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Overview of national applications of the Nearly Zero-Energy Building (NZEB) definition

Detailed report

April 2015

CONCERTED ACTION
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1 Introduction

One of the main and also novel requirements of the Energy Performance of Buildings Directive (EPBD) 2010/31/EU, compared to Directive 2002/91/EC, is that Member States (MSs) have to take measures so that, by the end of 2020, all new buildings are Nearly Zero-Energy Buildings (NZEBs) and, already by the end of 2018, all new public buildings are NZEBs. While the EPBD includes the general requirement, the deadlines and a general definition of a NZEB, it is the task of the Member States (MS) to transpose and implement the requirement into national law and regulations, to adapt the general definition to the national boundary conditions and to clarify the term in the national context. MSs shall inform the EC on their detailed application in practice of the NZEB definition in national plans.

The Concerted Action (CA) EPBD discussed in detail issues relating to setting up national requirements, designing, calculating, monitoring, financing and disseminating NZEBs. One of the key working areas was the exchange of information and discussion of national approaches of the application of the NZEB definition. This report summarises the status of the applications of the NZEB definition in the countries at the end of April 2015.

2 EPBD requirements regarding Nearly Zero-Energy Buildings

Directive 2010/31/EU contains requirements for MSs concerning NZEBs in two different articles and in Annex I:

- **Article 2: Definitions:** "…*'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby;"*

- **Article 9: Nearly zero-energy buildings:** "*1. Member States shall ensure that: (a) by 31 December 2020, all new buildings are nearly zero-energy buildings; and (b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings. Member States shall draw up national plans for increasing the number of nearly zero-energy buildings. These plans may include targets differentiated according to the category of building. … 3. The national plans shall include, inter alia, the following elements: (a) the Member State's detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national, regional or local conditions, and including a numerical indicator of primary energy use expressed in kWh/m² per year. …"*

- **ANNEX I: Common general framework of the calculation of energy performance of buildings:** In this annex it is defined that "*the energy performance of a building shall be determined on the basis of the calculated or actual energy that is consumed in order to meet the different needs associated with its typical use and shall reflect the heating energy needs and cooling energy needs (energy to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs."* Additionally, the annex refers to the primary energy indicator and the calculation methodology (which should take into account European standards), states which aspects have at least to be taken into account, and proposes that, for the purpose of the calculation, buildings be classified into several predefined building categories.

The main requirements of Articles 2 and 9 regarding the national application of the NZEB definition for new buildings can be summarised as follows:

The national application of the definition **shall** specify:

1. **a very high energy performance** of the building;
2. **a very low amount of required energy** by the building;
3. **a numerical indicator of primary energy in kWh/m².year.**

Furthermore, the national application of the definition **should**[1] contain:

4. **a very significant contribution of renewable energy** to cover the remaining energy use.

MSs shall include the national definition of NZEB into national legislation and inform the EC on the details in their national plans for increasing the number of NZEB.

The EPBD contains no requirements for a national application of the NZEB definition for existing buildings undergoing major renovations.

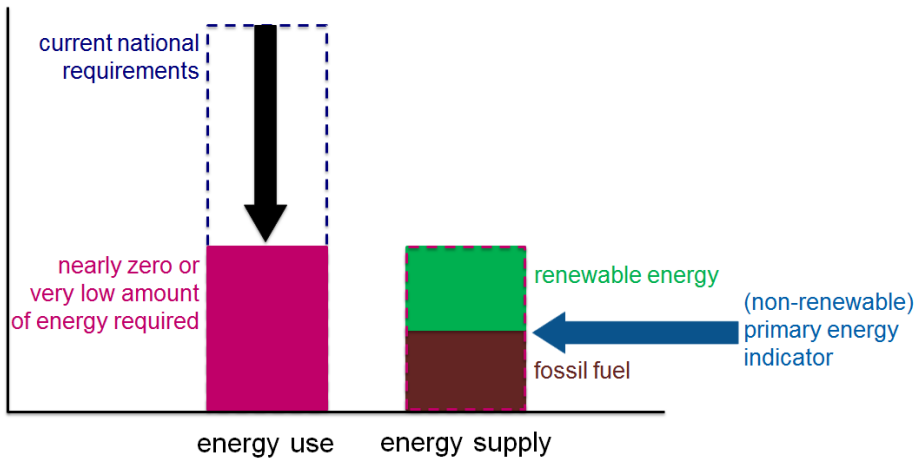

Figure 1: Graphical interpretation of the NZEB definition according to Articles 2 and 9 of the EPBD (Directive 2010/31/EU).

[1] The UK NZEB plan emphasises that "should" is used as a matter of Community legal practice to signify an aspiration rather an obligation.

3 Available sources of information

This overview of MSs' status concerning the national application of the NZEB definition is based on several information sources:

1. The national plans for increasing the number of NZEBs.

   The national plans for increasing the number of NZEBs have to be sent by the MS to the EC. The EC publishes the plans, as well as their English translations, on their website[2]. At the end of April 2015, national plans for NZEBs were available from 21 countries.

2. The CA EPBD book "Implementing the Energy Performance of Buildings Directive (EPBD) featuring country reports 2012"[3].

   The CA EPBD book series include national status reports on all aspects of the EPBD, thus also summarising the progress towards the NZEB definition. These reports are available for all 29 countries participating in the CA EPBD (28 MSs, plus Norway) and were therefore used together with results from the ongoing work in the CA EPBD for deriving information from the countries for which no official national plan for NZEB is available so far. The updated version of the book ("Implementing the Energy Performance of Buildings Directive (EPBD) featuring country reports 2016") will be available in the beginning of 2016.

3. The work and background information from the CA EPBD.

   Participants contributed with information on their national NZEB definition and a review of the information contained in Table 2.

Table 1 gives an overview of the available sources of information in April 2015 regarding the national application of the NZEB definition.

Table 1: Overview of available information sources for the analysis of national applications of the NZEB definition

Country		*Official national plan for increasing the number of NZEB*	*CA EPBD book 2012*	*Work in CA EPBD*
Austria				
Belgium	*Brussels Capital*	*1 national plan for all 3 regions*		
	Flemish Region			
	Walloon Region			
Bulgaria				
Croatia				
Cyprus				
Czech Republic				
Denmark				
Estonia				
Finland				
France				
Germany				
Greece				
Hungary				
Ireland				
Italy				
Latvia				
Lithuania				
Luxembourg				
Malta				
The Netherlands				
Norway				
Poland				
Portugal				
Romania				
Slovak Republic				
Slovenia				
Spain				
Sweden				
United Kingdom				

[2] http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/nearly-zero-energy-buildings

[3] Implementing the Energy Performance of Buildings Directive (EPBD) featuring country reports 2012

4 Analysis of the status of the national application of the NZEB definition

The analysis is based first of all on the official national document, the national NZEB plans. If this was not available, information collected from the work of the CA EPBD was used. The gathered information was then reviewed and, if necessary, updated by the head of the national CA EPBD delegation for each country.

4.1 Analysed main points of the NZEB definition

The following five main points have been analysed per country regarding the national application of the NZEB definition:

1. Is there a detailed definition available?
2. Is there a requirement for "a very high energy performance"?
3. Is there a requirement for "a very low amount of energy required"?
4. Is there a requirement for "a very significant extent of renewable energy"?
5. Is there a requirement for "a primary energy indicator in kWh/m².year"?

A **detailed definition** needs to be more specific than just the mere "*verbatim*" repetition of the general NZEB definition from EPBD (Directive 2010/31/EU) Article 2 into a national legal document. The definition should be fixed in a legal document, or at least clearly referred as the national application of the NZEB definition in the national plan.

A "**very high energy performance** of the building" is most probably not a defined value, but can be expressed, e.g., by a certain high class in the Energy Performance Certificate (EPC), a building level such as "passive house" or X% better than the national minimum energy performance requirements.

A "**nearly zero or very low amount of energy required** by the building" does not include a definition of the energy type. It can therefore be the energy need, the final energy, or the primary energy.

A "**very significant extent of renewable energy** to cover the remaining energy use" can be defined either as a percentage of renewable energy contribution, or as a minimum amount of renewable energy, e.g., in kWh/m².year. Another possibility is a minimum size of solar thermal or photovoltaic (PV) collector, or similar equipment. These kinds of specific requirements are assessed as "direct" in Table 2. Other requirements, where for example the low primary energy requirement leads usually (and intentionally) to the use of renewable energy, are assessed as "indirect". This concept is explained in more detail in 4.2.

According to Table 2 which was reviewed by the national representatives of the participating countries, about 40% of the MSs do not yet have a detailed definition of the NZEB in place. Some of them state this clearly in their national plan for increasing the number of NZEBs. About 60% of the MSs have laid out their detailed NZEB definition in a legal document, but a few of them emphasise the draft status of the definition, or that the definition might be updated later on. The relevant legal documents are either building regulations, energy decrees and official guidelines, or the national NZEB plans.

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

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

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

The vast majority of EU countries (twenty three MSs and one of the three Belgian regions) use a primary energy indicator in kWh/m².year, in line with Annex I of the EPBD, either in their detailed NZEB definition, or in their current energy performance requirements for new buildings. Two additional MSs and the other two Belgian regions use either E-levels (a figure for primary energy use divided by a reference primary energy use), or include primary energy as a calculation result, but not as the indicator.

Table 2: Analysis of the four main points of the NZEB definition and whether the detailed definition is fixed in a legal document.

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

Table 2 (cont.): Analysis of the four main points of the NZEB definition and whether the detailed definition is fixed in a legal document.

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

Table 2 (cont.): Analysis of the four main points of the NZEB definition and whether the detailed definition is fixed in a legal document.

Country	Main points of the NZEB definition				
	Detailed definition	**Very high energy performance**	**Nearly zero or very low amount of energy required; Limits placed on:**	**Very significant extent of renewable energy**	**Primary energy indicator in kWh/m².year**
Italy	EPBD text in Decree Law no. 63/90 of 2013, new energy decree includes detailed definition near completion	Primary energy significantly lower than current requirements (e.g., 60% tightening for a small multi-family building near Milano)	Primary energy for heating, primary energy for cooling, total primary energy	Direct: planned for NZEB is 50% of primary energy (direct requirements included in current minimum energy performance requirements)	Yes
Latvia	Included in Cabinet Regulation No. 383/2013	Building class A	Energy demand for heating ≤ 30 kWh/m².year; primary energy demand ≤ 95 kWh/m².year	Direct: at least partial use of RES (> 0%)	Yes
Lithuania	Included in Construction Technical Regulation STR 2.01.09:2012	Building class A++	Specific heat loss of the building envelope, efficiency of systems, primary energy	Direct: largest part of energy consumed (> 50%)	Yes
Luxembourg	Interpretation of EPBD text included in national plan and in national legislation (RGD 2014), detailed definition not yet fixed	Probably at least building class A-A	Net heating demand, primary energy	Indirect *	Yes
Malta	Proposed definition included in national plan, consultation process ongoing	Very high energy perfor-mance	Primary energy ≤ 40 kWh/m².year (for houses or apartments), ≤ 60 kWh/m².year (for other buildings)	Indirect *	Yes
Netherlands	National plan: aim to set requirement close to energy performance coefficient = 0 by 2018/2020, at least 2 feasibility studies	Close to energy performance coefficient = 0 (zero-energy building)	Mean thermal resistance of closed building envelope components, U-value of windows, (primary) energy performance coefficient	Indirect *	No. Energy performance coefficient is not in kWh/m².year); primary energy in MJ/m².year calculated as interim result
Norway	No detailed definition available	-	-	Direct requirements included in current minimum energy performance requirements	-
Poland	Translation of the EPBD text in national plan. Detailed definition included in Regulation of the Minister of Infrastructure on the technical conditions to be met by buildings and their location (Journal of Laws No 75, pos. 690), amendment in 2013	No details available	Maximum U-values for the building envelope components, maximum final energy performances indexes for heating, ventilation, hot water, cooling and lighting, maximum primary energy	Indirect *	Yes
Portugal	Translation of the EPBD text in Decree law 118/2013, Article 16. Detailed definition not yet available	-	-	-	Minimum energy performance requirements included in current legislation

Table 2 (cont.): Analysis of the four main points of the NZEB definition and whether the detailed definition is fixed in a legal document.

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

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

4.2 Recurring remarks and interesting comments in the national plans

There is some information included in the NZEB plans concerning the national application of the NZEB definition that either occur in many of the plans, or show interesting views on the EPBD requirements. These remarks show how the national definitions have been developed, or why some definitions are not in place yet. They are listed and discussed in the following paragraphs:

- **Studies for the detailed definition in the countries:** Most countries mentioned that there are studies for the detailed definition of the national application of the NZEB, either ongoing, already finished but still to be reviewed by politicians, or planned for the future. Even some of the countries with already available detailed definition stated that the definition might have to be adapted based on further studies.

- **Detailed definition is dependent on the results of the cost-optimal analysis:** Several countries wrote in their national NZEB plans that the detailed definition of the NZEB can only be prepared after the completed cost-optimal analysis of their current minimum energy performance requirements (Directive 2010/31/EU, Article 5). The NZEB will be the national minimum energy performance requirement in 2019/2021 and has, from the MSs view, to be cost-optimal by then. Therefore, the cost-optimal methodology can be used to define the NZEBs if the evolving factors, e.g., energy prices, primary energy factors for electricity and district heating, improved efficiency of systems and material due to research and industry innovations, building material costs, etc., are taken into account. Some countries stated that they would wait for lessons learned from pilot projects of high performance buildings.

- **National definitions are subject to public or industry consultations:** Some countries wrote in their national plans that they have developed a draft application of the NZEB definition. These definitions however are still subject to public or industry consultations. It can be assumed that this will happen in most of the other MSs as well, even though not specifically mentioned in the NZEB plans, and is therefore one reason of the late availability of the detailed national applications. Here, the rather small difference between a detailed national NZEB definition being published but possibly needing adjustment later on (as in the case of Denmark), and being developed and included in the national plan but subject to further consultations (as for example in the case of Ireland) needs to be highlighted.

- **NZEB as a voluntary building class now:** A sensible approach might be to have the detailed NZEB requirement as a dedicated building class in the EPC. This approach is used in several countries, e.g., Bulgaria, Denmark, Ireland, Latvia and Lithuania. The advantages include:
    - a visual indication on the EPCs about what the requirements for 2019/2021 will be;
    - the necessary adaptations of the currently used EPC and energy classes will most probably be smaller;
    - voluntary NZEBs in the coming years can be easily counted if national databases for EPCs are available.

- **Renewable energy source contributions included as indirect requirement:** Several countries, including Belgium-Brussels Capital, Denmark and the Czech Republic, have no specific renewable energy requirement included in their NZEB definition. They state however that due to the low maximum value of primary energy use allowed for NZEBs, the use of energy generated from Renewable Energy Sources (RES) is implied. Some countries which are still developing their national NZEB application, e.g., The Netherlands and Malta, also plan to use low primary energy requirements that will result in the very most cases in the use of RES in the building. In the case of Denmark, there are further rules like the prohibition of oil and gas boilers in new buildings, though exemptions are possible. That only leaves district heating with a target of a high renewable energy generation rate, heat pumps, combined heat and power units and biomass boilers as main energy supply systems for NZEBs. Countries like Denmark and Sweden mention that the national energy mix includes high contributions of RES.

  An interesting approach is presented by Luxembourg, where the EPC includes three classes, one for the net heat demand, which is based mainly on the thermal quality of the building envelope, one for primary energy use, and one for the CO_2 emissions. The requirements are calibrated in a way that a building that fulfils the net heat demand requirement in combination with a standard fossil fuel heating generation system (e.g., gas condensing boiler) would not fulfil the primary energy use requirement and could thus not be classified as NZEB. This leads, in most cases, at least to the partial use of renewable energy. However, the alternative of undercutting the net

heat demand by using lower U-values at the building envelope while keeping a standard fossil fuel heating generation system remains; in such case the building could be NZEB without using RES.

- **NZEB definition for buildings that undergo major renovations:** In general, the national application of the NZEB definition for buildings that undergo major renovations could be the same as the one for new buildings. However, there are many influencing factors that reduce the possibility for insulating and air-tightening the building envelope, or limit the possible use of efficient heating, ventilation and cooling technologies or the application of RES in existing buildings. These can be limitations of space (not enough space for thick insulation packages), limitations regarding cost-efficiency (increased investment costs compared to new buildings), or limitations concerning the statics (roofs that cannot carry the extra weight of solar thermal collectors or ventilation units).

  A few countries have thus started to analyse how much less ambitious an adapted NZEB definition for buildings that undergo major renovation might have to be, if compared to new NZEBs. For example, Slovenia's national plan includes not only a detailed NZEB definition for new buildings, but also a NZEB definition for buildings undergoing major renovations. It is planned that these buildings will also have to meet the 50% renewable energy requirement, as well as the primary energy requirements, that are about 112 – 145% less tight than for new NZEB buildings.

5 Examples of national NZEB definitions

Two approaches for national NZEB definitions are included to illustrate the differences in the national applications.

5.1 Denmark's application of the NZEB definition

Denmark has introduced the Building Class 2020 into their current building regulation (BR10) to meet the EPBD Article 9 requirements for the NZEB buildings. So far it is a voluntary class which reduces the energy consumption of the building by approximately 75% compared to the energy performance level of 2006, according to a political agreement. Denmark's regulations state that the intention of this early introduction is to "*send a definite signal to players in the building industry with regard to the coming requirements*". They expect it will give a push for energy efficient building technology developments for both building material and technology, as well as their sale. The NZEB requirements are not yet thought to be viable from a cost-optimal viewpoint, but Denmark expects that the development of energy prices, technology efficiencies and primary energy factors will result in a cost-optimality in 2021. The Building Class 2020 is a "*development class*" that might need adjustment over the coming years. However, the adjustments will most likely be minor.

The energy requirements in the Danish building regulations comprise an overall framework for the energy consumption of a building and are combined with specific requirements for the building envelope, elements and components. Two building categories are distinguished: residential buildings (homes, residential colleges, hotels, etc.) and other buildings. For both categories a maximum primary energy use has been defined:

- for residential buildings: maximum primary energy use ≤ 20 kWh/m².year, based on the heated floor area;
- for other buildings: maximum primary energy use ≤ 25 kWh/m².year, based on the heated floor area.

The so-called energy frame (maximum primary energy use) includes the energy use for heating, cooling, ventilation, Domestic Hot Water (DHW) and electricity for operating the building (pumps, fans, plus lighting for non-residential buildings only), conversion and distribution losses and penalties for potential overheating. The requirements are technology open. However, there is a general prohibition of oil and gas boilers in new buildings, though exemptions are possible in case there are no other alternatives for heating available. This leaves district heating and heat pumps or biomass boilers as main energy supply systems for new buildings from now on. The Danish district heating networks already include considerable rates of energy produced from RES and the intention is to increase these rates in the future. The aim for 2020 is a renewable energy ratio included in the grids (electricity and district heating) of at least 51%. The 20 kWh/m².year and 25 kWh/m².year primary energy requirements are very difficult to be met without including renewable energy into the building, but there is no specific requirement regarding the renewable energy ratio for each building in the Danish NZEB definition.

A table in the national report specifies the required size of PV panels in order to comply with the NZEB requirements for different building types, using the best building materials in combination with either a heat pump or a connection to the district heating system. Denmark expects that their primary energy factors (conversion factors) will drop for electricity from 2.5 (now) to 1.8 (by 2020) and for district heating from 1.0 to 0.6. For buildings that meet Building Class 2020 it is already now allowed to use the lower primary energy factors in the energy performance calculations. A building that does not meet the Building Class 2020 has to use the current primary energy factors.

Additionally to the primary energy requirement, there are other requirements that are tightened for NZEBs compared to the current requirements:

- dimensioning heat loss (at 32 K temperature difference) of the opaque parts of the building envelope: 3.7 – 5.7 W/m² building envelope area dependent on the number of storeys;
- airtightness: 0.5 l/s per m² at 50 Pa pressure difference;
- energy balance of windows: +0 kWh/m².year for windows and +10 kWh/m².year for roof- and skylights (the calculation is based on the solar incidence, the solar energy transmittance (g-value), the degree hours in the heating season and the transmission coefficient (U-value) of the window);
- specific electricity use for ventilation systems: < 1500 J/m³ with central systems and < 800 J/m³ for individual dwelling systems;
- maximum room temperature during summer in residential buildings: not more than 100 h/year with room temperature > 27 °C, not more than 25 h/year with room temperature > 28 °C;
- daylight: glass area not lower than 15% of the floor area with light transmittance of at least 75%.

Other requirements, like maximum U-values for building components, maximum requirements for thermal bridges, minimum heat recovery rates, minimum efficiencies of heat producing systems, maximum requirements for electricity use of pumps, daylight requirements for offices and schools, as well as maximum CO_2-levels, apply for all new buildings.

5.2 Lithuania's application of the NZEB definition

The Law of the Republic of Lithuania on Renewable Energy (Official Gazette, 2011, No. 62-2936) contains a slightly adapted version of the text description in Article 2 of Directive 2010/31/EU. Minimum energy performance requirements for buildings are set in the Law of the Republic of Lithuania on Construction (Official Gazette, 1996, No. 32-788 and 2001, No. 101-3597). The Construction Technical Regulation STR 2.01.09:2012 'Energy Efficiency of Buildings. Energy Efficiency Certification' (Official Gazette, 2012, No. 99-5071) defines that buildings are classified into 9 classes: A++, A+, A, B, C, D, E, F and G. Class C represents the requirements for new buildings at the date of the national NZEB plan. The energy performance of buildings is calculated with the standard LST EN 15217:2007 and includes the following six building indicators:

- calculated specific heat loss of the building envelope;
- building airtightness;
- technical indicator for mechanical ventilation systems with recuperation;
- primary non-renewable energy efficiency for heating, ventilation, cooling and lighting (C_1);
- primary non-renewable energy efficiency for DHW (C_2);
- ratio of renewable energy use in the building (K_{ers}).

The detailed Lithuanian NZEB definition is also included in the Construction Technical Regulation STR 2.01.09:2012. It states that a NZEB has to comply with the energy performance requirements for buildings of class A++. Therefore it has to meet the following energy performance indicators:

- calculated specific heat loss not exceeding the normative heat loss (no tightening compared to regular new buildings);
- building airtightness of maximum 0.6 air changes/hour at 50 Pa pressure difference;
- in case of mechanical ventilation systems with recuperation: heat recovery rate ≥ 0.90 and fan energy ≤ 0.45 Wh/m³;
- primary non-renewable energy efficiency for heating, ventilation, cooling and lighting C_1 < 0.25;
    - for a typical 1-2 apartment house with 150 m² heated area, this means a non-renewable primary energy use of less than 7 kWh/m².year for heating, ventilation, cooling and lighting. For class C (requirement for regular buildings at the time of the provision of the national plan) the limit is 192 kWh/m².year;
- primary non-renewable energy efficiency for DHW C_2 ≤ 0.70;
    - for a typical 1-2 apartment house with 150 m² heated area, this means a non-renewable primary energy use of maximum 5 kWh/m².year for DHW. For class C, the limit is 45 kWh/m².year;
- energy from renewable resources must form the largest part of the energy consumed (K_{ers} > 1).

If the NZEB primary energy requirements (class A++) are compared to the current minimum primary energy performance requirements of class C, the NZEB has to be 27.6 times more energy efficient at the heating, ventilation, cooling and lighting side and 8.3 times more energy efficient at the DHW side.

6 Summary & conclusions

Concerted Action (CA) EPBD has closely followed the process of setting up national applications of the Nearly Zero-Energy Building (NZEB) definition in the Member States (MSs) during the years 2012 to 2015. Continuous effort was spent on presenting, analysing and discussing first ideas for the detailed definition, draft definitions, and definitions by front runner countries. Specific topics like the integration of renewables, the necessary and possible number of specific NZEB requirements, how to introduce NZEBs in the national Energy Performance Certificates (EPCs) and the analysis of already built demonstration projects on NZEB level (see CA EPBD report "Selected examples of Nearly Zero-Energy Buildings"[4]) have been part of the work.

Still, the progress in developing and fixing the national application of the NZEB definition in most countries has been sluggish. This is reportedly due to a primary focus by the countries on the cost-optimal calculations regarding the current national energy performance requirements and the uncertainty concerning future developments in the field of technologies, energy prices, primary energy indicators and building material costs. Various studies concerning these issues and their impact on possible tightening of the energy performance have been contracted by the MSs, some of which are still ongoing or being analysed. Also the experiences made with pilot NZEB projects shall contribute to the national applications of the NZEB definition. Public and industrial consultation processes are other reasons for the late availability of the national application of the NZEB definition.

By the end of April 2015, about 60% of the MSs had fixed their detailed NZEB definition in a legal document. Several others have draft definitions available that are under review by the government and other organisations. However, a few countries had not yet published clear directions concerning their approaches. Countries use different ways to require the "*very high energy performance*" including building energy performance classes and tightening ratios compared to current requirements. The limits for the "*nearly zero or very low amount of energy required*" are mostly placed on a combination of primary energy, together with other parameters, like U-values of the building envelope or final energy demands or CO_2 emissions. The requirement concerning the use of renewable energy is realised by the country either by minimum renewable energy shares of the primary energy, or by specific minimum renewable energy contributions in kWh/m².year. Many MSs use, and plan to use, only indirect renewable energy requirements. They set other energy performance requirements (mostly the maximum (non-renewable) primary energy limit), so low that they can only be fulfilled if renewable energy contributes to the energy consumption of the building. The renewable energy requirement for NZEBs, as written in Directive 2010/31/EU Article 2, is on the other hand an aspiration rather than an obligation. The required primary energy indicator in kWh/m².year is already in use and will be used for NZEBs by the vast majority of MSs.

CA EPBD will continue to support the development, as well as analyse and discuss upcoming national applications of the NZEB definition. A stronger focus will be needed for the NZEB requirements for existing buildings, since their increasing numbers shall also be supported by political, financial and other measures in the MSs. At present, little can be stated regarding the NZEB definition for existing buildings. Will they be defined exactly as the NZEB-level for new buildings, or should the energy performance requirements be less tight?

[4] http://www.epbd-ca.eu/wp-content/uploads/2011/05/CT5_Report_Selected_examples_of_NZEBs-final.pdf

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