however many of them are still to elaborate the application of the definition and the numerical requirement in terms of annual primary energy use.

4.2.1 Numerical indicator of primary energy use

From the target countries of RePublic_ZEB project, only two, Croatia and Hungary have introduced the numerical primary energy requirement of nZEB into the national legislation. Slovenia and Romania have also detailed the national numerical requirements for nZEB, but the values are not yet confirmed officially.

Residential buildings

In Croatia the total primary energy requirement for nearly zero energy residential buildings is 30-80 kWh/m²a (depending on the climate zone and type of the building). In Slovenia it is 80-85 kWh/m²a for new residential buildings, and 90-105 kWh/m²a for existing residential buildings undergoing major renovation. Hungary has a primary energy requirement of 110-140 kWh/m²a (depending on A/V of the building), whilst in Romania it is 93-217 kWh/m²a (depending on the climate zone and type of the building). The review of available national nZEB definitions shows high variation in nZEB primary energy values for residential buildings being between 30 and 217 kWh/m²a. It is partly due to different climates, but it is worth noting the variation still occurs even with similar climate.

Across the United Kingdom the energy performance requirements are framed in terms of CO₂ compliance for all building types. The Zero Carbon Hub (ZCH) is undertaking a major project to look at the extent and causes of the so-called performance gap in new dwellings as well as proposing initiatives and research to address it. For the 2016 zero carbon target the ZCH has proposed a Fabric Energy Efficiency Standard (FEES) for dwellings:

- Apartments and mid terrace: 39 kWh/m²a
- Detached, semi-detached and end terrace: 46 kWh/m²a

This is delivered energy consumption only for space heating and cooling, it does not include energy for domestic hot water (DHW) and lighting, and does not include the gains from these either.

The ZCH has also proposed carbon compliance targets for new dwellings:

- Apartments (up to 4 storeys): 14 kgCO₂/m²a

- Semi-detached, end terrace and mid terrace: 11 kgCO₂/m²a
- Detached: 10 kgCO₂/m²a

Non-residential buildings

As for the requirements of nearly zero energy office buildings, the situation is as follows. In Croatia, the requirement for primary energy consumption seems very low as it is only 25-30 kWh/m²a, while in Hungary the requirement is five times higher, since it is set to 132-160 kWh/m²a. In Romania the requirement for nZEB office buildings is 45-89 kWh/m²a, and in Slovenia it is 55 and 80 kWh/m²a (55 kWh/m²a relates to new non-residential (office) buildings, 80 kWh/m²a is for existing office buildings undergoing major renovation).

The requirement for education buildings is also different. In Croatia it is set to 50-55 kWh/m²a, in Hungary it is 90-150 kWh/m²a, in Romania 92-185 kWh/m²a, whilst Slovenia has not introduced nZEB requirements for educational buildings.

Croatia and Romania have also introduced nZEB primary energy requirement for health facilities. In Croatia the requirement is 190-200 kWh/m²a, while in Romania it is set to lower values: 76-167 kWh/m²a.

In Romania both the maximum allowable level of primary energy from conventional sources (fossil fuels), and the CO₂ emissions of buildings are fixed as targets by building types and winter climates zones.

In addition to the above building types, Croatia has introduced nZEB primary energy requirements for retail buildings (140 -170 kWh/m²a), sport halls (140-190 kWh/m²a) and hotels and restaurants (65-80 kWh/m²a).

Bulgaria and the United Kingdom have partially satisfied the requirements of the EPBD to introduce numerical indicators for nZEB. Bulgaria have not set a particular numerical figure (kWh/m²a) for primary energy consumption of nZEBs, but they introduced in their legislation that nZEB means a building with primary energy consumption of class “A” (including appliances) on the national scale, and that at least 55% of the final energy (heating, cooling, ventilation, DHW and lighting, without appliances) covered by RES. In Bulgaria the current requirements of class “A” for primary energy consumptions are:

- | | |
|----------------------------------|-----------------------------|
| • Office buildings: | 70-140 kWh/m ² a |
| • Hospitals: | 70-140 kWh/m ² a |
| • School buildings: | 25-50 kWh/m ² a |
| • Kindergarten buildings: | 33-65 kWh/m ² a |
| • Buildings for cultural events: | 56-110 kWh/m ² a |

In Italy the national law establishes a “nearly zero energy building” as a building characterized by a very high energy performance in which the very low energy demand is largely met by renewable sources, produced within the building system boundaries. Moreover, the nZEB has to meet energy requirements that will be defined in further regulations expected by 2014 or spring 2015. According to Law 90/2013, specific building energy parameters are expected for the definition of nZEB, and the following indices will be required:

- Mean transmission heat transfer coefficient [W/m²K];
- Ratio of summer effective collecting areas to net floor area [-];
- Specific ideal energy need for heating [kWh/m²];
- Heating system global efficiency [-];
- Energy performance index for heating, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Ideal energy need for DHW index [kWh/m²];

- DHW system global efficiency [-];
- Energy performance index for DHW, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Energy performance index for ventilation, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Specific ideal energy need for cooling [kWh/m²];
- Cooling system global efficiency [-];
- Energy performance index for cooling, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Energy performance index for lighting, expressed in non renewable primary energy and in total primary energy [kWh/m²];
- Global energy performance index (heating, cooling, DHW, ventilation, lighting), expressed in non renewable primary energy and in total primary energy [kWh/m²].

According to the draft copy of the Italian regulation implementing Law 90/2013, a building is defined as nZEB if the values of the above energy indices are lower than those defined for the target building, and the use of renewable sources complies with Legislative Decree 28/2011.

In Greece the national nZEB definition matches the precise EPBD definition: nZEB means a building that has a very high energy performance; and the nearly zero or very low amount of energy required should be met to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby. However, the national application of the nZEB definition has not been made yet.

In Portugal, the nZEB definition has been transposed into the national legislation, however the requirements related to nZEB for annual primary energy consumption, and for share of RES have not yet defined in a quantitative manner.

In Spain currently there is no definition of the nZEB, only the proposed steps for its implementation have been established. One main step towards nZEB implementation is to improve the energy efficiency requirements, for example, the limitation of non-renewable primary energy consumption both in residential and non-residential buildings. A possible approach for new buildings would be via the indicators of demand and consumption and the introduction of a CO₂ emission-indicator. The limit for the demand and the consumption would depend on climatic zones. For existing buildings, the requirement will depend on the depth of the intervention. For bigger renovations the limitation of the demand will be on basis of a reference building, and there will be consumption requirements in certain actions.

In Macedonia there is no nZEB definition in the national legislation.

4.2.2 Mandatory share of RES

The review of the requirement related to the mandatory share of RES in nearly zero energy buildings shows variety between the analyzed target countries. For example there is a wide range in the numerical figures, furthermore in some countries the basis is primary energy, while elsewhere the basis is final energy (delivered energy to the building), or only some part of final energy.

The mandatory share of RES in nZEBs in the target countries is as follows (from low to high share of RES):

In Romania 10% of the total calculated primary energy consumption of an nZEB shall be met from renewable energy (non-fossil) sources. Renewable energy systems shall be installed according to their technical, economic and environmental feasibility and installed on the building or on the corresponding land under the same ownership as the building. In existing buildings undergoing major renovation, the maximum admissible primary energy from conventional sources shall be determined to the extent that these investments are technical and economical feasible, based on the return of investment expected during the normal service lifetime of the building. Currently the meaning of “on-site or nearby” is not clearly detailed, however it is generally accepted that it refers to the considered building and corresponding land which it is linked with in terms of property.

In Hungary, at least 25% of annual primary energy need shall be covered by RES.

In Croatia, 30% of the energy demand (delivered energy) of the building shall be covered by RES produced on site or nearby.

In Italy the requirements in the Legislative Decree 28/2011 relate to the mandatory share of RES in nearly zero energy buildings, which are:

- Share of RES for DHW: 50% (from 2015)
- Share of RES for space heating/cooling and DHW: 35% from 2015, 50% from 2017
- Electrical power installed per building footprint area [kW/m²]: 0.015 from 2015, 0.02 from 2017.

In the Legislative Decree 28/2011 it has not yet been specified if the renewable energy ratio (RER) requirements refer to primary or to delivered energy. In Italy the concept of “nearby” is not clearly specified yet; currently FprEN 15603 is applied, in which “nearby the building site” is defined as the energy source which can be used only at local or district level having a dedicate connection, requiring specific equipment for the assessed building or building unit to be connected to it.

In Slovenia at least 50% share of RES in respect to the total delivered energy is mandatory.

In Bulgaria, at least 55% of the final energy (heating, cooling, ventilation, DHW and lighting, without appliances) shall be covered by RES.

The rest of the target countries, such as Macedonia, Greece, Portugal, Spain and United Kingdom have not specified numerical requirement for mandatory share of RES concerning nZEBs.

4.3 Cost optimal level requirements

Article 4 of the recast EPBD requires Member States to take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. According to Article 5, Member States shall calculate cost-optimal levels of minimum energy performance requirements using the comparative methodology framework.

In most of the target countries, except Macedonia and Greece, the cost optimal calculations have been made.

In Bulgaria and Croatia, the primary energy requirement for new buildings has been modified according to the cost optimal levels, i.e. the current requirement level of annual primary energy use reflects the cost optimum.

In Spain, the cost optimal calculations and comparison with the current and future energy performance requirements of buildings have been undertaken. The energy consumption considered in the calculations is the non-renewable primary energy for heating, cooling and domestic hot water, including lighting for non-residential buildings. Six reference existing buildings and ten new buildings were used, combining them with six climatic zones and different orientations, giving 120 subcategories of buildings. The cost-optimal values for existing and new buildings were reached in most of the cases and it served as a basis for the update of the Building Technical code in 2013. Therefore the current Spanish requirements are also set on cost optimal level.

In Hungary the cost optimal requirements relate to the heat transmittance, the specific heat loss coefficient of the building and the primary energy use. The values will be mandatory from 2015 for every major renovation, which is implemented through the use of national or EU funding grants. From 2018 all new building and existing building undergoing major renovation must meet these requirements.

In Romania, the cost optimal levels of specific primary energy consumption were defined as a range for each reference building in various representative climatic conditions, and gaps against current requirements for reference buildings were identified. Since no minimum energy performance requirements are currently set in terms of a global indicator (kWh/m²y), the gap was calculated against the primary energy indicators calculated for the reference buildings taking into account the minimum thermal requirements (e.g. maximum transmittances) for reference buildings. Cost-optimal levels will be applied from 31 December 2015.

In the United Kingdom the cost optimal calculations have been performed both for residential and non-residential buildings. For new dwellings it was noted that the requirements were better than the cost-optimal levels, whereas the requirements for new non-domestic buildings fell just short of the cost-optimal levels. It should be noted that the activity needs to be updated in light of the new, more demanding requirements that came into force in April 2014. For existing dwellings, the requirements are either at or better than the cost-optimal levels, and for existing non-domestic they fall just short of the cost-optimal levels. Although new requirements came into force in April 2014 those relating to existing buildings are largely unchanged from the previous requirement.

In Italy there is currently no cost-optimal level requirement in the national legislation, however optimal levels derived from the Italian application of the Cost Optimal Methodology with the requirements currently in force are compared in the National plan for increasing the number of nearly-zero energy buildings dated 22th October 2013. The comparison shows that in almost all the buildings, it is more cost-effective to exceed the minimum legal requirements and construct higher-performance buildings than those required by the current law. As concerns performance of individual building elements, the minimum requirements currently in force, as laid down in Legislative Decree No. 311/2006, have been found to be on the whole in line with optimal values, with the exception of the colder climate zones, where there is room for some improvement. The results of the Cost Optimal Methodology shall be used to determine the new energy performance

requirements for buildings. Thus, these requirements are destined to be revised and expanded, including certain services currently excluded, first and foremost space cooling.

In Slovenia the cost-optimal analysis was performed using dynamic simulations on reference buildings covering the typology included in the EPBD and representative buildings for the existing building stock as well as for new buildings. The analysis focused on four building categories: single family houses, multi-family houses, public buildings and non-residential (office) buildings. Cost optimal levels of specific primary energy consumption (kWh/m²a) were defined as a level for each reference building and gaps against current requirements for reference buildings were identified. The results of the analyses on new buildings show that in financial calculations, which is selected as a national benchmark, the gap does not exceed -14%, which is within the allowable tolerance between the current minimum requirements for the energy performance of the building and the cost-optimal levels. The results for existing buildings show that in financial calculations, the gap does not exceed +13%, which is also within the allowable tolerance.

In Portugal the comparative methodology framework to calculate the cost optimum levels of minimum energy performance requirements for residential buildings has been undertaken. The report presents the information and results achieved in the determination of cost optimal levels for the energy performance of residential buildings in Portugal. Concerning non-residential buildings the first results will be produced later.

4.4 Policies and measures for the promotion of nZEBs

Article 9 (3c) of the EPBD recast requires the national plans to include information on policies and financial or other measures for the promotion of nearly zero energy buildings. Every Member State of the EU is required to implement measures for the promotion of nZEBs. Several measures have been already implemented and are summarized in Section 4.4.1 'Status Quo' and the recommendations are elaborated in Section 4.4.2 'Recommendations'.

4.4.1 Current status

According to the EPBD, every Member State must prepare national action plan to increase the number of nZEBs, together with measures for the promotion of these buildings. Furthermore, the Commission must prepare and publish report on the progress of each Member State and its accomplishments in the area of nZEBs. The first report was published in 2013 and includes a chapter on policies and measures for promotion of nZEBs. The next report is expected late 2015 or early 2016.

According to this report, and the national NEEAPs, the countries reported wide range of measures and policies for promotion of nZEBs. Some of the measures are not clear to what extent they are for nZEBs, but apply in that case as well.

As shown in Figure 1, the measures and policies for promotion of nZEB on European level include financial instruments and support measures, including tax credits for notary fees, subsidised mortgage interest rates for energy efficient homes and low-interest loans for retrofitting into low-energy homes. Other notable measures that are included by the EU countries are strengthening of building regulations, awareness raising, education and training activities, and pilot or demonstration projects for very efficient buildings. The scope of the measures and policies varies significantly between countries. The focus of some countries is central government buildings only, while others also included all publicly-owned buildings or those used for public purposes.

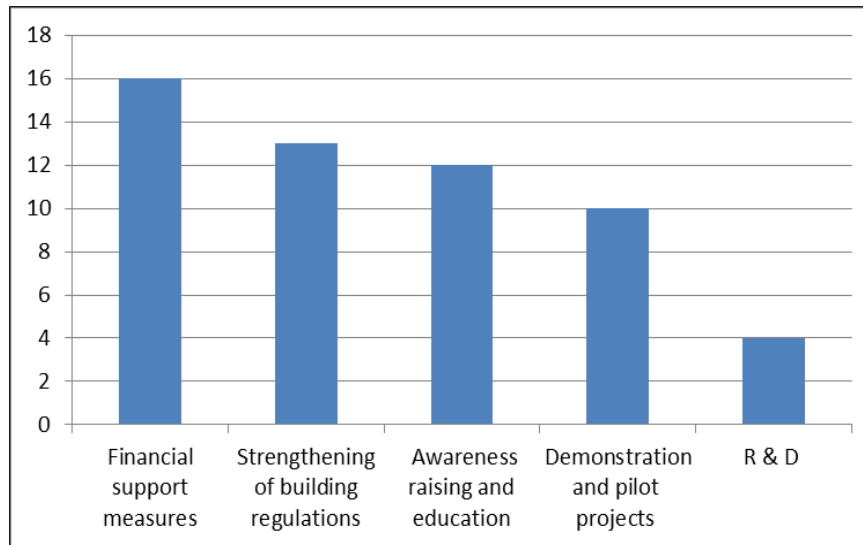


Figure 1. Main policies and measures in support of nZEBs in Member States [62]

Article 9 (3c) of the EPBD requires Member States to also inform the Commission in their national plans about the "...details of national requirements and measures concerning the use of energy from renewable sources in new buildings and existing buildings undergoing major renovations in the context of Article 13(4) of Directive 2009/28/EC...."

Article 13 (4) of Directive 2009/28/EC on the promotion of the use of energy from renewable sources (hereafter called RES Directive) states that:

"Member States shall introduce in their building regulations and codes appropriate measures in order to increase the share of all kinds of energy from renewable sources in the building.

In establishing such measures or in their regional support schemes, Member States may take into account national measures relating to substantial increases in energy efficiency and relating to cogeneration and to passive, low or zero-energy buildings.

By December 2014, Member States shall, in their building regulations and codes ... require the use of minimum levels of energy from renewable sources in new buildings and in existing building that are subject to major renovation."

Only a few countries reported on this requirement in their national plans or NEEAPs. However, some Member States reported on the share of renewable energy in buildings in the context of their National Renewable Energy Action Plans (NREAPs), although not in much detail. The countries that reported measures included mainly minimum levels of thermal solar energy for the production of domestic hot water.

Article 9 (2) of the EPBD requires Member States to follow "... 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 NZEBs, and inform the Commission thereof in their national plans..."

The main reported policies and measures to stimulate refurbishments into nZEBs can be divided into specific measures for this kind of refurbishment, establishing specific building regulations for refurbishment, financial benefits such as rebates, tax credits and advantageous bank loans or specific studies on the subject.

4.4.2 Recommendations

Three types of measures will be covered here: financial incentives, legislative measures and promotional measures. They are based on the national plans of the Member States and in practice are proven to be effective in some degree.

Financial incentives

Favorable loans

Loans that target specifically nZEBs can encourage builders. These loans should have favourable (or even zero) interest rates and have been used frequently in the past to stimulate energy efficiency and have had significant impact and are likely to be used in practice.

Revolving funds

National revolving funds with favorable conditions can be good long term solution to stimulate nZEBs. All points that were mentioned in the above *Favorable loans* section are true here also.

Grants

Grants can help the nZEBs to create several pilot showcases in every country and can help in order for nZEBs to become main stream (not just a futuristic concept) among builders and the general population. This can be a driving force, especially in the beginning and can help in raising awareness also.

Tax incentives and subsidies

Tax credits and other tax incentives are proven driving force in the field of energy (efficiency, renewable etc.) These kinds of measures must be implemented when it comes to nZEBs. For new buildings, tax release (e.g. communal tax) can be offered, while in the case of refurbishment, asset tax releases and similar incentives can be implemented.

Subsidies (apart from tax releases) can also play a significant motivational role in regard of nZEBs.

Legislative measures

Strengthening building regulations

The building regulations have not yet been created with requirements that deliver nZEBs. The legislative procedures should be changed to meet the needs on nZEBs as this can deliver nZEBs faster than stimulation measures. In any case, the building regulations must be revised in respect of nZEBs.

Promotional measures

Pilot demonstration

Public buildings should be showcases for the general population, thus the first nZEBs should be built by central or local authorities. Accordingly such buildings should be educational, libraries or other public buildings that are regularly visited by a high number of people, so a large proportion of the population would see the benefits of refurbishment towards the nZEB level.

Events and raising awareness

Event types like open days, school lectures, TV appearances and other similar publicity should be created regularly. The purpose is to raise awareness of the general population. The most common barrier, apart from financial nature, is the lack of knowledge about the benefits from every new concept that is introduced. Raising awareness should be the first step in every promotional activity.

Education

Education (i.e. training and guidance/dissemination) should be introduced to companies that offer services to the general population. These companies must be up-to date with new information and procedures and must implement state-of-art technologies. The education should cover the general population as well through open lectures that will help to promote nZEBs and raise awareness. Lectures in primary and secondary schools should also be implemented. Courses in universities can significantly help to create trained personnel.

Competitions

There are many showcases with local authorities and competitions for best garden, energy efficient house or similar. These may be small incentives, but are great pilot demonstration and publicity events for the general population. The drawback is that nZEBs must be present for this kind of publicity measure, so this initiative must come after the other initiatives are in place.

Projects

Multi-level governance for Energy Efficiency (multEE) is a new Horizon 2020 project that should start from March 2015. MultEE's objective is to improve the ease and quality of energy efficiency policy planning and implementation in the project's partner countries and beyond, addressing the challenges of evidence-based policy-making in a multi-level governance setting. The project pursues a two-faceted, yet integrated, approach in order to reach this objective: (1) based on a mapping of European best practices and experience from a pioneering project put in place by the lead partner, country-specific solutions for effective monitoring and verification (M&V) based on bottom-up data will be proposed and their implementation supported; (2) such innovative M&V schemes require exchange and cooperation between policy levels, with coordination mechanisms to be developed and implemented together with the partners. The project pays particular attention to providing opportunities for peer learning to partner countries from the EU and its South-Eastern neighbourhood as well as to disseminate results beyond partner countries and other policy areas.

4.5 Drivers and barriers of transformation of existing buildings into nZEB level

In this section the drivers and barriers of transformation of existing buildings towards nZEB level are presented. The major and most common drivers and barriers are gathered in order to assess which countries are similar or different from each other. This will be useful input data for D3.2 report, and also for WP5 activities, which are focused on the definition of accompanying strategies to promote and accelerate the refurbishment of the public building stock towards nZEB.

4.5.1 Barriers

A very important issue, which can be a driver or barrier to transform existing buildings towards nZEB level, is the **regulatory framework** for implementing nZEB buildings. The transposition of nZEB definition with numerical requirements into the national legislation is a precondition to increase the number of nearly zero energy buildings. Currently only Croatia and Hungary have fully transposed the nZEB definition with numerical requirements into the national legislation, consequently it can be said the current legislation status of detailed nZEB definition is a barrier for the other countries, since the requirements have not been set completely in the legislation. However, it should be noted that introducing the detailed nZEB definition in the legislation has started in most of the countries.

According to Article 2 (2) of the EPBD recast a nZEB means a building that has a very high energy performance, the nearly zero or very low amount of energy required should be covered to a very

significant extent by energy from renewable sources produced on-site or nearby. It may cause difficulties, so it can be a barrier to increase the number of nZEB building if there is not any requirement for **mandatory share of RES**. Currently, in the Mediterranean countries, such as Spain, Greece, Italy and Portugal, and also in Slovenia there are obligations to use renewable energy sources. It may serve as a good starting point to increase the share of RES, compared to those countries, where there is not any current requirement to use RES, like in Bulgaria, Macedonia, Hungary and United Kingdom.

If **definitions, algorithms and requirements greatly vary locally within the country** (due to several local regions) it may cause difficulties. This barrier appears in Italy, Portugal and Macedonia.

- From an administrative point of view Italy is divided in 20 regions which can chose to apply the national transposition of the EPBD or chose to adopt directly the Directive. This leads to a complex situation, in which definitions, algorithms and accuracy of the EPBD implementation can greatly vary locally. Currently, the Italian government is working to increase the uniformity of the procedures, but this process will require a long time. Furthermore, Italy is divided into six climatic zones according to heating degree days, which makes the situation more complex, since the requirement of thermal transmittance, primary energy need for heating and delivered energy for cooling have been set for each climatic zone.
- In the Portuguese legislation there are three summer climatic zones defined from the average outside temperature corresponding to the conventional cooling season and three winter climatic zones defined according with heating degree days in 18°C base. The requirements are different in the climatic zones. Due to the temperate Mediterranean climate giving high temperatures in summer and mild in winter, investment in infrastructure, heating and cooling has not be considered to have great significance, as indicated by low levels of use.
- Even though Macedonia is a small country it still has a diverse climate, with eight climatic regions. There are several characteristic climate regions with sub-Mediterranean, continental and mountain climate. Three climatic zones are defined in the Rulebook for energy performance of buildings which are distinguished by the value of the degree-days.

The **low state or local budget** for energy efficiency projects of public buildings is a common issue, and it is a barrier in Croatia, Macedonia, Greece, Italy, Portugal, Spain and United Kingdom. There is a lack of financial instruments for major renovation of existing buildings in almost all target countries.

The **high initial costs of investments**, or the **long payback time** is a barrier to implement the refurbishment of existing buildings towards nZEB level in all target countries except Italy and Bulgaria.

The **energy prices** have also a great influence on implementing energy saving projects. The lower energy prices hinder the implementation of energy efficiency projects, since the lower energy prices increase the payback time of an investment which focuses on reducing energy consumption and cost. The expert of the project in Macedonia, Hungary, Romania, Portugal and United Kingdom stated that the relatively low level of energy prices is a barrier.

Often, the definition of nearly zero energy building has only been introduced in the target countries' national legislations within the last year. The nZEB requirement will be mandatory for new public buildings after 31st December 2018 therefore there is very **low number of demonstration projects**, which follows particularly the nZEB definition.

A common barrier in almost all target countries is the **limited technical skill in the decision making process at public institutions**, which may lead to choosing conventional, less energy-efficient options. As concerns the decision criteria of an investment, in many cases there is a priority in the decision to initial cost, and there is a lack of awareness concerning the economic benefits from refurbishment measures.

Table 1. Barriers of refurbishment the existing public buildings towards nZEB level

	Bulgaria	Croatia	Macedonia	Greece	Hungary	Italy	Portugal	Romania	Slovenia	Spain	United Kingdom
Numerical indicator for energy demand of nZEB has not been specified											
No requirement for mandatory share of RES in the current status											
No requirement for mandatory share of RES concerning nZEBs											
Definitions, algorithms, requirements greatly vary locally within the country, due to several local administrations (regions)											
Low state/local budget for energy efficiency projects of public buildings											
Lack of financial instruments for major renovation of existing buildings with nZEB targets											
High initial costs of investments											
Long payback time of investments											
Low level of energy prices											
Limited technical skill in the decision making process at public institutions, which may lead to choosing conventional, less energy-efficient options											
There is no (or very low) number of demo projects of renovation existing buildings onto nZEB level											
Lack of awareness concerning the economic benefits from refurbishment measures											
Uncertainties concerning the measurement and verification of the energy-saving											

4.5.2 Drivers

As regards the drivers of refurbishment the existing buildings towards nZEB level, the first precondition is the transposition of the **nZEB definition** into the national legislation. As mentioned above only Hungary and Croatia confirmed officially the related legislations which contain the nZEB definition.

Energy costs savings, lower dependence on energy suppliers, and improved comfort in the buildings are major drivers for renovation in several countries. Public building owners (central/local authority) are interested in reducing the energy cost. Nearly zero energy consumption reduces operational costs, thus it gives the possibility to use the state/local budget for other more useful purposes. Apart from some exceptional situations, however, merely energy cost savings are

usually not sufficient drivers to launch a major renovation. Improved comfort and better living or working conditions are often important criteria.

The inclusion of energy aspects into planned renovations seems to depend greatly on government support programmes, such as **grants, tax deductions and low-interest loans**. Grants are drivers in Bulgaria, Macedonia, Hungary, Italy, Spain and in Portugal. In these countries the tax deductions only appear in Italy, Spain and United Kingdom, and low interest loans are available in Croatia, Macedonia, Spain and in United Kingdom. Support programmes seem to influence the type and scope of energy improvements included in the renovations, so the increase of these financial instruments is necessary.

Energy Performance Certification databases exist in each country (except Croatia), which can help energy experts to choose the potential buildings for major renovations.

Best practices and demonstration projects are major drivers. Although many buildings have been refurbished with national or EU funding grants, which proves the value of energy efficiency, the levels achieved are far from nZEB ones. It is anticipated that best practices and a well-developed raising awareness campaign would accelerate the refurbishment of buildings towards nZEB level. An additional condition for the successful change towards high energy performance building stock is the implementation of monitoring systems (equipment and procedures) in order to assess the effect of renovation programmes.

The nZEB definition has been transposed to the national legislation with numerical requirements only in Bulgaria and Hungary, from which Bulgaria has one best practice building, which is the Research centre of the Technical University, in Sofia.

However, **best practices of policies** can be found in several countries in terms of increase the nZEB buildings.

- In Italy a number of Regions are currently promoting initiatives targeting nearly-zero energy buildings, via dedicated regional calls and efficient building construction initiatives in the social housing and non residential (schools, offices etc.) sectors. For example, the Lombardy Region has already issued a regional law requiring all (new) buildings, public and private, to be nearly zero-energy from 1 January 2016. The Region has already implemented a number of energy upgrading projects in public and private buildings including several schools and healthcare centres. A showcase example is the laboratory at the Bovisa campus of the Milan Polytechnic University. This is a nearly zero-energy new university pavilion hosting a cutting-edge laboratory for the development of energy efficiency technologies. The main national incentives promoting the energy efficiency in buildings as well as the use of renewable sources are summarized as follows:
 - Tax deduction for energy efficiency improvement actions
 - The Thermal Account
 - White certificates
 - Guarantee funds and promotion of TPF (Third-Party Financing) models
- In Macedonia several public buildings (schools and kindergartens) were completely renovated a few years ago and they represent important example of implementation of energy efficiency and renewable energy measures.
- United Kingdom government's policy towards zero carbon homes.

Table 2. Drivers of refurbishment the existing public buildings towards nZEB level

	Bulgaria	Croatia	Macedonia	Greece	Hungary	Italy	Portugal	Romania	Slovenia	Spain	United Kingdom
nZEB definition is described in the legislation											
Energy cost saving											
Lower dependence on energy suppliers											
Improved comfort, better working or living conditions											
Grants											
Tax deductions											
Low interest loans											
Availability of innovative building retrofitting solutions											
Best practices are available related to renovation existing buildings onto high energy efficiency level											
Best practices are available related to renovation existing buildings onto nZEB level											
Demonstrational projects, which enable the builders to get to know the benefits fulfilling the nZEB requirements											
Energy Performance Certification database, which may can ease to choose the potential buildings for major renovations											

4.5.3 Other indicators connected to drivers and barriers

After the partners identified the different aspects that can help or hinder the refurbishment of the existing public buildings into nZEB, indicators have been identified that are closely connected to drivers and barriers. These indicators are climatic conditions (average maximal and minimal temperatures, average horizontal radiation), energy prices, gross domestic product per capita, main heating sources of public buildings, and primary energy factors. These are also used here to group countries and to identify where countries in one category are similar or different from each other, in order to better assess the common nZEB definition in WP3, and the concrete strategy proposals in WP5.

Climatic conditions

As for the climatic conditions, it is obvious that they have a very significant effect on the heating and the cooling energy consumption, therefore it is interesting to know which countries or zones of countries have similar winter and summer climatic condition. In the future legislations concerning the numerical requirement of nZEB, the climatic condition may serve as an input for setting the requirements, as we can see examples for this in the Italian, or in the Romanian legislation.

The *monthly average temperature* both for the coldest and the warmest month have been gathered for each target country, which are shown in Figures 2 and 3 respectively. In those countries where more than one climatic zone exists within the country, the values of each climatic zone are presented.

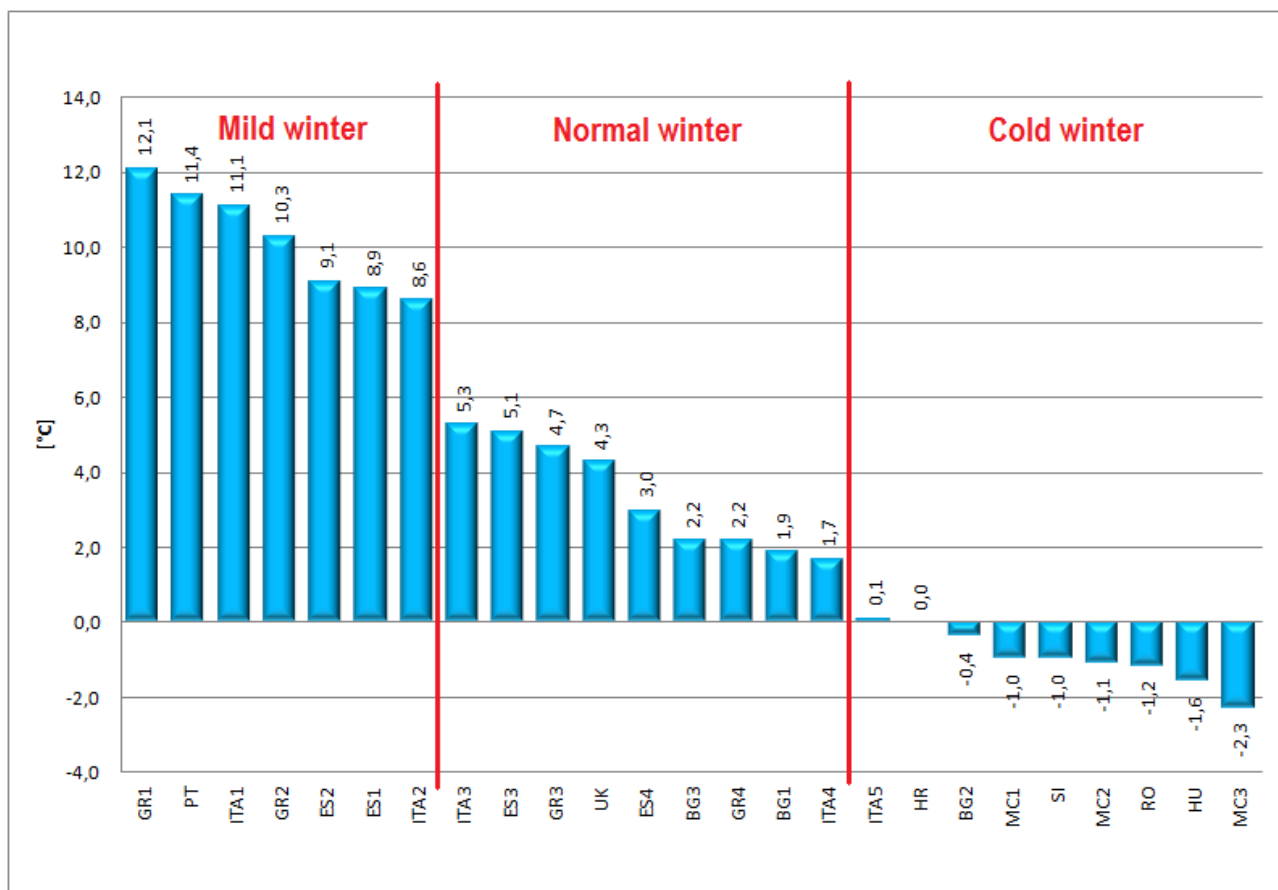


Figure 2. The average monthly temperature in the coldest month

According to Figure 2, in the target countries three groups can be set concerning the characteristic winter climatic conditions: mild winter, normal winter and cold winter. The target countries can be grouped as regards the monthly temperatures in the coldest month as follows:

1. Mild winter, average temperature of coldest month 8...13°C
Mild winter appears in Portugal, and some climatic zones of Greece, Italy and Spain:
 - PT
 - GR1-2
 - ITA1-2
 - ES1-2
2. Normal winter, average temperature of coldest month 0.5...8°C
Lower winter temperatures appear in United Kingdom, and in some climatic zones of Bulgaria, Greece, Italy and Spain:

- UK
- BG1, BG3
- GR 3-4
- ITA 3-4
- ES 3-4

3. Cold winter, average temperature of coldest month -2...0.5°C

The lowest monthly average temperature appears in Croatia, Hungary, Macedonia, Romania and Slovenia as well as in some climatic zones of Bulgaria, Greece, and Italy.

- BG2
- HR
- MC 1-3
- GR 4
- HU
- ITA 5
- RO
- SI

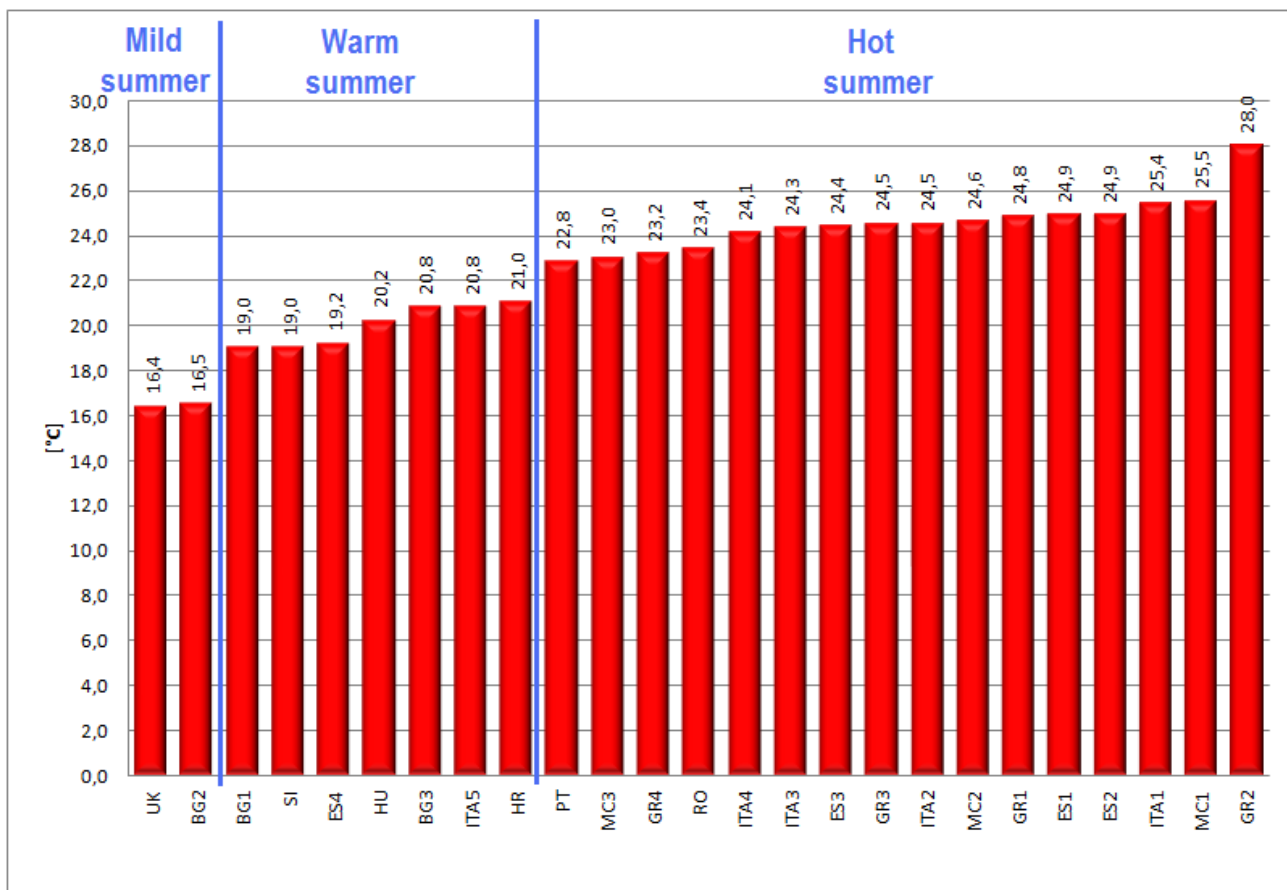


Figure 3. The average monthly temperature in the warmest month

As for the summer conditions, according to Figure 3, in the target countries three groups can be set concerning the characteristic summer climatic conditions: mild, warm and hot summer. The target countries can be grouped as regards the monthly temperatures in the warmest month as follows:

1. Mild summer, average temperature of warmest month 16...17°C

Mild summer appears in United Kingdom, and some part of Bulgaria:

- UK
- BG 2

2. Warm summer, average temperature of warmest month 17...21°C

Warm summer appears in Croatia, Hungary, Slovenia and some climatic zones of Italy, Spain and Bulgaria.

- BG 3
- HR
- HU
- ITA 5
- SI
- ES4

3. Hot summer, average temperature of warmest month 21...28°C

Hot summer appears in Romania, Macedonia, Greece, Portugal, and most area of Spain and Italy.

- MC 1-3
- GR 1-4
- ITA 1-4
- PT
- RO
- ES 1-3

The *global horizontal radiation* can also be an important indicator, as it has direct influence on potential of solar renewable energy. The global horizontal radiation depends on the geographical place, therefore a band is given in Figure 4 by each country.

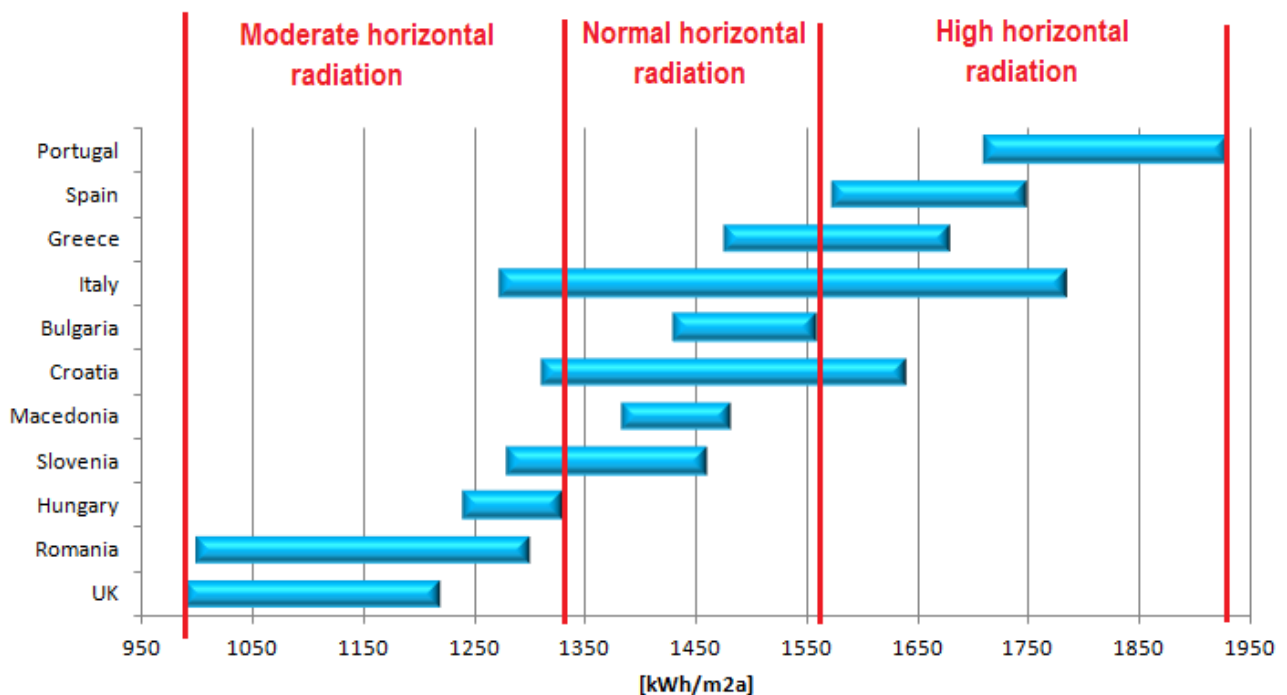


Figure 4. Global horizontal radiation [61]

The target countries can be categorized into three groups based on the solar irradiance.

1. Moderate horizontal radiation (990-1330 kWh/m²a)
From the target countries the lowest horizontal radiation appears mainly in UK, Romania and Hungary, and some parts of Slovenia, Croatia and Italy.
2. Normal horizontal radiation (1330-1560 kWh/m²a)
Moderate values of horizontal radiation appear mainly in Slovenia, Macedonia, Bulgaria and some parts of Italy and Croatia, and some parts of Croatia, Italy and Greece.
3. High horizontal radiation (1560-1930 kWh/m²a)
High values of horizontal radiation appear mainly in Greece, Spain, Italy, Portugal and some parts of Croatia.

Main heating sources

The main energy sources of public building's heating systems were presented in D2.1. The main heating energy source is natural gas in almost all target countries, except Bulgaria and Macedonia, where heating oil is the main source. Heating oil is also important in Slovenia and Croatia, but not as significant as in Bulgaria and Macedonia. After natural gas district heating is the characteristic heating source in Bulgaria, Hungary, Romania, Slovenia and the UK. It should be noted that in the Spanish climatic zones where the winter is mild the most common heating source is the electricity. Currently, wood is important as a heating source in Macedonia.

Energy prices

Natural gas and electricity are important heating sources in most of the target countries, therefore the prices of these energy sources can be considered as an indicator. Natural gas prices (excluding VAT) are similar in the target countries, except Romania, where the price is half of that in Greece, which has the highest gas price. In Croatia, Greece and Portugal the natural gas price is between 0.04-0.045 EUR/kWh. The gas price is lower in Hungary, Slovenia, Spain, Macedonia, UK, Italy, and Bulgaria, where the price is between 0.034-0.039 EUR/kWh. The Romanian gas price is only 0.021 EUR/kWh.

Electricity prices are highest in UK, Spain, Italy, Portugal and Greece, with 0.1-0.13 EUR/kWh, the electricity can be purchased on a bit lower level of price in Croatia, Hungary, Slovenia, Bulgaria and Romania, with 0.07-0.09 EUR/kWh, while Macedonia has the lowest electricity price, 0.042 EUR/kWh.

Gross domestic product

Gross Domestic Product (GDP) measures the size of a country's economy. It is the monetary value of all the finished goods and services produced within a country's borders in a specific time period, though GDP is usually calculated on an annual basis. It includes all of private and public consumption, government outlays, investments and exports less imports that occur within a defined territory. GDP is commonly used as an indicator of the economic health of a country, as well as to gauge a country's standard of living. Figure 5 shows the GDP per capita of each target country: at the extremes among target countries the highest GDP is almost eight times higher than the lowest GDP. The economic performance of target countries may also serve as an indicator for setting the numerical requirement of nearly zero energy buildings. Probably those countries which have lower GDP cannot meet the same requirements, or at least they may need more time and financial support to refurbish the existing building stock.

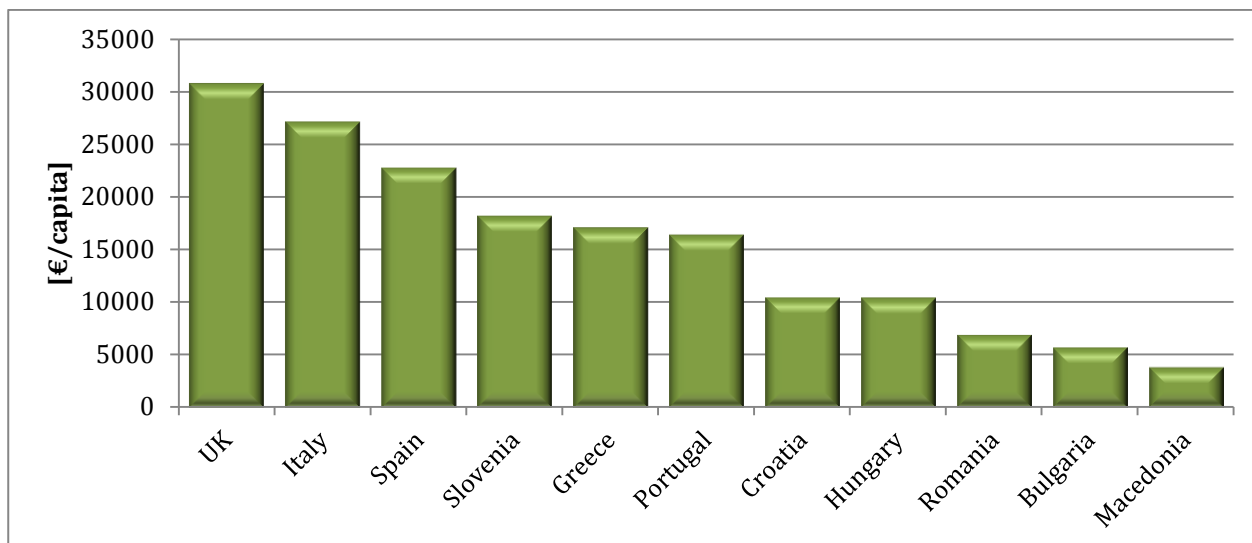


Figure 5. GDP per capita [27]

Primary energy conversion factors

There are not so many differences in the values of primary energy factors for natural gas and electricity among the target countries. The primary energy factor for natural gas varies between 1-1.2, while the conversion factor for electricity varies between 2.4 and 3.0, the value is lower than this only in Croatia, where the primary energy factor for electricity is 1.61. As for the biomass, there are more significant differences, in Slovenia the conversion factor for biomass is 0.1, in Hungary is 0.6, in Greece, Italy and Portugal it is 1.0, in Bulgaria, Romania and Spain the value is a bit higher than 1.0, whilst in Croatia it is 1.19 and 1.5 in Macedonia. The total primary conversion factor of solar energy is around 1.0, while in Hungary the value is 0. The district heating system's primary energy factor depends on the type of primary energy production (heating energy production, combined heating and electricity production), and the energy source (natural gas, biomass, etc.). In those countries where the district heating systems have low primary energy conversion factor (Hungary, Greece and Romania) the fulfilment of buildings' nearly zero energy consumption may be easier.

5. CONCLUSION

This report presents the national regulatory frameworks as regards nZEB legislation, presenting current nZEB definitions and numerical requirements, as well as policies and measures for the promoting of nZEBs. This together with an evaluation of the drivers and barriers of refurbishment of existing public buildings towards nZEB level are essential results for the further work in the RePublic_ZEB project, especially for the D3.2, D3.3 and WP5 activities.

Legislative status of nZEB definition

The national legislation process of nZEB definition and the application in practice show considerable variety between the target countries of RePublic_ZEB project. **Some countries have not transposed the nZEB definition into the national legislation yet, other countries have introduced only the general nZEB definition without any numerical requirement. Some countries have elaborated the requirements with numerical values but confirmation of the values is in progress, while other countries have already officially transposed the definition with numerical values.**

As for the details, two of the target countries – Macedonia, and Spain – have not transposed the nZEB definition into the national legislation. Unfortunately Macedonia has currently no plans for the future implementation of the EPBD and transposition of nZEB into the legislation, while Spain has made steps towards nZEB implementation by improving the energy requirements, i.e. the limitation of non-renewable primary energy consumption both in residential and non-residential buildings.

The nZEB definition has already been introduced to the national legislation in Greece, and Portugal, but only in general terms, so the detailed requirements and the application in practice have not been specified yet. In Italy the law established the definition of nZEB, and the draft copy of the expected regulations implementing the law incorporate many interesting indices which will be the requirements to prove the given building is nZEB. The numerical values of these requirements will be set later. These indexes may serve as good examples for D3.2 when setting the common framework and suitable parameters to describe a nZEB.

In Romania the general nZEB definition is included in the law, and the detailed definition was integrated within the National Plan to increase the number of buildings with nearly zero energy consumption. The numerical targets, which are under approval process, are maximum allowable level of primary energy use and CO₂ emission, by building type and climatic zone, and mandatory share of RES. In Slovenia, the situation is similar, since the definition of nZEB is being added through the National Plan for nZEB. In Slovenia the requirements have been set for primary energy consumption and share of RES, and the confirmation of the values is in progress.

In Bulgaria the national definition of nZEB has been formulated, but for the implementation an update of three legislative documents is needed. The national nZEB definition has been transposed into the legislation with numerical requirements for several building types in Croatia and Hungary, and ready for the implementation in practice.

Across the United Kingdom the energy performance requirements are framed in terms of CO₂ compliance for all building types. The set of requirements and the legislation of zero carbon buildings are in progress. However, there are some results for zero carbon homes, for example the final energy-, and CO₂ emission-requirement for heating and cooling of dwellings, which may serve as indicators for D3.2.

Numerical indicator of primary energy use and share of RES of nZEB

As mentioned above, only Croatia and Hungary have introduced a numerical primary energy requirement of nZEB into their national legislation. Slovenia and Romania have also elaborated on it for nZEB, but the values are not yet confirmed officially.

A review of these four countries' (Croatia, Hungary, Slovenia and Romania) national nZEB definitions for residential buildings shows high variation in primary energy requirements of between 30 (in Croatia) and 217 kWh/m²a (in Romania). As for office buildings, the requirements also show variety among target countries, since it is set in the range 25 - 160 kWh/m²a. In Croatia the requirement for nearly zero energy office buildings are only 25-30 kWh/m²a (due to very low primary energy conversion factor for electricity), in Romania 45-89 kWh/m²a, in Slovenia 55-80 kWh/m²a, while in Hungary the value is set to 132-160 kWh/m²a. In Bulgaria the current requirements of class "A" means nZEB, so the primary energy consumption for office buildings is 70-140 kWh/m²a.

The difference in the available nZEB numerical requirements is also great in the target countries if we consider education buildings. The Croatian requirement is 50-55 kWh/m²a, while the Hungarian (90-150 kWh/m²a) and the Romanian (92-185 kWh/m²a) values are much higher. The Bulgarian class "A" requirement is 25-50 kWh/m²a for school buildings, and 33-65 kWh/m²a for kindergartens.

Croatia and Romania have also introduced nZEB primary energy requirements for health facilities. In Croatia the requirement is 190-200 kWh/m²a, while in Romania it is set to lower values (76-167 kWh/m²a). The Bulgarian class "A" requirement is 70-140 kWh/m²a for hospitals.

In conclusion in most cases the available numerical requirements for different types of buildings (both residential and non-residential) show large variety among the target countries. It is partly due to different climatic conditions, but it is worth noting the variation still occurred even where there were similar climates. The review of these values and common criteria for setting the requirements is therefore necessary, which is to be undertaken in D3.2.

There is also a great variety in the numerical figures of mandatory share of RES. In some countries the basis is primary energy, while elsewhere it is final energy (delivered energy to the building), or only some part of final energy. The requirement for mandatory share of RES varies between 10% and 55% in the target countries: Romania 10%, Hungary 25%, Croatia 30%, Italy 35-50%, Slovenia 50% and Bulgaria 55%. The rest of the target countries, such as Macedonia, Greece, Portugal, Spain and United Kingdom have not yet specified numerical requirement for mandatory share of RES concerning nZEBs.

Drivers and barriers of transformation of existing buildings towards nZEB level

As a result of this analysis it can be concluded that both the drivers and the barriers of transformation of existing buildings towards nZEB level are very similar in the target countries of the RePublic_ZEB project. There are special issues within some countries, but generally the situation is similar. **The major barriers, which can be highlighted, are as follows:**

1. The **high initial costs of investments**, or the long payback time is a barrier to implement the refurbishment of existing buildings towards nZEB level in almost all target countries.
2. Related to the first point, the **low budget for energy efficiency projects of public buildings** is a common issue, and it is a barrier mainly in Croatia, Macedonia, Greece, Italy, Portugal, Spain and United Kingdom; moreover there is a lack of financial instruments for major renovation of existing buildings in almost all target countries.

3. **Low energy prices** hinder the implementing of energy efficiency projects, since they increase the payback time of an investment which focuses on reducing energy consumption and cost. The project experts in Macedonia, Hungary, Romania, Portugal and United Kingdom stated that the relatively low level of energy prices is a barrier.
4. The nZEB requirement will be mandatory for new public buildings after 31st December 2018 therefore there is **very low number of demonstration projects**, which adopted the concepts of nZEB.
5. A common barrier in almost all target countries is the limited **technical skill in the decision making process at public institutions**, which may lead to choosing conventional, less energy-efficient options.
6. If **definitions, algorithms and requirements vary greatly locally within the country** (due to several local regions) it may cause difficulties. This barrier appears in Italy, Portugal and Macedonia.

As regards the drivers it can be concluded that energy cost savings, lower dependence on energy suppliers and improved comfort in the buildings are major drivers for renovation in several countries. The inclusion of energy aspects into planned renovations seems to depend greatly on government support programmes such as grants, tax deductions and low-interest loans. Support programmes seem to influence the type and scope of energy improvements included in the renovations, so an increase in these financial instruments is necessary in the target countries.

Other indicators have also been identified that are closely connected to drivers and barriers. These indicators are climatic conditions, energy prices, GDP per capita, main heating sources of public buildings and primary energy factors. Grouping of countries have been made in terms of these indicators in order to better assess the common nZEB framework in D3.2. Three groups were identified concerning the summer and winter conditions, which has very significant effect on heating and the cooling energy consumption. The global horizontal radiation was also analysed. Taking into account all of these climatic conditions **Greece, Italy, Spain, Portugal and Croatia can be grouped in one category (1st group), and the rest of the countries to another category (2nd group).** However, the boundary between the two groups is not sharp. Energy prices are generally higher in the 1st group, which may ease the implementation of major energy saving projects as refurbishment towards nZEB.

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7. ACRONYMS

BPIE	Building Performance Institute Europe
DHW	Domestic hot water
EC	European Commission
EE	Energy Efficiency
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ESCO	Energy Service Company
EU	European Union
GDP	Gross Domestic Product
HVAC	Heating, Ventilation, Air Conditioning
MS	Member State
NEEAP	National Energy Efficiency Action Plan
nZEB	nearly Zero Energy Building
RED	Renewable Energy Directive
RER	Renewable Energy Ratio
RES	Renewable Energy Source
SEDA	Sustainable Energy Development Agency
VAT	Value Added Tax