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# **ZEBRA 2020 - NEARLY ZERO-ENERGY BUILDING STRATEGY 2020**

Strategies for a nearly Zero-Energy Building  
market transition in the European Union





#### Authors

Agne Toleikyte (TU Wien), Lukas Kranzl (TU Wien), Raphael Bointner (TU Wien), Frances Bean (BPIE), Jordi Cipriano (CIMME), Maarten De Groot (BPIE), Andreas Hermelink (Ecofys), Michael Klinski (SINTEF), David Kretschmer (Ecofys), Bruno Lapillonne (Enerdata), Ramón Pascual (EURAC), Andrzej Rajkiewicz (NAPE), Jose Santos (CIMME), Sven Schimschar (Ecofys), Carine Sebi (Enerdata), Jonathan Volt (BPIE)

#### Review and editing

Cosmina Marian (BPIE)  
Lukas Kranzl (TU Wien)  
Raphael Bointner (TU Wien)

#### Graphic design

Ine Baillieul



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## ABOUT ZEBRA2020

### NEARLY ZERO-ENERGY BUILDING STRATEGY 2020

Sustainability of the European society and economy will be based on renewable energy and high resource efficiency. For the building sector, this implies the large scale deployment of nearly zero-energy buildings (nZEB). European legislation (recast Energy Performance of Buildings Directive) makes nZEBs a standard for new buildings by 2020. Therefore, the key objective of ZEBRA2020 is to monitor the market uptake of nZEBs across Europe and provide data and as well as recommendations on how to reach a high level nZEB standard. The resulting ZEBRA2020 observatory for nZEBs will be based on market studies and various data tools and will thereby generate data and evidence for policy evaluation and improvement.

ZEBRA2020 covers 17 European countries and about 89% of the European building stock and population. Thus, it is actively contributing to meeting the ambitious target of 100%- share of nZEBs for new buildings from 2020 and a substantial increase of deep nZEB renovations.

Learn more at [www.zebra2020.eu](http://www.zebra2020.eu)



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**“WE CHOOSE TO GO TO THE MOON IN THIS DECADE AND DO THE OTHER THINGS, NOT BECAUSE THEY ARE EASY, BUT BECAUSE THEY ARE HARD, BECAUSE THAT GOAL WILL SERVE TO ORGANIZE AND MEASURE THE BEST OF OUR ENERGIES AND SKILLS, BECAUSE THAT CHALLENGE IS ONE THAT WE ARE WILLING TO ACCEPT, ONE WE ARE UNWILLING TO POSTPONE, AND ONE WHICH WE INTEND TO WIN.”**

JOHN F. KENNEDY – DEDICATED TO  
THOSE WHO WANT TO ACHIEVE  
AMBITIOUS GOALS

## FOREWORD

We currently accumulate and consume Earth's resources far beyond sustainable levels. We exploit fossil reserves, which were formed over millions of years, in a few generations and emit a vast amount of CO<sub>2</sub> every year. In the light of COP21, a global commitment to limit global warming well below 2 degrees, aiming at 1.5 degrees was agreed upon. It is important to take immediate action to mitigate climate change. The EU sees itself as a frontrunner with ambitious climate and energy targets for 2020 and 2030. Given that at least two-thirds of today's buildings will still be standing in 2050 and considering their vast energy consumption, a longer term vision is necessary to align with the challenges ahead.

The recast of European Directives, in particular the Directive on the Energy Performance of Buildings and the Energy Efficiency Directive, offer a unique opportunity to move forward towards lower energy consumption and a strengthened use of renewable energy sources. ZEBRA2020 collected numerous information and data on the European building stock and obtained the opinion of building professionals about nearly Zero-Energy Buildings (nZEBs), Energy Performance Certificates (EPCs) and many other issues in the building sector. Based on these sources we developed the nZEB tracker, a brand new tool to estimate nZEB market maturity, and pulled together many recommendations to foster the transition towards sustainability in the building sector.

In the name of the whole ZEBRA2020 team I would like to thank all contributors and wish all readers enlightening insights with our report.

Sincerely yours,

*Raphael Bointner*

Coordinator of ZEBRA2020

## CONTENTS

1. INTRODUCTION	8
2. BUILDING PERFORMANCE MARKET DATA	10
<b>2.1 NZEB and renovation activities</b>	<b>11</b>
<b>2.2 Selected high performat buildings</b>	<b>14</b>
3. THE IMPACT OF ENERGY PERFORMANCE CERTIFICATES	18
<b>3.1 Real estate agents survey</b>	<b>18</b>
<b>3.2 Real estate prices and energy performance certificates</b>	<b>20</b>
4. NZEB TRACKER	23
<b>4.1 Methodology and criteria</b>	<b>23</b>
<b>4.2 NZEB market maturity progress: the nZEB tracker</b>	<b>24</b>
5. SCENARIOS	27
<b>5.1 Summary of methodology and scenario definition</b>	<b>27</b>
<b>5.2 Scenario results</b>	<b>28</b>
6. RECOMMENDATIONS	33
<b>6.1 Recommendations on Member State level</b>	<b>34</b>
6.1.1 Recommendations on legislative or regulatory instruments to foster nZEB market transition	34
6.1.2 Recommendations on economic level to foster nZEB market transition	35
6.1.3 Recommendations on communication to foster nZEB market transition	35
6.1.4 Recommendations on quality level to foster nZEB market transition	36
6.1.5 Recommendations on new business models and innovation to foster nZEB market transition	37
6.1.6 Recommendations on social aspects to foster nZEB market transition	37
<b>6.2 Recommendations on EU Level</b>	<b>38</b>
EU1 - Clarify the nzeb definition	39
EU2 - Gather more and better data	41
EU3 - Improve quality and compliance	42
EU4 - Implement a long-term vision for the building stock	44
EU5 - Provide a pathway for existing buildings	44
EU6 - Evolve EPCs into Building Passports	45
EU7 - Public buildings as role models	46
EU8 - Focus on vulnerable groups	47
EU9 - Link policies and financing	47
EU10 - Future-proof buildings	49

## EXECUTIVE SUMMARY

European legislation makes nearly Zero-Energy Buildings (nZEBs) a standard by 2020. The technology is available and proven; however, the large-scale uptake of nZEB construction and renovation remains a challenge. ZEBRA2020 monitored the market uptake of nZEBs across Europe and provided data and knowledge on how to reach the nZEB standard. This information was structured and analysed to derive recommendations. ZEBRA2020 covers 17 European countries and almost 90% of the EU/EEA building stock and population.

The online data tools provide unique information regarding nZEB market development and nZEB characteristics. New approaches have been developed in order to allow for a better comparability of national data. However, the absence or difficult accessibility to key data and in particular for non-residential and existing buildings as well as for renovations remains an important obstacle.

The online nZEB tracker, based on a set of criteria, assesses the nZEB market maturity. On EU-level, the tracker shows a substantial gap of market maturity that still has to be closed by 2019/2021. A set of barriers and related recommendations have been identified both at national and EU level:

- The implementation of a common, shared long-term vision for the building stock is crucial.
- A quantitative comparison of national nZEB definitions is complex due to different system boundaries, calculation methodologies, applied factors etc. However, our analysis indicates that a significant share of nZEB definitions does not meet the intention of the EU directive on energy efficient buildings (EPBD) that the energy consumption should be “nearly zero or very low amount” and the remaining part “should be covered to a very significant extent by energy from renewable sources”. Thus, the new EPBD requires clear definitions of these terms and thresholds. Further, it is important to distinguish between new buildings and renovations – despite of a common nZEB definition for both cases.
- The nZEB compliance monitoring and sanctions regimes need improvement. Only about half of the covered Member States monitor the compliance of new buildings with energy performance requirements.
- The lack of professional skills continues to be an important barrier and should remain a focus, especially in case of new built.
- In many Member States, the reliability and credibility of Energy Performance Certificates (EPC) is often questioned by actors on the real estate market. Transforming EPCs into Building Certificates (“Passes”) for the whole lifetime of a building may increase credibility and serve as a key measure to foster building renovation towards an nZEB standard. Storage of building data in an electronically accessible national database may contribute to better data availability.
- Energy poverty and vulnerable consumers are a European-wide issue and need further attention. Shifting from fuel subsidy to energy efficiency support is required.
- Future-proof buildings will be highly-efficient micro energy-hubs consuming, producing, storing and supplying energy. A revised nZEB definition should be future-proofed to be a smart building and district-ready.

**“THIS REPORT PROVIDES A SUMMARY OF DATA, RESULTS AND RECOMMENDATIONS DEVELOPED DURING THE ZEBRA2020 PROJECT AS A BASIS FOR A STRATEGY TOWARDS A DECARBONISATION OF THE EUROPEAN BUILDING STOCK.”**



## 1 INTRODUCTION

European legislation (Energy Performance of Buildings Directive) makes nearly Zero-Energy Buildings (nZEBs) a standard by 2020. The technology is already available and proven; however, the large-scale uptake of nZEB construction and renovation will be a big challenge for all market actors and stakeholders involved. A substantial gap in reliable data on current market activities makes it difficult for policy-makers to evaluate the success of their policies and measures. Therefore, ZEBRA2020 monitors the market uptake of nZEBs across Europe and provides data on how to reach the nZEB standard. This information gathered was structured and analysed to derive recommendations and strategies.

This report provides a summary of data, results and recommendations developed during the ZEBRA2020 project as a basis for a strategy towards a decarbonisation of the European building stock. The aim of this report is to highlight the most relevant results and provide links to more detailed reports, data and online tools developed in the frame of ZEBRA2020.

Chapter 2 summarises the key results and presents online tools developed to monitor building performance market data in Europe. Several questions are tackled: What are the current and recent developments in the nZEB market and building renovation? What can we learn from a detailed analysis of selected nearly Zero-Energy Buildings in Europe?

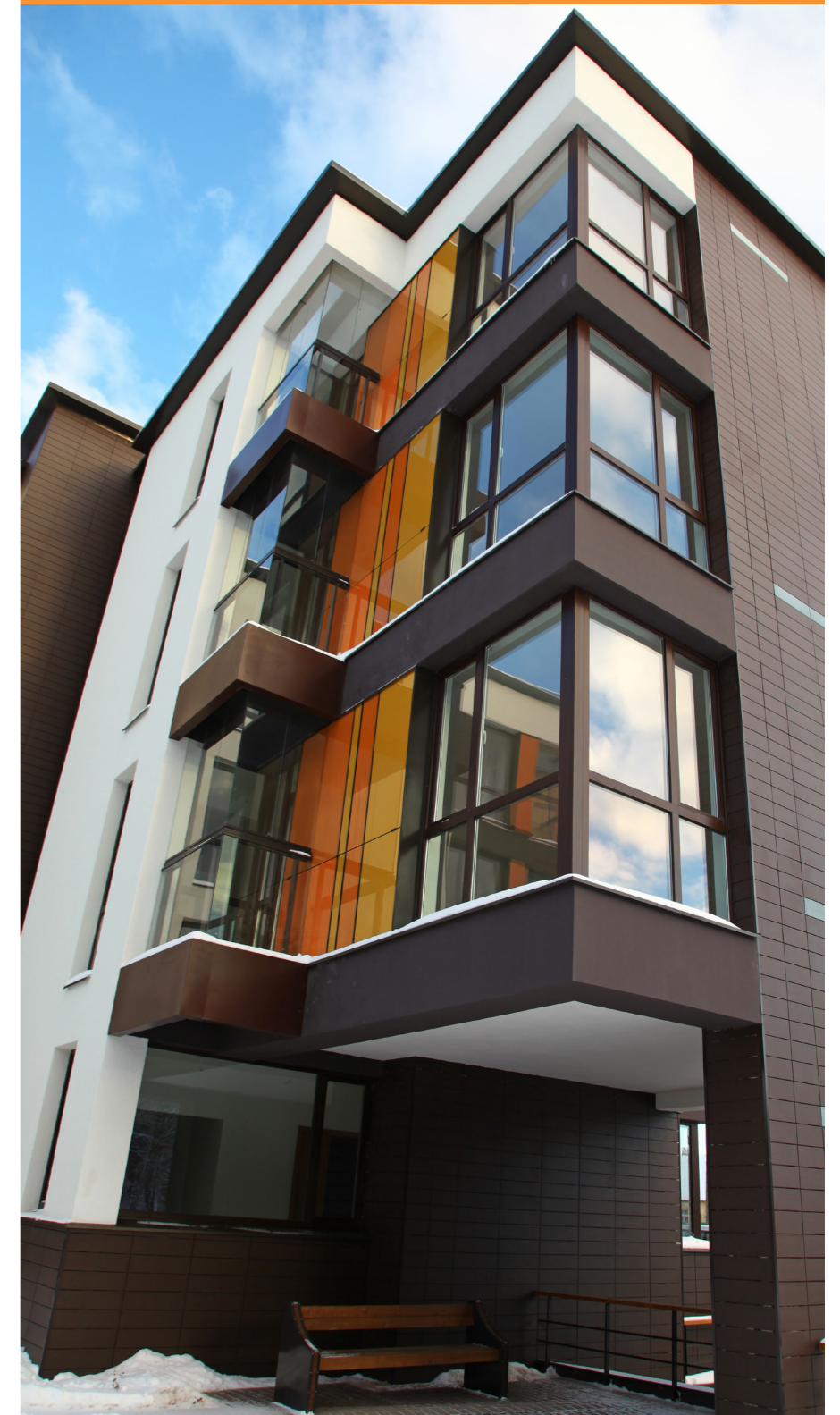
Chapter 3 deals with the role of energy performance in real estate transactions. Results of a broad survey among real estate agents in Europe are presented and the impact of energy performance on real estate prices has been analysed.

Chapter 4 presents the nZEB tracker. This is an online wiki-based tool tracking nZEB market maturity in several European countries tackling the following: How mature are nZEB markets in various EU countries in terms of different indicators? How close is Europe in reaching the nZEB target for 2020?

The question, how energy demand in buildings could develop in the coming years and decades is addressed in chapter 5 of this report. What role can more ambitious policies play and how far are we from reaching climate mitigation targets in the building stock until 2050?

Finally, we derive recommendations, which are shown in chapter 6. Both, recommendations at Member State level and EU level are discussed.

**“EUROPEAN LEGISLATION (ENERGY PERFORMANCE OF BUILDINGS DIRECTIVE) MAKES NEARLY ZERO-ENERGY BUILDINGS (NZEBS) A STANDARD BY 2020.”**



“SEVERAL ONLINE DATABASES WERE DEVELOPED IN ORDER TO FACILITATE A QUICK, EASY AND TAILOR-MADE ACCESS TO NATIONAL AND COMPARATIVE INDICATORS ON NZEB ACTIVITIES.”

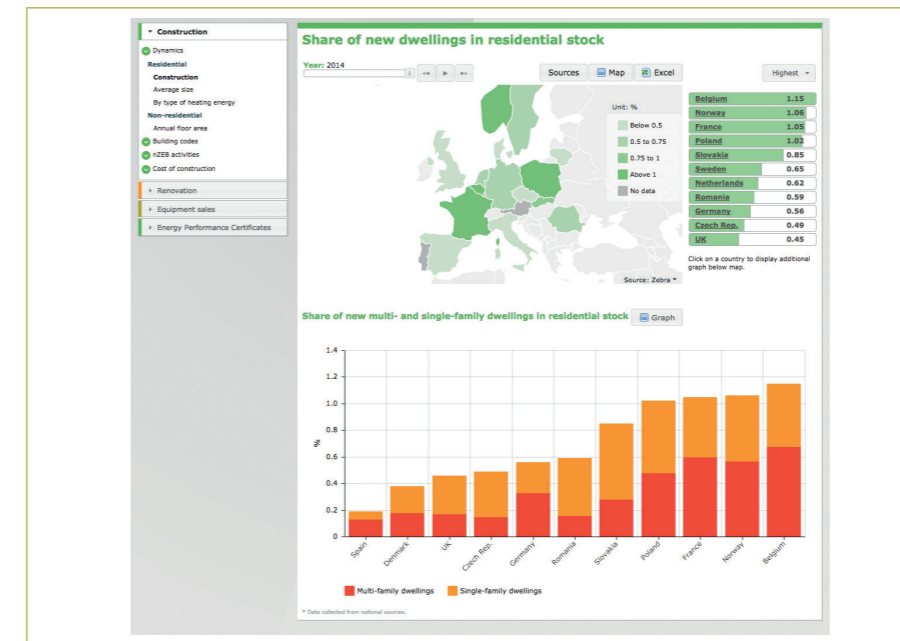


## 2 BUILDING PERFORMANCE MARKET DATA

During the ZEBRA project several online databases were developed in order to facilitate a quick, easy and tailor-made access to national and comparative international indicators on nZEB activities. These tools can also act as a comprehensive basis for decision-making processes both for policy makers and other stakeholders. Two online data tools were developed (see [www.zebra2020.eu](http://www.zebra2020.eu)):

- The first data tool, energy efficiency trends in buildings, presents an overview of the current building stock including renovation and construction and monitors Energy Performance Certificates (EPC) activities by country (focusing on 17 target countries). The tool endeavours to overcome data gaps and provide comprehensive datasets which support stakeholders in their efforts to consolidate the transition to an nZEB market.
- The second tool, selected nZEB buildings, displays relevant indicators of nZEB buildings in selected European countries. It aims to provide information of selected best cases in Europe, thereby showing most recurrent technologies, materials and strategies towards the nZEB target. The tool differentiates residential and non-residential nZEB buildings and shows some of the most significant indicators regarding energy performance, passive and active solutions and production of renewable energy.

Figure 1 – Screen shot data tool – Share of new dwellings in residential stock.



### 2.1 NZEB AND RENOVATION ACTIVITIES

In order to implement effective policies for the transition to nZEBs, there is a crucial need to have reliable and comprehensive information and data on building activities. After years of research and by integrating relevant data sources like Episcope, Odyssee, the BPIE Data Hub, Tabula, Eurostat and other studies as well as country specific national data we are able to depict a fairly detailed picture of the European construction and renovation activities. Because of lack of homogenous data or non-homogeneous and unclear definitions, the ZEBRA2020 consortium had to develop new methodologies and defined new indicators to track i) the diffusion of nZEBs combining qualitative and quantitative analysis of building standards of a specific region; ii) and major renovations activity. The following paragraphs describe 2 of the 43 indicators developed within the energy efficiency trends of the buildings data tool. Thus, it is not an exhaustive representation of all information included in the database.

#### Tracking the nZEB market

As concrete numeric thresholds or ranges are not defined in the EPBD, these requirements allowed room for

interpretation and thus gave Member States the liberty to define their nZEB in a very flexible way taking into account their country specific climate conditions, primary energy factors, ambition levels, calculation methodologies and building traditions. This is also the main reason why existing nZEB definitions differ significantly from country to country. It is thus a challenging task to find a common denominator for defining an nZEB on a European scale.

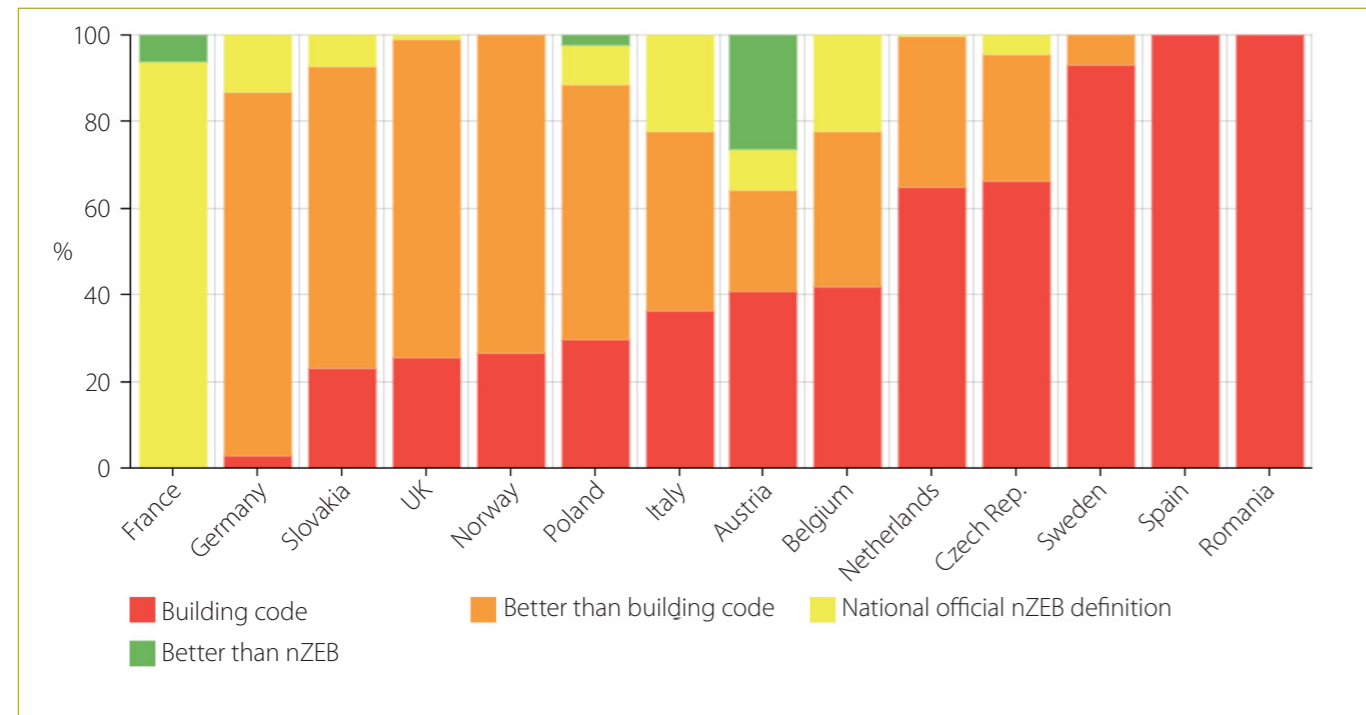
ZEBRA2020 defines a methodology for nZEB market tracking, with the nZEB radar graph. This nZEB radar is based on an analysis of building standards and clusters new buildings in 4 different energy efficiency categories that have been defined at national level by experts:

1. Better than nZEB standard;
2. nZEB buildings according to the national definition;
3. Buildings with an energy performance better than the national requirements in 2012;
4. Buildings constructed/renovated according to national minimum requirements in 2012.

“ZEBRA2020 DEFINES A METHODOLOGY FOR NZEB MARKET TRACKING, WITH THE NZEB RADAR GRAPH.”

The following figure shows the diffusion of nZEB constructions in the residential sector. The penetration of nZEB varies a lot between countries. In France, the nZEB definition matches the actual thermal regulation i.e. the primary energy performance of residential buildings must be below 50kWh/m<sup>2</sup>/year. As a consequence, all new buildings are already nZEB (since 2013), assuming full compliance with building codes. In other countries, the diffusion is less rapid as the nZEB standards are more stringent compared to the building code requirements. For instance, in Italy, the share of nZEB corresponds to 16% of the total residential construction in 2014. Indeed, it is defined that the nZEB primary energy shall be significantly lower than the current requirements. However, it was not possible to properly compare the ambition level of national nZEB definitions due to different indicators, calculation methodologies, applied primary energy factors, system boundaries etc.

**Figure 2** – Distribution of new constructed dwellings in the year 2014 according to different building standards. *Source: Zebra*



**Major renovation rate equivalent**

Article 7 of the EPBD states that “Member States shall take the necessary measures to ensure that when buildings undergo major renovation, the energy performance of the building or the renovated part thereof is upgraded in order to meet minimum energy performance requirements set in accordance with Article 4 so far as this is technically, functionally and economically feasible”. Major renovations, as defined in Article 2 of the EPBD recast, include the renovation of a building where:

- (a) the total cost of the renovation relating to the building envelope or the technical building systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated; or

- (b) more than 25% of the surface of the building envelope undergoes renovation.

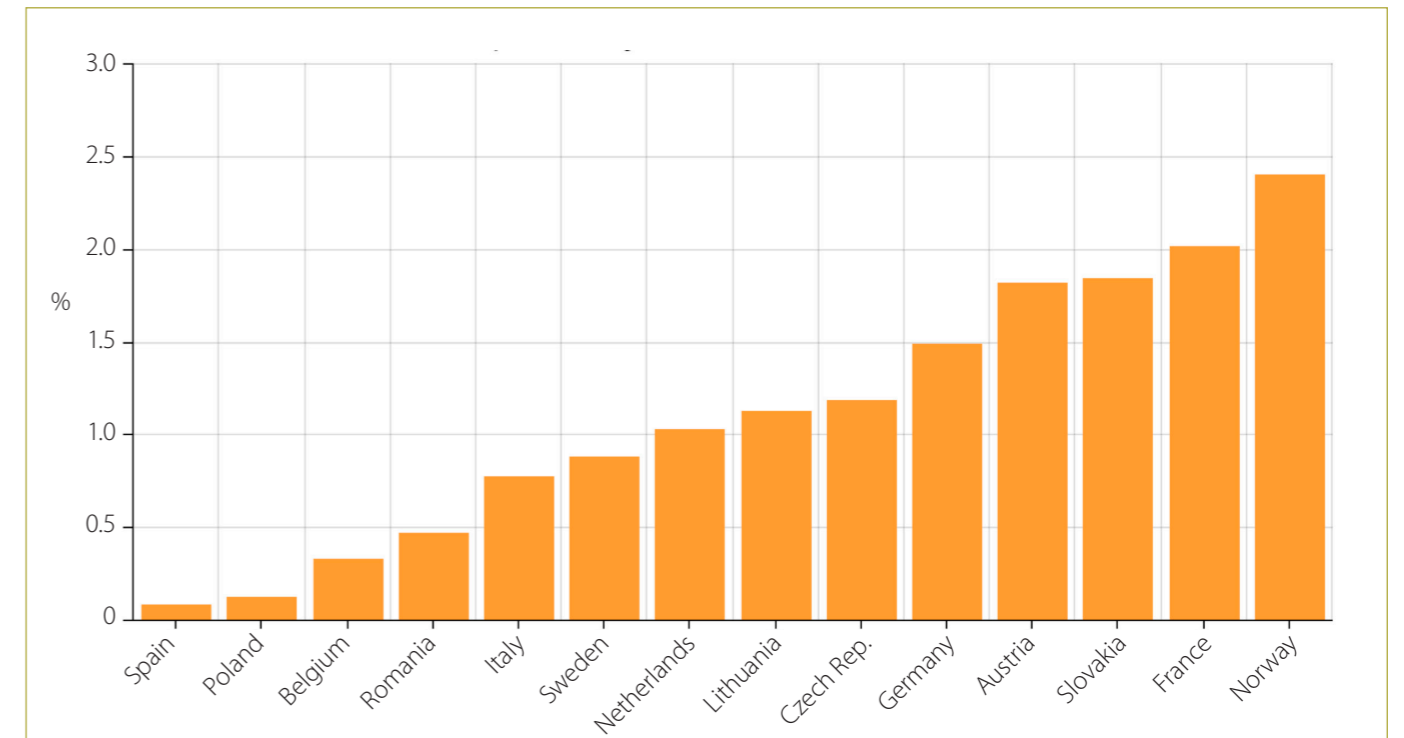
Member States may choose to apply option (a) or (b).

Again, Article 2 allows each MS to interpret and define differently major renovations. Countries have indeed chosen different ways to define and monitor them. Hence, it’s very difficult to compare the outcome of different renovation rates between countries. Due to the lack of an official European definition, to ease comparisons we developed the indicator “major renovation equivalent”. Three renovations levels have been defined: “low”, “medium” and “deep”. However, these 3 level definitions are different across countries and do not correspond to the same level of energy savings. Therefore, the data

can hardly be compared. For that reason, we assume that, with major renovations, a building’s final energy demand for heating can be reduced by 50 to 80% (range depending on the country and defined by national experts according to the current efficiency of the building stock). The major renovation equivalent is based on assumptions regarding the type of measures considered for the different level of renovations and is determined by country. For each country, national experts defined the national renovation level and determined to which extent the allocated renovations fulfil the predefined major renovation level. The published renovation activities for each of these levels are weighted with the achieved energy savings compared to the major renovation level.

The following figure shows the major equivalent indicators stemming from our research. The annual share of the building stock representing an equivalent to major renovation is very low: it is below 0.5% in Spain, Poland or Belgium; around 1% in the Netherlands or Lithuania; above 1.5% in others like Germany, France or Austria.

**Figure 3** – Equivalent major renovation rate. *Source: Zebra*



This introductory analysis of data stemming from the ZEBRA data tool shows clearly a lack of definition and monitoring processes. The absence of accessibility of key data concerning the buildings stock and in particular non-residential and existing buildings as well as renovations remains an important obstacle to policy planning.

**2.2 SELECTED HIGH PERFORMAT BUILDINGS**

To identify recurrent building solutions used recently in Europe to build nZEBs, the ZEBRA2020 consortium collected data of 411 nZEBs<sup>1</sup>. The buildings have been classified according to commonly defined climate zones, different kind of construction and type of uses.<sup>2</sup>

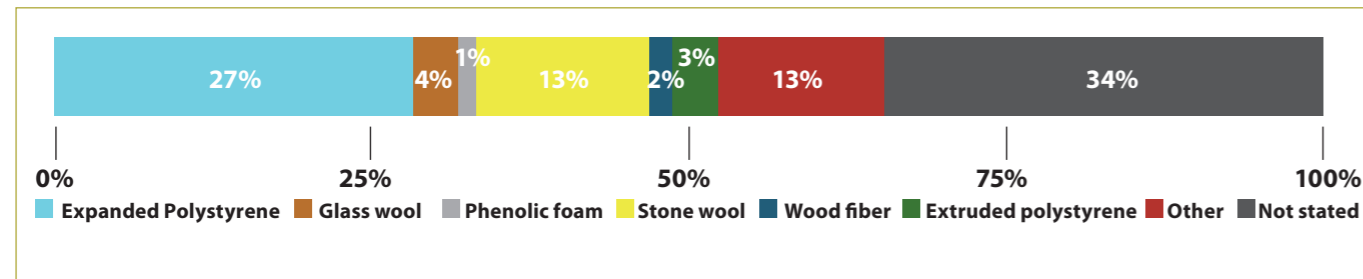
It can be noticed that the heating demand in nZEBs is generally lower for new built than for renovated buildings, but no patterns were found among climate zones.

With regards to the building envelope, expanded polystyrene as insulating material seems to be more frequently used in residential buildings, while stone wool is more used in non-residential buildings. The use of triple glass windows is by far the most frequent type among fenestration solutions, followed by low-emission double glass window, which is more common in warm summer climates. The average U-value in windows is clearly lower in cold winter climates (about 0,85 W/m<sup>2</sup> K), while in warm summer climates it’s about 1,15 W/m<sup>2</sup> K.

<sup>1</sup> We want to emphasize that due to very different national definitions of nZEBs (and partly still lacking definitions), we did not compare the energy performance of these buildings with national nZEB definitions. Rather, we focused on high-performance buildings estimated to achieve the nZEB level.

<sup>2</sup> The results are presented in more detail in the report “Nearly Zero-Energy Building (nZEB) technology solutions, cost assessment and performance of ZEBRA2020”, where the nZEB topic in Europe has been approached from different perspectives. It presents different strategies used by designers to reach the nZEB level, an assessment of nZEB costs and macro-economic benefits, main reasons and suggestions to overcome deviations between energy predicted and energy monitored in nZEBs, and the opinion of professionals concerning the nZEB topic.

**Figure 4** – Wall insulating materials in cold winter climates for new residential buildings (Sample 118 nZEBs).



Concerning active technologies, mechanical ventilation with a heat recovery system is widespread (> 80% of the nZEBs) in all kind of buildings and climates. But some contrasts were found in the selection of heating systems. Heat pumps are the most used technology, especially in warm summer climates, while district heating is especially used in cold winter climates. On the other hand, boilers - as a heating system type - are more frequent in renovated nZEBs.

With respect to the use of renewable energies, the photovoltaic systems, and especially solar thermal systems, are more common in warm summer climates, where radiation is higher. Nonetheless, in addition to the climate conditions, the use of renewable energies is also highly influenced by national strategies and subsidy schemes.

The expected savings of new and renovated nZEBs are sometimes overestimated and behind this issue there are various factors. In order to identify them, 12 case studies of monitored nZEBs have been analysed, existing literature about this deviation has been reviewed and professionals involved in the monitoring of nZEBs have been interviewed.

The different reasons for the deviation identified in the analysis have been classified in 4 main categories: user impact; design and planning; commissioning, control and monitoring; and other. User behaviour seems to be one of the chronic and recurrent reasons of the deviation, since users are not always familiar with new technologies; they lack knowledge and environmental awareness. In the

design and planning process, the input data is inaccurate and some installations are wrongly sized. Sensors, monitoring and control systems appear to not be properly set and calibrated, which leads to malfunctioning of the installations. Among the other reasons, we can find construction problems (e.g. airtightness), unexpected lower performance of the used technologies or other unpredictable issues (e.g. unusual weather conditions). It is observed that the deviation depends on different factors, which are especially related to the use of the building (residential vs non-residential) rather than to the type of intervention (new vs renovated).

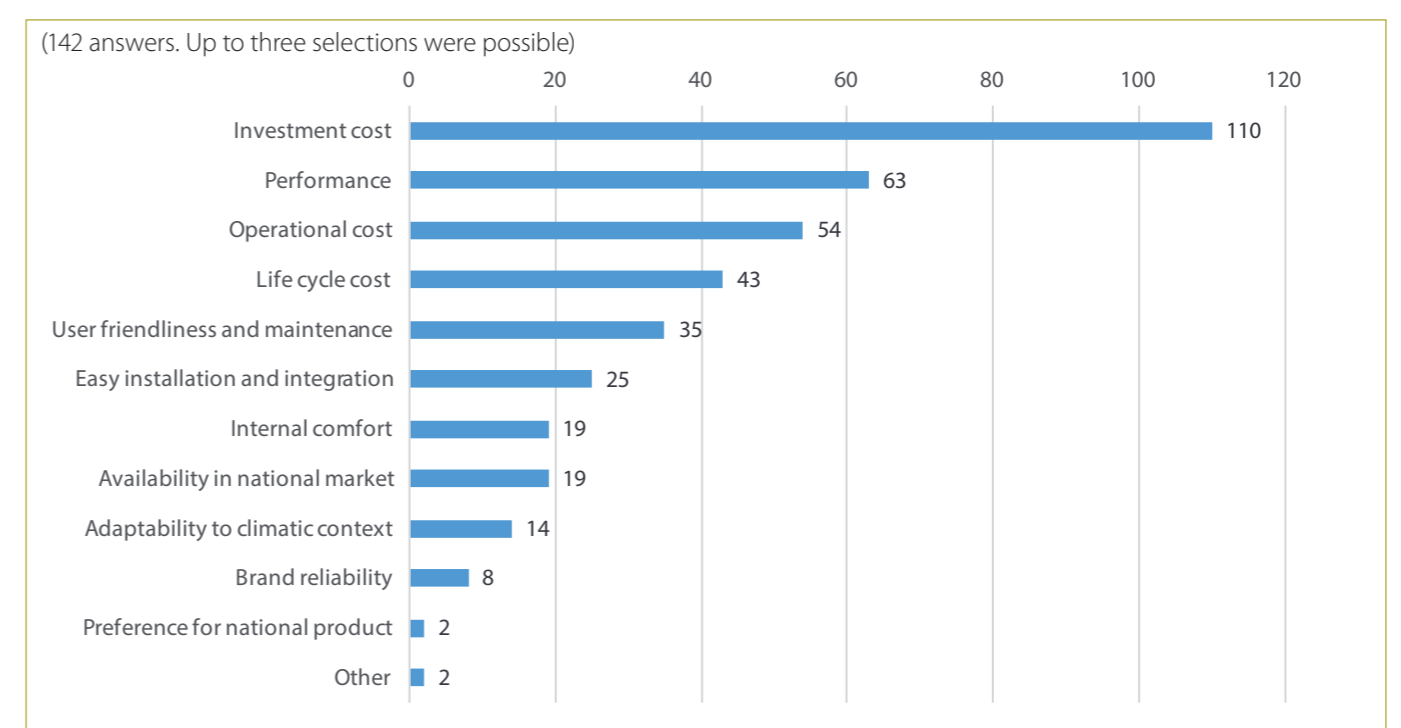
Among the recommendations to minimise the impact of these causes are training, support, involve and raise awareness of building users, Integrated Energy Design with a bigger effort in the design process (e.g. increasing details levels), continuous commissioning and monitoring of the thermal plants and energy consumption, regular maintenance and critical observation of the building systems. It is also recommended to ensure the quality during the whole process with regular visits on-site, selection of experienced companies and implementation of quality tests like thermography and the blower door test. Besides, knowledge-transfer and exchange of experiences with pilot programmes may be crucial to avoid the mentioned mismatch.

Moreover, the opinion of 179 building professionals from 8 European countries concerning the market and construction of nZEBs and their professional competence on nZEBs has been collected. The results show that high performance windows

seem to be a recurrent passive solution, nevertheless professionals showed also special interest in architectural solutions (e.g. natural ventilation). For active technologies, the widespread of heat pumps and heat recovery systems in ventilation is remarkable. District Heating and Combined Heat and Power are mentioned to be the less used active technologies. Condensing boiler remains in a modest position even while being the most available active technology, together with heat pumps. Also the use and interest of professionals in automation and control systems is remarkable. Concerning the use, interest and availability of renewable energy technologies, solar thermal and photovoltaic systems are clearly the most selected technologies. On top, professionals indicated that investment cost and performance are the most used criteria in the selection of a technology, while the preference for national products or brand reliability are the less preferred criteria.

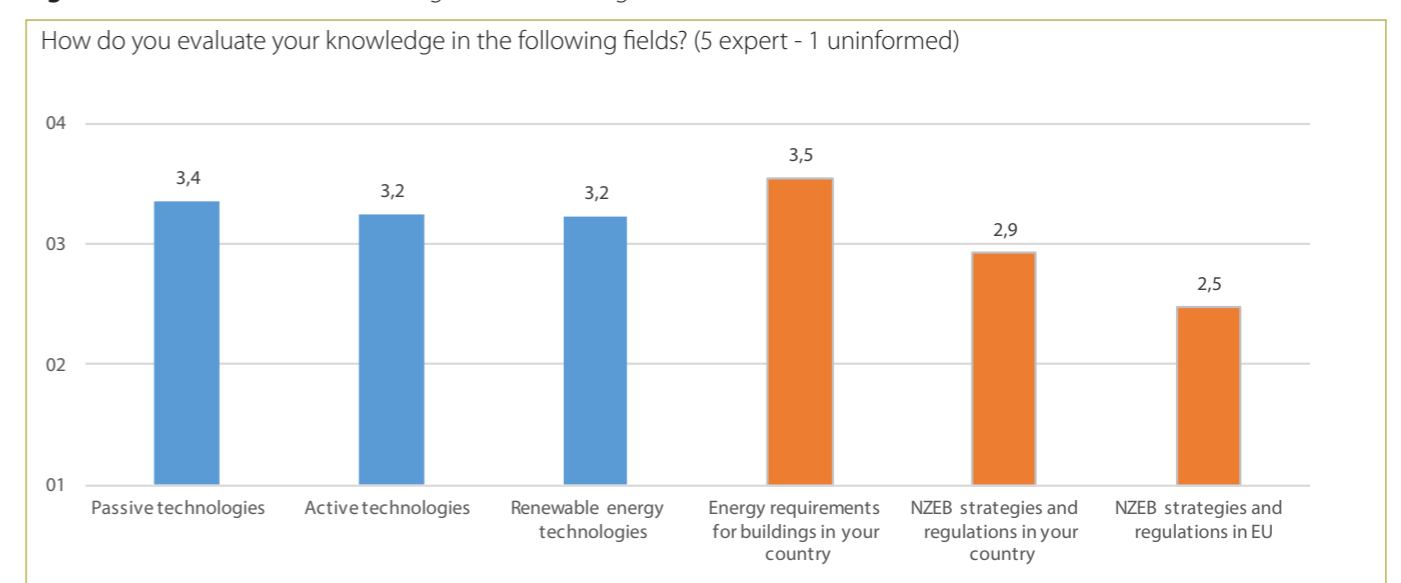
**“CONCERNING THE USE, INTEREST AND AVAILABILITY OF RENEWABLE ENERGY TECHNOLOGIES, SOLAR THERMAL AND PHOTOVOLTAIC SYSTEMS ARE CLEARLY THE MOST SELECTED TECHNOLOGIES.”**

**Figure 5** – Most used criteria in the selection of technologies for high energy performant buildings.



In relation to the professional competence, self-learning and professional experience are the most common ways to improve knowledge in the field of high energy performant buildings, while internet, workshops, fairs and conferences are the favourite ways to be informed about development of components and technologies. More than half of the professionals mentioned that they did at least one training course in the last 3 years. Moreover, they estimated to have relatively good knowledge on technologies as well as on energy requirements for buildings in their own country, but a lower knowledge-level of nZEB strategies and regulations, especially at EU level.

**Figure 6** – Self-evaluation of knowledge of real estate agents.



Regarding the market penetration of nZEBs in their own country, about 75% of professionals think it is too slow and builder skills together with high investments are the main reasons for this weakness. In line with the mentioned lack of builder skills, professionals think that there is also a lack of experts in the construction process, but a relative good pool of experts for planning and in particular for examination and certification.





### 3 THE IMPACT OF ENERGY PERFORMANCE CERTIFICATES

#### 3.1 REAL ESTATE AGENTS SURVEY

In order to find out what are the main factors that households consider when selecting properties to buy or rent, we carried out a survey among real estate agents. Additionally, the survey asked questions concerning the impact of energy performance certification on the values of properties, exposure time of properties and a set of questions, which assesses the problems with the wider use of Energy Performance Certificates (EPCs) on a daily basis. The survey has been conducted on the territory of 8 EU Member States – Austria, France, Germany, Italy, Norway, Poland, Romania and Spain. The survey included 618 interviews in total<sup>3</sup>.

Many of the statements expressed by real estate agents on the impact of energy performance on choices of customers, on the value of real estate and on the use of certificates are negative and statistically significant. However, there is a share of positive answers, which should not be neglected:

- The energy cost factor is on the 10th place on the list of property selection factors, still the location, price and size of the real estate play the dominant role in the choice of customers.
- The reliability and usefulness of EPC's is positively assessed by approximately 30% of real estate agents, however a considerable share of them assesses negatively these features of EPCs, stating that EPCs are treated by customers as an unnecessary additional cost and a bureaucratic burden. For 38% of interviewees the EPCs are not clear enough for customers in terms of presenting the energy performance of buildings.
- In fact, 27% all respondents see a connection between the high evaluation of energy performance of buildings and high prices of real estate. And 14% of all respondents noticed that the exposure time for properties with a higher energy class is shorter by 2-4 months.
- For instance, in some countries EPCs are not yet mandatory at all stages of real estate use (e.g. design, primary market release, secondary market transactions, and renovations). In those countries where EPCs are already mandatory, this requirement is not fully respected due to the disinterest of buyers and sellers accepted by notaries and lawyers being witnesses of transactions.

**“MANY OF THE STATEMENTS EXPRESSED BY REAL ESTATE AGENTS ON THE IMPACT OF ENERGY PERFORMANCE ON CHOICES OF CUSTOMERS, ON THE VALUE OF REAL ESTATE AND ON THE USE OF CERTIFICATES ARE NEGATIVE AND STATISTICALLY SIGNIFICANT.”**

Figure 7 – Real use of EPCs in property sales or rent transactions.



The analysis of the real estate agents' survey results provides significant recommendations on how to increase the impact that EPCs have on the choice of real estate by customers, on the property value and how to overcome many obstacles related to the wider use of EPC's across EU:

- Bureaucratic hurdles in issuing EPCs shall be reduced while the evaluation in terms of reliability shall be improved. Improved training and qualifying of the certifiers and proper quality control as well as changing of the form of EPCs would increase their reliability and credibility as well as help real estate agents to use them properly in their daily work.
- Requirement of EPC by law at each stage of real estate use (designing, primary market release, secondary market transactions, and renovations) in such a way that notaries and lawyers are witnesses of transactions.
- The scope of information included in EPC should be understandable by each property user. The wider market analysis, like regression studies of advertised property values, impact of energy performance on property value and time exposure as well as an improvement of real estate valuation procedures may increase the usefulness of EPCs.
- Obstacles in improving the energy performance of buildings may be less important, if the cost of improvements and the cost of issuing of EPCs will be reduced by the state policy, accompanied by awareness raising campaigns and a fairer division of profits from energy savings among the stakeholders (landlords, tenants).
- There is a need for maintaining incentives for real estate owners and tenants. The introduction of economic incentives and well-designed information campaigns in a transparent way, not necessarily through regulations and in the form of long-term programmes helps to better understand energy efficiency and climate change goals and the role of EPCs in this context.

<sup>3</sup> Full results are available at <http://zebra2020.eu/publications/the-impact-of-energy-performance-certificates-on-property-values-and-nearly-zero-energy-buildings/>

### 3.2 REAL ESTATE PRICES AND ENERGY PERFORMANCE CERTIFICATES

As already mentioned, the energy rating level given in EPCs is used as an indicator for the energy efficiency of a property. However, the question arises to which extent energy performance of buildings has an impact on real estate prices. In order to deal with this question, we collected data on real estate prices and energy efficiency classes from web-based advertisements and carried out a regression analysis. Despite the fact that EPCs are available in all EU MSs, cross-country comparisons must be made with caution due to different EPC systems, real estate market characteristics and type of property. In addition, the quality and size of samples vary between the analysed countries. Data limitations remain and

a comprehensive report on the level of energy efficiency capitalisation in all EU and EEA Member States is not yet possible.

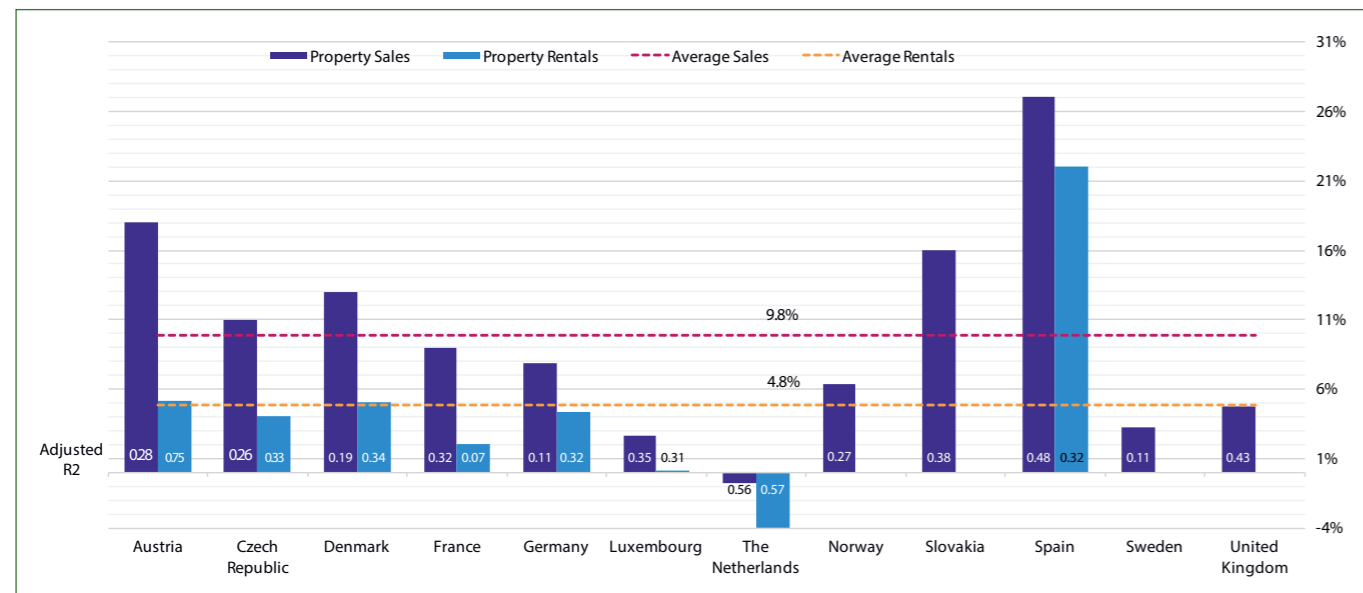
The EPC's impact is given by the obtained regression results based on estimated price surpluses by country due to EPC ratings given in sales and rental markets. Data on the characteristics of dwellings in the selected countries was collected from different real estate agency websites, for both sales and rental transactions. In addition to EPC ratings and advertised prices, the useable area was collected for each dwelling and in most cases the construction year.

The following EU/EEA Member States were chosen for analysis in this

assessment: Austria, the Czech Republic, Denmark, France, Germany, Luxembourg, the Netherlands, Norway, Slovakia, Spain, Sweden and the United Kingdom.

Taking into account data limitations, in particular data availability and the susceptibility for cross-country comparisons, the results for each of the analysed markets are presented together in the following figure, with surpluses given as percentage values of the average dwelling price in each of the samples. These percentage values are therefore estimations of the added value of a dwelling due to any one-letter improvement in the EPC rating.

**Figure 8** – Dwelling price surpluses due to EPC ratings in the respective samples of each of the analysed countries<sup>4</sup>  
The Luxembourgish surplus (with a point-based rating instead of a letter rating) assumes a 50-point improvement, which is fairly typical for other national systems with letters.



The first observation that can be made from this figure is that surpluses in rental prices are lower than surpluses in sales prices for all countries for which the rental and sales markets were analysed. This also applies when comparing the average

values between sales and rentals markets as shown by the dotted line. This result can be explained by the split-incentive dilemma.

On the other hand, these results are

similarly limited due to omitted variables. For instance, with the maximum values appearing in above figure, it is possible that the results for Spain (27/22%) have been inflated by omitted variables. In this report, location and quality are the most

important omitted variables as qualitative information was not available on the real estate websites consulted. The country with the most unexpected results in this report is the Netherlands, for which deficits, instead of surpluses were noted. Other studies also provide evidence that suggests that the Netherlands struggled to implement the transposition of the 2002 EPBD and a lack of trust due to a negative press reception of the scheme. Nevertheless, "omitted variables" such as quality and location are more likely to be the cause of the unexpected deficits.

This analysis has contributed to a small, but growing field of regression analyses into the extent to which the EPC scheme has been capitalised in European housing markets. In particular, it has confirmed the existence of price surpluses in all but one of the analysed markets, and has also demonstrated the effect of the split-incentive dilemma in these markets, which is the most likely cause for the discrepancy between sales and rental surpluses. Given the significant higher share of tenants as opposed to homeowners in most of the analysed countries, true market

transformation to account for energy efficiency should include measures to tackle this distribution. The key reason given for the existence of this discrepancy in the surpluses between the two markets is the fact that landlords do not usually bear the costs of maintenance. Policies that provide incentives for landlords to invest in energy efficient improvements, such as subsidy schemes, could increase the surplus on the rental market and guide market transformation towards more efficient buildings. However, a negative consequence of such measures would be a strengthening of the energy poverty effect, whereby energy efficient dwellings can only be accessed by richer tenants and homeowners.

Finally, it is recommended to perform such investigations periodically to assess changes in the level of capitalisation of energy efficiency, thereby providing information that can be used to assess the success of policies such as the ones related to energy performance certification.

**"THIS ANALYSIS HAS CONTRIBUTED TO A SMALL, BUT GROWING FIELD OF REGRESSION ANALYSES INTO THE EXTENT TO WHICH THE EPC SCHEME HAS BEEN CAPITALISED IN EUROPEAN HOUSING MARKETS."**

<sup>4</sup> See also De Graaf, I. (2016) "Capitalising Energy Efficiency in Housing Markets: An Investigation into the Impact of Energy Performance Certificates on Transaction Prices in Selected European Countries" (Master Thesis TU Wien) and the ZEBRA2020 report "The impact of energy performance certificates on property values and nearly zero energy buildings" available at <http://zebra2020.eu/publications/the-impact-of-energy-performance-certificates-on-property-values-and-nearly-zero-energy-buildings/>.

**“A SET OF CRITERIA WAS DEVELOPED TO MEASURE THE STATUS OF THE MARKET MATURITY FOR NEARLY ZERO-ENERGY BUILDINGS (NZEB) IN THE EUROPEAN UNION.”**



## 4 NZEB TRACKER

### 4.1 METHODOLOGY AND CRITERIA

As part of ZEBRA2020, a set of criteria was developed to measure the status of the market maturity for nearly Zero-Energy Buildings (nZEB) in the European Union. The nZEB tracker focuses on dynamic market aspects and uses data derived during the project and from national sources to create nZEB-tracking graphs for each country and the EU as a whole (see <http://zebra2020.ecofys.com/>).

The used tracking criteria cover various market aspects and thus, a sound and consistent evaluation tool is necessary to aggregate these results and present them in a clear way. The calculation and aggregation methodology has been described in the ZEBRA2020 report on the “Aggregation of nZEB monitoring criteria”<sup>5</sup>.

There are 10 tracking criteria (in parentheses the abbreviation used in the charts), but the red criteria were not measured due to data constraints:

<b>CRITERION 1</b>	Market penetration of nZEB (C1: Market penetration nZEB) assesses the share of nZEB on newly constructed floor area (residential + non-residential) per year.
<b>CRITERION 2</b>	Ambition level and accuracy of national nZEB definition (C2: Ambition level) aimed at comparing the ambition levels of nZEB definitions. There are several national approaches to developing an nZEB definition making this a very complex task. Additional research would be necessary, going beyond the scope of the ZEBRA2020 project. Thus, this criterion has not been assessed so far.
<b>CRITERION 3</b>	National policies supporting the market development for nZEB (C3: National policies). For this criterion, national policies have been rated based on their effectiveness to support the establishment of nZEBs on the national markets (residential + non-residential). Therefore, policies have been allocated to seven categories and rated on a scale from 0 to 3.
<b>CRITERION 4</b>	National progress towards cost-optimal building performance requirements (C4: Cost-optimality) compares the minimal primary energy performance requirements of reference buildings (Single family houses, Multifamily houses) according to the national building codes in place with the cost-optimal energy performance.
<b>CRITERION 5</b>	Level of industry involvement (C5: Industry involvement) aimed at assessing the actions of nZEB-related industry in order to promote the implementation of nZEB. A possible approach is to identify the marketing expenditures for commercials and workshops for promoters or multiplications. Since companies treat this information as being confidential, this criterion has not been assessed.
<b>CRITERION 6</b>	Availability of nZEB-relevant components (C6: Component availability) assesses the availability of 16 nZEB-relevant components on the national markets via questionnaires that were filled in by national experts.
<b>CRITERION 7</b>	Market penetration of nZEB-relevant components (C7: Market penetration components) aimed at assessing the share of energy efficient products on the total sales of a building component category. Possible sources are manufacturers and associations. However, this requires efforts that exceeds the scope of ZEBRA2020. Therefore, this criterion has not been assessed.
<b>CRITERION 8</b>	Level of nZEB-relevant expertise of actors (C8: Expertise) assesses the availability of experts to cover the increasing demand regarding the planning, construction and examination/certification of nZEB constructions or renovations.
<b>CRITERION 9</b>	Level of awareness / information / acceptance in society (C9: Communication) assesses the awareness/information/acceptance for nZEB based on the number of search requests for nZEB-relevant keywords in the Google search engine.
<b>CRITERION 10</b>	Dependency of property value/rent on the energy performance (C10: Property value) assesses the impact energy performance has on a potential customer’s decision to buy/rent real estate. The 2014 evaluation for the ZEBRA2020 core countries is based on a survey among real estate agents on the importance of different aspects of a decision to buy or rent. For the remaining countries and years, the evaluation is based on the estimations of the national experts.

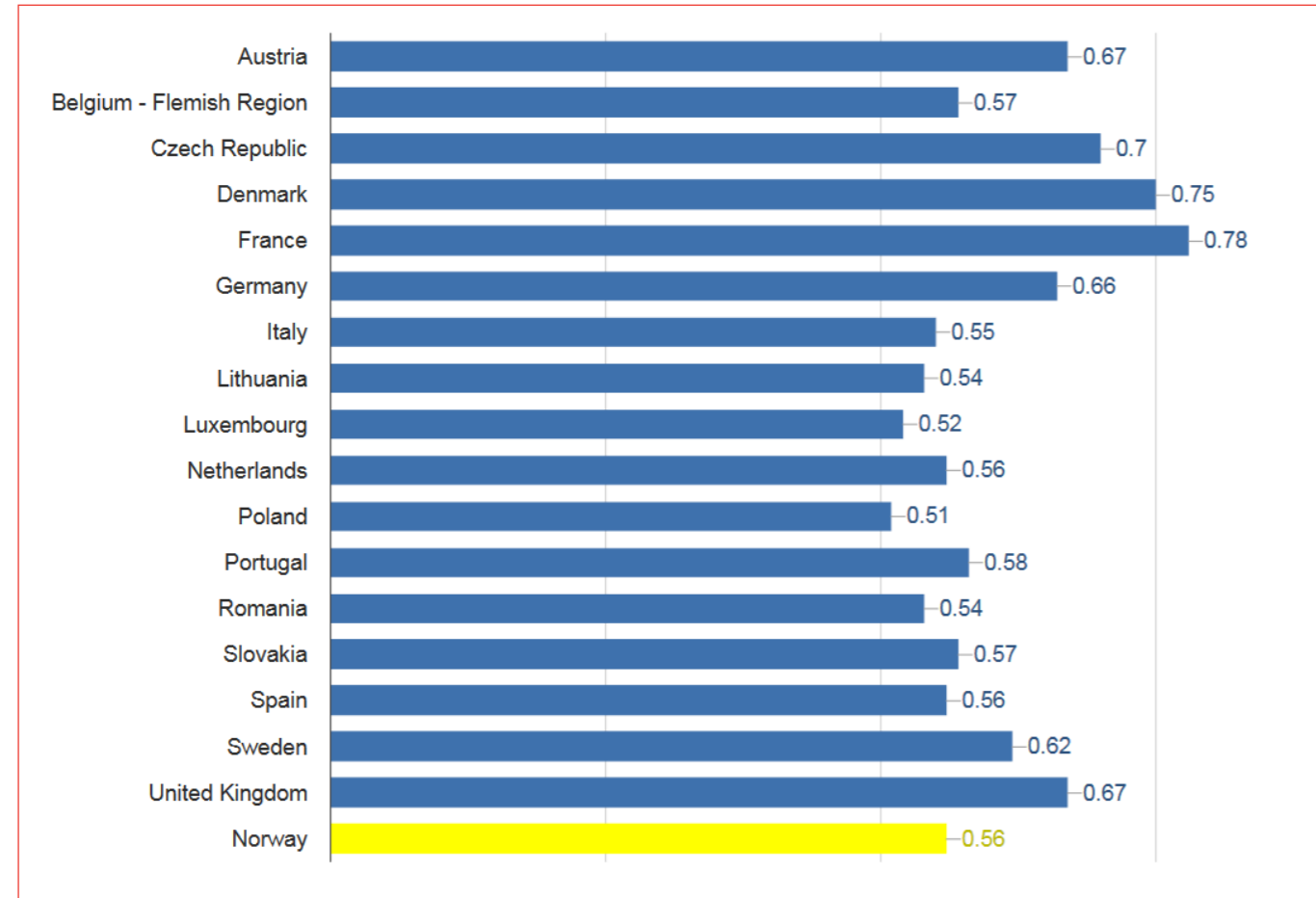
The criteria are expressed in scores between 0 and 1 as is the resulting maturity of the national/EU nZEB market. Values of 0 can be interpreted differently: (a) requirements for a criterion are not fulfilled; (b) the nZEB market is not developed. Values of 1 can be interpreted as follows: (a) all requirements for a criterion are fulfilled, (b) the nZEB market is mature.

<sup>5</sup> See <http://zebra2020.eu/publications/tracking-the-market-maturity-for-nzeb/>

## 4.2 ZEB MARKET MATURITY PROGRESS: THE NZEB TRACKER

Dynamic weighting factors, depending on the availability of data, have been applied for the aggregation of the criteria scores on national level. The below figure displays the resulting national scores, i.e. the resulting maturity of the national nZEB markets.

**Figure 9** – Resulting maturity of the national and EU nZEB markets in 2014.

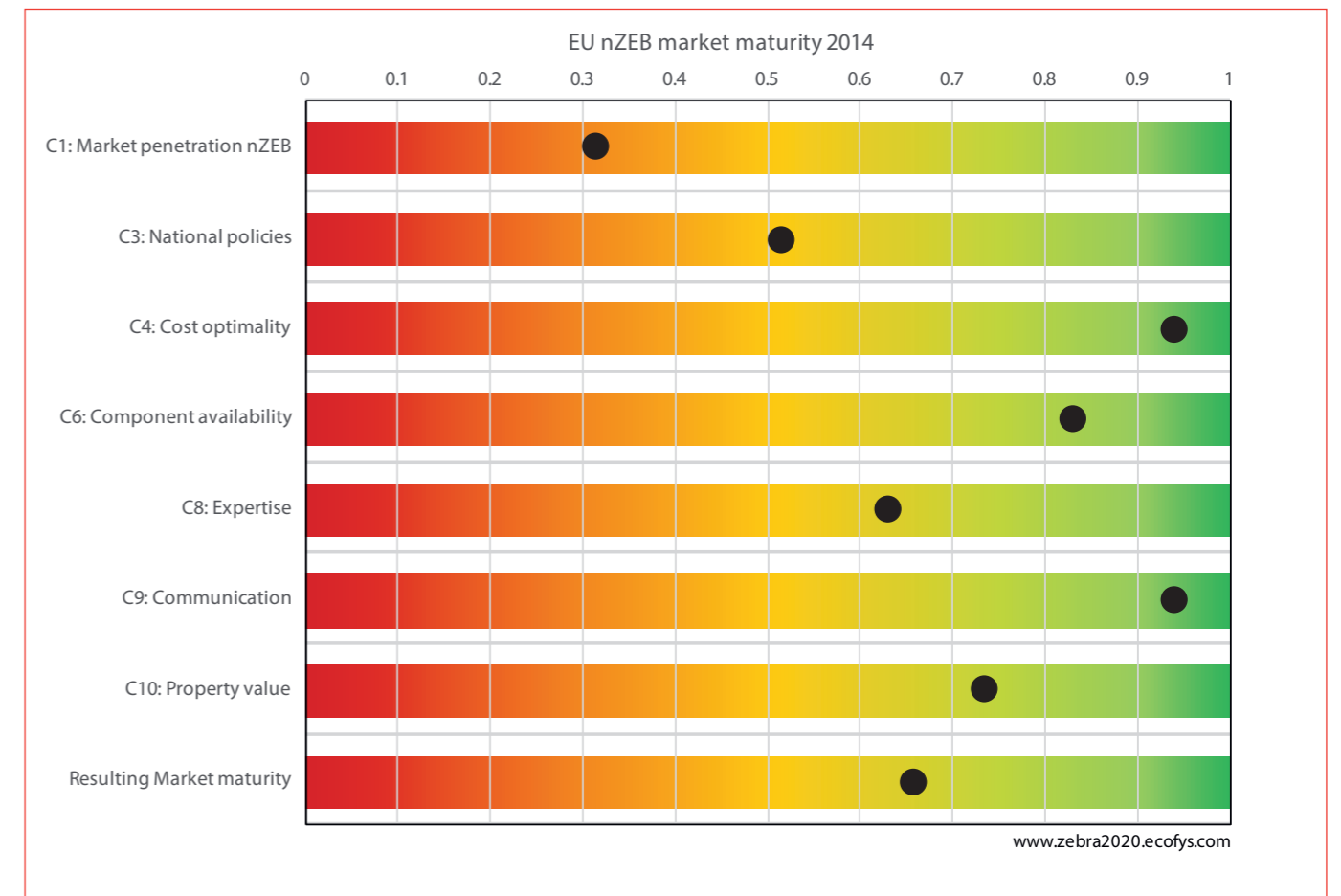


The aggregation of criteria scores on EU level (grey bar) is based on the national scores of the participating EU Member States (blue bars). Non-EU Member States, like Norway (yellow bar), are excluded from this aggregation level but displayed in the chart separately.

The next figure displays the aggregated scores for the European market for nearly Zero-Energy Buildings.

**“NZEB HAD A SHARE OF 1/3 ON THE REPORTED NEW CONSTRUCTED ZEBRA FLOOR AREA IN 2014.”**

**Figure 10** – Aggregated results per criterion and resulting maturity of the EU nZEB market for 2014.



The tracker allows to identify critical aspects that might restrict the further development of the nZEB market.

Below are selected key findings and aspects identified for 2014:

- nZEB had a share of 1/3 on the reported new constructed ZEBRA floor area in 2014.
- The result is very much affected by the figures for France. In France, nZEB became standard in 2013. France makes up for about 28 % of the ZEBRA floor area reported for 2014. The nZEB share in most of the other ZEBRA countries is below 10 %.
- Policies on nZEB requirements become more and more effective and concrete. Still not every country implemented nZEB as a national building standard.
- “Education and training” is the category that in average achieved the weakest rating in the assessed countries.
- Building codes in place match or exceed cost-optimal energy performance levels in 9 out of 16 ZEBRA2020 countries.
- Only in 2 out of 17 countries, experts think that professionals can cover the future demand for nZEB construction/renovation. The majority of experts in the other ZEBRA2020 countries is sceptical.
- The energy performance of buildings still has a minor impact on customers’ decision to buy/rent real estate, compared to other aspects like location, price and size of the real estate.

Though market conditions appear to improve throughout the EU, nZEBs are still rare in most EU Member States. Even if their share is expected to increase over the next years, supporting policies (e.g. financing instruments, energy performance certificates, energy audits) and the expertise of building professionals are crucial for a successful nZEB market development. Harmonised nZEB standards at the European level and periodic nZEB market status updates would enhance this development<sup>6</sup>.

<sup>6</sup> More findings can be found at [http://zebra2020.ecofys.com/Key\\_findings](http://zebra2020.ecofys.com/Key_findings).

**“THE ANALYSIS OF THE REAL ESTATE AGENTS' SURVEY PROVIDES SIGNIFICANT RECOMMENDATIONS ON HOW TO INCREASE THE IMPACT OF EPCS ON THE PROPERTY VALUE AND HOW TO OVERCOME THE MANY OBSTACLES IN WIDER USE OF EPC'S ACROSS EU.”**



## 5 SCENARIOS

### 5.1 SUMMARY OF METHODOLOGY AND SCENARIO DEFINITION

In this chapter we analyse how current building standards and other policy settings affect the building stock transition and corresponding energy demand targets of the building sector until 2050 and how more ambitious policies could affect this transition. For this purpose, a current policy scenario and an ambitious policy scenario of the market transition to nZEB up to 2020, 2030 and 2050 were developed.

**The current policy scenario** is driven by the existing policies including energy performance requirements, financial instruments and obligations for renewable sources (detailed information on policies is available in “Overview of building-related policies”).

**The ambitious policy scenario** is based on more intensive policies which lead to higher renovation rates and depths, more efficient new building construction, a higher share of renewable energy and corresponding CO<sub>2</sub>-emissions and energy savings. Still, the ambitious policy scenario is not meant as a maximum policy intensity scenario nor as a scenario reaching certain climate or energy targets.

The following policy instruments were explored and implemented in the model (although not all instruments were considered in all countries and not with the same intensity):

- Building codes for new buildings and building renovation;
- Financial and fiscal support policies/programmes;
- Increase of renovation rate in public buildings;
- Obligation to install renewable heating systems;
- Compliance with regulatory policies;
- Other instruments like CO<sub>2</sub> taxes, mandatory thermal retrofitting in case of façade maintenance or/and during real estate transaction, prohibition of oil boilers or in general all fossil fuel boilers.

More details of scenario assumption and results are documented in the ZEBRA2020 report “Strategies for nZEB market transition on national level”.

The scenarios are modelled by using the bottom-up building stock model Invert/EE-Lab. Invert/EE-Lab is a dynamic bottom-up simulation tool that evaluates the effects of different policies on the total energy demand, energy carrier mix, CO<sub>2</sub>-reductions and costs for space heating, cooling, lighting and hot water preparation in buildings. The key idea of the model is to describe the building stock, heating, cooling and hot water systems on a disaggregated level, calculate related energy needs and delivered energy, determine reinvestment cycles and new investment in building components and technologies as well as to simulate the decisions of building owners and tenants (see also [www.invert.at](http://www.invert.at)).

### 5.2 SCENARIO RESULTS

The following figures show the reduction of the building related final energy demand, primary energy demand and CO<sub>2</sub>-emissions in the ZEBRA2020 target countries in the current policy scenario (figure 11) and in the ambitious policy scenario (figure 12). The reduction of the CO<sub>2</sub>-emissions, primary energy demand and final energy demand varies from 27% to 70%, 27% to 61% and from 11% to 48% respectively from 2012 and 2050 in the examined European countries within the current policy scenario. In the ambitious policy scenario, which implements more stringent measures and additional financial instruments on existing buildings, reduction of the CO<sub>2</sub>-emissions, primary energy demand and final energy demand from 2012 to 2050 is as follows: 36% to 81%, 37% to 70% and from 17% to 60%, respectively.

Although the ambitious scenario includes more stringent policy instruments compared to the current policy scenario, the CO<sub>2</sub>-reductions reach a level of around 80% only in the most ambitious cases. However, the climate targets clearly indicate that reductions in the building sector beyond 80-90% will be required. This shows that an achievement of agreements like that from COP21 require higher policy ambitions, going beyond the assumptions of ambitious policy scenarios developed in this project together with policy makers.

The reduction potential in the building

sector varies strongly from one country to another. The scenario's energy savings and CO<sub>2</sub>-emission reduction is very much depending on the status quo situation in this complex sector. There are several key drivers for the energy savings and CO<sub>2</sub>-emission reduction (1) current energy performance of buildings (2) renovation rates and depth (3) the current role of different energy carriers (4) policy packages (5) energy prices and (5) the reduction in CO<sub>2</sub>-intensity of electricity generation.

- **The current energy performance of buildings** has a strong impact on achievable energy savings and cost of building renovation. Thus, the higher the current efficiency of the building stock, the more expensive is a further improvement and the stronger the political incentives have to be.

- **The role of different energy carriers.** In almost 50% of the examined countries, fossil fuel-based heating systems make up a significant share of the total energy demand for building space heating in 2012. **Natural gas** is the most common energy fuel. 50% of the energy demand for space heating is supplied by the natural gas in the examined countries. The scenario shows a decrease of natural gas demand in almost all countries. In the current policy scenario, the share of natural gas demand is 35% from the total energy demand for space heating in 2050.

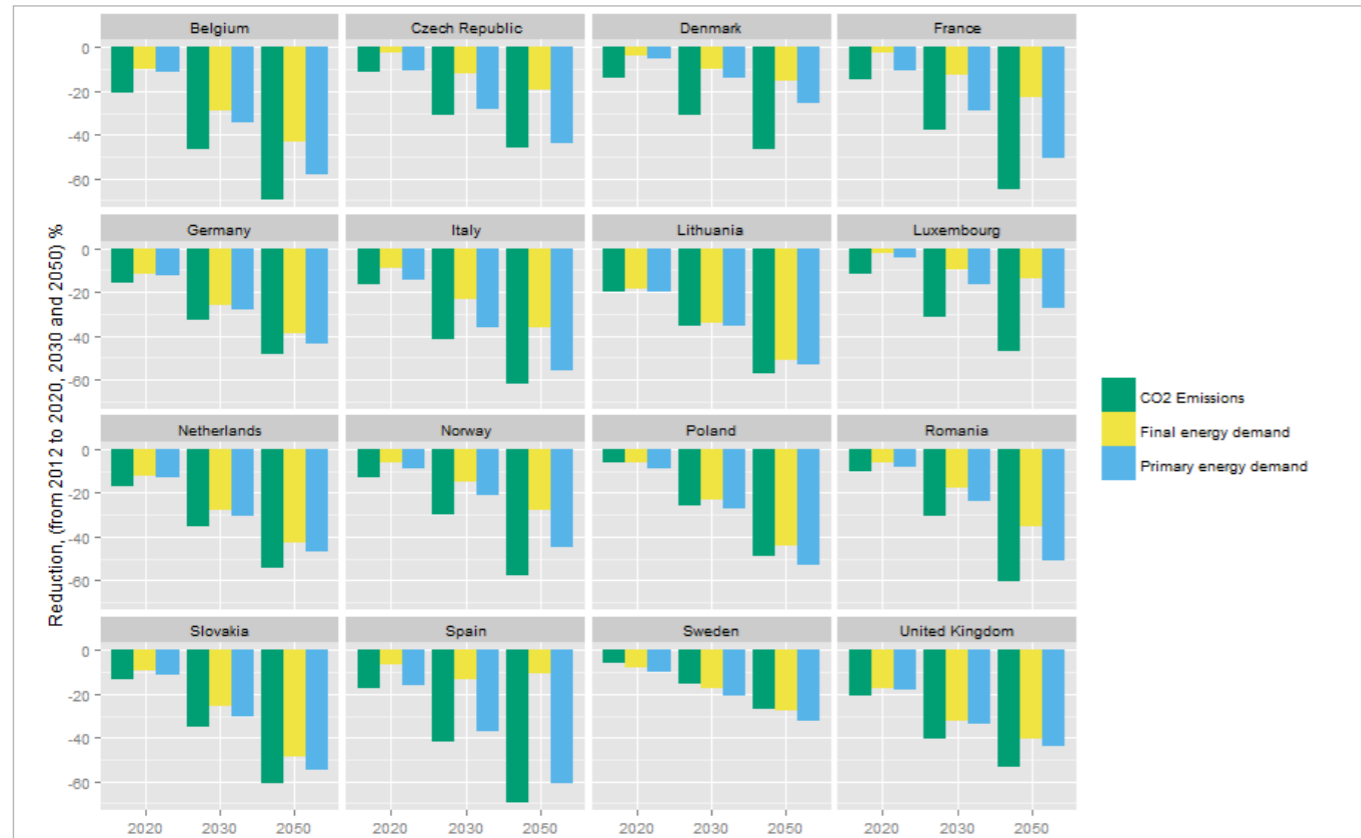
The key drivers are policies supporting renewable heating systems and its economic feasibility. **Renewable energy** makes up a high share of the total energy demand for space heating in countries such as Denmark, Lithuania, Romania and Sweden in 2012 (figure 13). Building related CO<sub>2</sub>-emissions are correspondently low in 2012 in these countries and high CO<sub>2</sub>-emission savings cannot be achieved. **Coal**, which is mainly used in the European transitioning countries, will slowly run out in the long-term scenario in almost all countries. Poland's current policies are supporting the coal industry which correspondingly keeps coal as an important fuel for the future space heating in this country.

- **Electricity demand for space cooling** is growing in South European countries. In Spain, the share of the electricity demand for space heating and cooling is 11% of the total energy demand for space heating and cooling in 2012 while in Italy – 7%. The cooling market is going to grow and reach the share of 26% in 2050 in Spain and 16.5% in Italy's building-related energy demand for space heating and cooling.

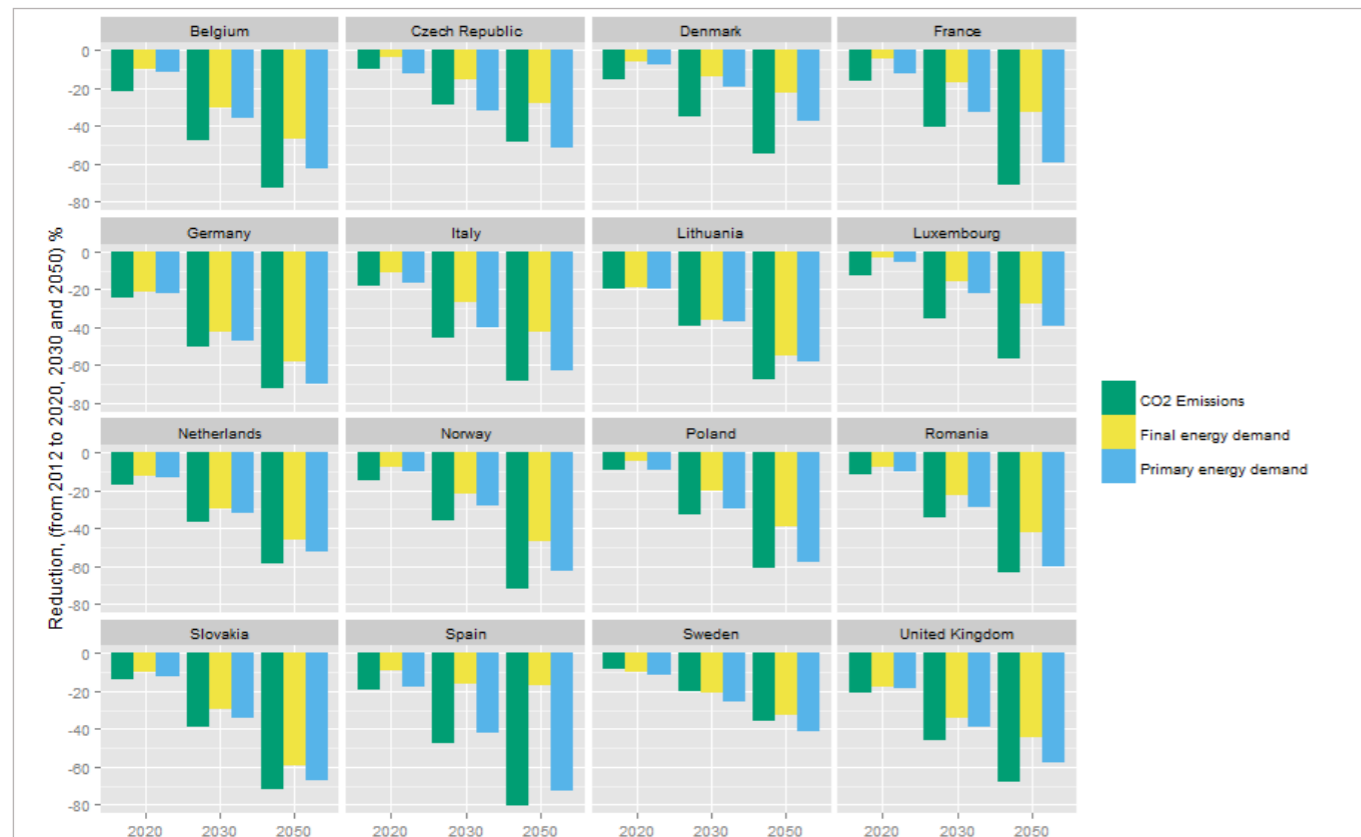
- **Renovation rate and depth** are the key drivers for energy savings. Renovation rate and the share of the renovation levels as well as other indicators are shown in the scenario tool (<http://zebra2020.eu/tools/>).

<sup>7</sup> [http://zebra2020.eu/website/wp-content/uploads/2014/08/D4-2-Building-related-policies\\_final.pdf](http://zebra2020.eu/website/wp-content/uploads/2014/08/D4-2-Building-related-policies_final.pdf)

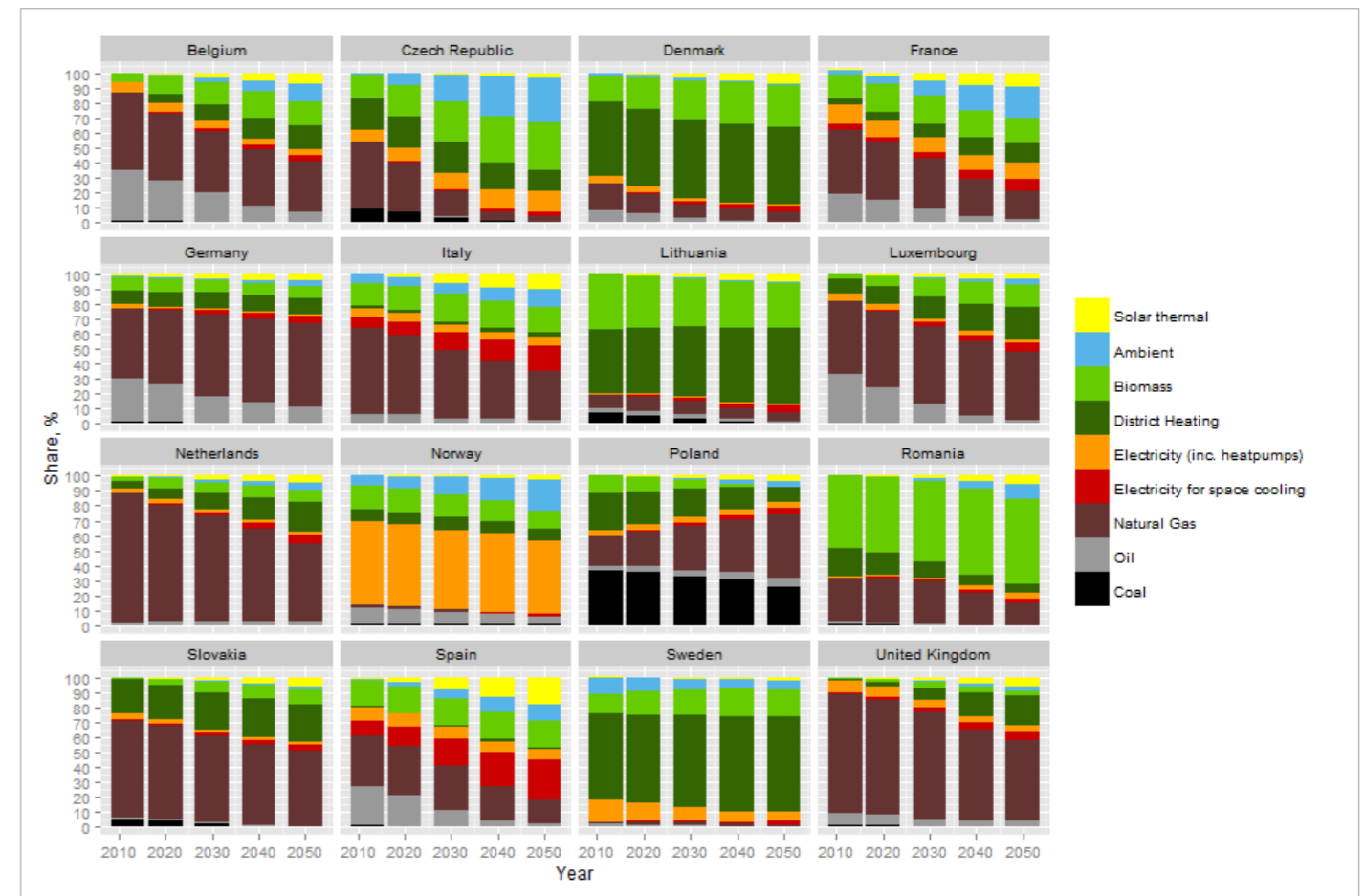
**Figure 11** – Reduction of the building related CO<sub>2</sub>-emissions, final energy demand and primary energy demand from 2012 to 2020, 2030 and 2050 in the current policy scenario (More details of scenario assumption and results are documented in the report D6.2 “Strategies for nZEB market transition on national level”).



**Figure 12** – Reduction of the building related CO<sub>2</sub>-emissions, final energy demand and primary energy demand from 2012 to 2050 in the ambitious policy scenario (More details of scenario assumption and results are documented in the report D6.2 “Strategies for nZEB market transition on national level”).



**Figure 13** – Share of the energy carrier on the total energy demand for space heating and cooling, ambitious policy scenario (More details of scenario assumption and results are documented in the report D6.2 “Strategies for nZEB market transition on national level”).



The scenario results show that fast changes are almost impossible to achieve in the building stock due to long self-life of building components and the low number of renovations and system replacement rates. This is an essential point to be considered in policy design: Buildings constructed now will most likely still be in place beyond 2050. Buildings renovated within the next 10 years will often not be renovated once again until 2050. And a considerable part of the heating systems installed in the next 10 years will still be in place in 2050. Thus, an absolute phase out of fossil-based heating systems in new installations would be required within the next 5-10 years in order to reach strong decarbonisation levels in 2050.



## 6 RECOMMENDATIONS

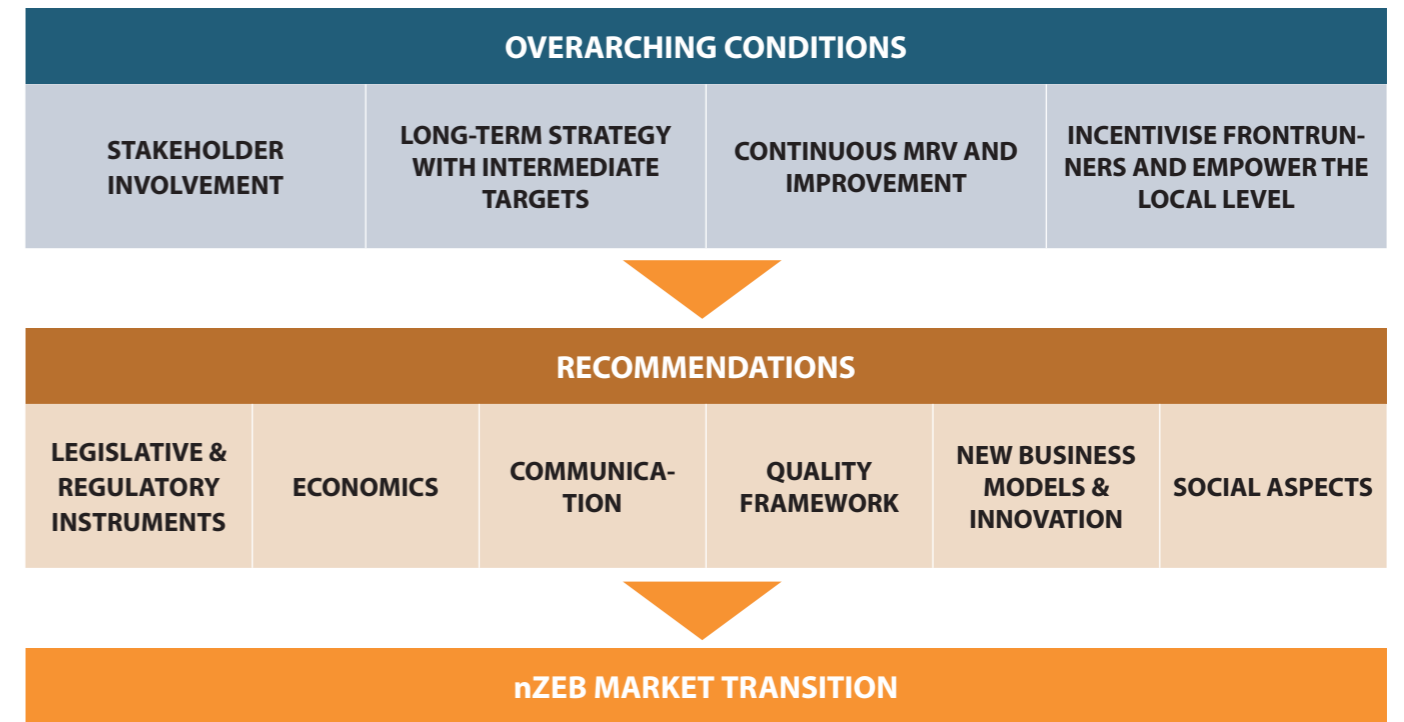
**“THE BUILDING SECTOR IS TRANSFORMING FROM A PASSIVE ENERGY DEMANDING BLOCK TO ACTIVE NZEBs AND BEYOND.”**

The building sector is transforming from a passive energy demanding block to active nZEBs and beyond. Policy makers should set ambitious goals for nZEBs and the energy efficiency of the building stock, in order to make use of the potential environmental, social and economic benefits of a faster nZEB transition.

Before outlining the specific recommendations, the key foundational principles are described. These overarching conditions must be in place in order to ensure an effective nZEB policy process.

- First of all, the nZEB transition requires involvement from a broad set of **stakeholders**. It is essential that governments and authorities involve stakeholders early in the process. An effective measure is specifically designed for the situation at hand, which is best understood by the actors working with these issues.
- Secondly, it is key that Member States adopt **long-term strategies** to upgrade the building stock.
- Thirdly, **assessment and review** should be an on-going exercise that includes data collection and quality assurance to ensure and monitor progress.
- Lastly, **empowering local level** or private initiatives to go beyond the set goals and lead by example can help accelerate the rate and depth of nZEBs.

A good strategy for a market transition to nZEB requires collaboration between the local, national and EU level. In section 6.1 recommendations for EU Member States are described, followed by - in section 6.2 - recommendations on how the EU can support states in this important task.



### 6.1 RECOMMENDATIONS ON MEMBER STATE LEVEL

Based on previous ZEBRA2020 outcomes and related research, 35 recommendations have been derived for EU Member States<sup>8</sup> divided in six different categories: legislative and regulatory, economic, communication, quality of action, new business models and social measures.

The nZEB tracker (see chapter 4) illustrates the average nZEB market maturity for 12 target countries. According to the result displayed in the tracker, the market penetration of nZEBs is still in an early phase. The recommendations in this chapter outline what is needed to increase market penetration of nZEBs. Explanations and best practices related to all the recommendations can be found in the ZEBRA20202 report “Strategies for nZEB market transition on national level”.

#### 6.1.1 Recommendations on legislative or regulatory instruments to foster nZEB market transition

Legislative and regulatory instruments are at the heart of a policymaker’s authority. Effective use of these instruments, such as setting long-term goals, strengthening building codes or reforming the public procurement processes to focus more on energy efficiency requirements can push nZEBs from a demonstration stage to becoming the new normal.

Some Member States are frontrunners and put in place regulation before it becomes a European requirement or implement it more strictly than required (e.g. Denmark on building performance regulation). On the contrary, other Member States transpose only the strict minimum within national legislation, often lacking control and compliance measures and with a very limited assessment of implementation on the ground. Based on ZEBRA2020 findings, eight legislative and regulatory recommendations have been derived:

<sup>8</sup> The recommendations have been outlined for EU Member States but many of them can be useful in other parts of Europe as well.

### Recommendations on legislative or regulatory instruments to foster nZEB market transition

<b>A1 - Regulate building performance minimum standards through building codes</b>
<b>A2 - Improve the usage of Energy Performance Certificate, including a robust compliance system</b>
<b>A3 - Define a long-term vision to guide the transformation of buildings as integrated parts of society and the wider energy system</b>
<b>A4 - Provide building owners and investors with tailored advice according to specific renovation roadmaps</b>
<b>A5 - Encourage nZEB with public procurement processes</b>
<b>A6 - Implement standard methodologies for secure data gathering and assessment</b>
<b>A7 - Set long-term voluntary targets for existing buildings</b>
<b>A8 - Mandatory upgrades for non-residential buildings, in case of new lease and tenancy</b>
<b>A9 - Scale up deep renovation through public leadership</b>

### 6.1.2 Recommendations on economic level to foster nZEB market transition

Although nZEBs are (mostly) cost-optimal over the total lifetime, the high up-front investment is often appointed as a main barrier for transforming the building stock into nZEBs. Economic measures are therefore a key enabler to increase investments in nZEB projects and thus spur market uptake. While there are many financial programmes in place, the understanding of their overall effectiveness and interaction (or enforcement) with each other is unclear. Financial instruments available should be bundled and since the investment funds required for the nZEB transformation cannot come solely from public sources, the private sector should be encouraged to get involved. Based on ZEBRA2020 findings five economic recommendations have been derived:

### Recommendations on economic level to foster nZEB market transition

<b>B1 - Incentivize the market uptake of nZEBs through active price signals</b>
<b>B2 - Stimulate the market uptake of Energy Performance Contracting by renovating public buildings in an ESCO-framework</b>
<b>B3 - Financial support for (holistic or step-by-step) renovation according long-term benchmarks</b>
<b>B4 - Adapting new financing products that look long term and entitle nZEB investors with preferential mortgages</b>
<b>B5 - Clever legislation can mitigate the problem of split-incentives</b>

### 6.1.3 Recommendations on communication to foster nZEB market transition

Awareness among investors and citizens about the multiple benefits and feasibility of nZEBs (e. g. cost savings over the life-time, on-site electricity generation, increase of internal comfort) is another big barrier to nZEB market penetration. All EU Member States must raise awareness about the benefits of investing in nZEB. Effective communication is key to increase interest in nZEB and sway the market. Most Member States must become better at guiding investors, home owners and the construction sector through the legislative and financial maze of regulations, schemes and subsidies. In many cases, the required legislation is in place but its complexity can be a pricey barrier, hampering the nZEB transition. Based on ZEBRA2020 findings four recommendations on communication have been derived:

### Recommendations on communication to foster nZEB market transition

<b>C1 - Brand nZEB as part of a positive sustainability narrative</b>
<b>C2 - Promote demonstration projects to exemplify the benefits and viability of highly performing buildings</b>
<b>C3 - Promote market uptake of nZEB with information campaigns and easy-grasping guidelines</b>
<b>C4 - Facilitate effective knowledge sharing via adequate communication tools</b>

### 6.1.4 Recommendations on quality level to foster nZEB market transition

The process of building nZEB is more complex than the construction of buildings once was. nZEBs require high quality all throughout the construction chain. A high market penetration of nZEB needs consumers to be able to rely on the skills of building professionals. This requires high skills in the nZEB supply chain as highly energy efficient products require proper understanding from installers.

One problem within the EU is the web of different laws, methods, languages and cultures among Member States, making it hard for workers to transfer their skills across borders. Appropriate training possibilities and quality frameworks should be created so high levels of expertise can be assured and the workforce used effectively. Based on ZEBRA2020 findings seven recommendations for quality of action have been derived:

### Recommendations on quality level to foster nZEB market transition

<b>D1 - Develop and consolidate quality frameworks for nZEB techniques and technologies</b>
<b>D2 - Training building professionals with "nZEB and beyond" qualifications preparing them to build and upgrade the building stock for the future</b>
<b>D3 - Set up a detailed data collection of training programmes and cross-learning initiatives</b>
<b>D4 - Enhance the proficiency of certifiers in order to increase the reliability of Energy Performance Certifications</b>
<b>D5 - New technologies allow us to collect and analyse performance data in a more effective way that was not possible some years ago</b>
<b>D6 - Improve coherence within and among states through better coordination</b>
<b>D7 - Install "One-Stop-Shops" for high energy performant buildings to reduce complexity and hassle</b>



### 6.1.5 Recommendations on new business models and innovation to foster nZEB market transition

Compared to other sectors, the construction sector is characterised by low levels of innovation. Good product innovation is severely scarce, while process innovation is applied more frequently. This can partly be explained by the large number of Small and Medium Size Enterprises, mainly providing services in the 'on-site execution market segment'. Manufacturing firms (such as building material manufacturers) are more orientated towards product innovation, while service industries rather engage in process innovation. An active innovation strategy on national level could foster a deep market transformation of the construction sector with new technologies and service-driven business models fulfilling consumers' needs. Based on ZEBRA2020 findings, five recommendations for new business models and innovation have been derived:

#### Recommendations on new business models and innovation to foster nZEB market transition

**E1 - Foster the uptake of industrialised renovation through increased market confidence**

**E2 - Encourage new business models to aggregate demand to provide sufficient scale**

**E3 - Enable the market to embrace the new features of buildings as micro energy-hubs (nZEB2.0)**

**E4 - Incentivise the frontrunner entrepreneurs exploring new business models**

**E5 - Involve and empower local authorities in pilot projects**

### 6.1.6 Recommendations on social aspects to foster nZEB market transition

Energy poverty is a major problem for Europe, as between 50 and 125 million people are unable to afford proper indoor thermal comfort. Despite the fact that there is no common European definition and only four countries have an official energy poverty definition, the importance of the problem, as well as, the severe health impacts caused by energy poverty are widely recognised. Specifically, increased winter deaths, mental disabilities, respiratory and circulatory problems are consequences of fuel poverty. Based on ZEBRA2020 findings six recommendations for social issues have been derived:

#### Recommendations on social aspects to foster nZEB market transition

**F1 - Explicitly define energy poverty and set up monitoring mechanisms**

**F2 - Include the benefits of alleviating (energy) poverty in nZEB decisions**

**F3 - Specify and increase support measures for vulnerable target groups customised to their profile**

**F4 - Move from fuel subsidies to energy efficiency measures**

**F5 - Improve all social housing to nZEB standards, in order to provide comfortable and affordable housing**

**F6 - Fighting air pollution to be an integrated part of nZEB strategies**

## 6.2 RECOMMENDATIONS ON EU LEVEL

At the EU level there is an array of legislation looking to improve the energy performance of buildings with the Energy Performance of Buildings Directive (EPBD)<sup>9</sup> and the Energy Efficiency Directive (EED)<sup>10</sup> at the heart.

The EPBD specifically requires Member States to define what constitutes an nZEB and that public new buildings and major renovations are nZEBs from 2019, respectively all buildings by 2021. The EPBD also requires Member States to take necessary measures to ensure that minimum energy performance requirements for buildings are set with a view to achieving cost-optimal levels.

The EED sets further level goals, requiring Member States to establish long-term strategies for mobilising investment in the renovation of national residential and commercial buildings, both public and private. The first versions of these strategies were submitted by Member States to the European Commission in 2013. However, assessments indicate that more action is needed to ensure these strategies deliver the required transformation of the building stock<sup>11</sup>.

The reviews of the EED and EPBD are an opportunity to update and strengthen the existing legislation to push the transition towards nZEB even further.

Other steps can also be taken to better link policies and financing streams and promote existing implementation and projects. For example, the Concerted Actions for the EPBD and on the EED, supported by the European Commission provide an opportunity to bring policy makers together to share their experiences implementing policies and learn from one another.

The following recommendations to push forward nZEBs across Europe build on the recommendations for Member States, and the opportunities arising from the upcoming legislative proposals.

#### RECOMMENDATIONS ON EU LEVEL

**EU1 - Clarify the nZEB definition**

**EU2 - Gather more and better data**

**EU3 - Improve quality and compliance**

**EU4 - Implement a long-term vision for the building stock**

**EU5 - Provide a pathway for existing buildings**

**EU6 - Evolve the EPCs into Building Passports**

**EU7 - Walk the talk with public buildings**

**EU8 - Focus on vulnerable groups**

**EU9 - Link policies and financing**

**EU10 - Future-proof buildings**

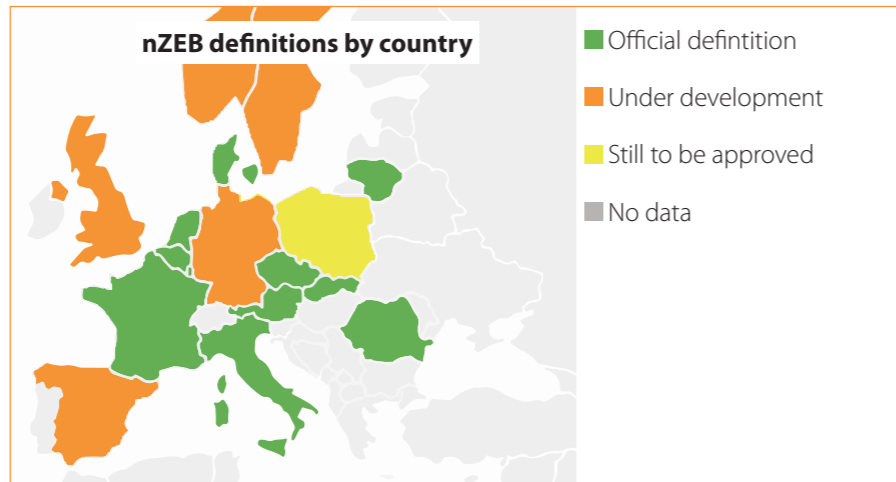
<sup>9</sup> Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

<sup>10</sup> Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency

<sup>11</sup> BPIE (2016), Building Renovation Strategies under the Spotlight <http://bpie.eu/publication/survey-article-4-eed/>

## EU1 - CLARIFY THE NZEB DEFINITION

The EPBD specifically requires Member States to define what constitutes a nearly Zero-Energy Building. First and foremost, it must be ensured that this national definition for nZEB is in place in all EU Member States. The map below illustrates the extent and stages of development of nZEB definitions across the EU<sup>12</sup>.



The nZEB concept, and requirement in the EPBD to set nZEB standards, is very flexible with no single harmonised nZEB definition. This flexibility is needed to take into account the variation between different countries in terms of their climatic conditions and the cost-effectiveness of energy efficiency and renewable energy measures. However, the EPBD leaves much freedom for interpretation by Member States (e.g. what is meant by “a very low amount of energy required” or “renewable energy produced on-site or nearby”).

The European Commission has recommended specific benchmarks for the energy performance of nZEBs for offices and new single family houses in four different climatic zones. This provides a good starting point and a useful comparison for the current national definitions. These **benchmarks**<sup>13</sup> should be reflected in all national definitions and clarifications should be provided by Member States when definitions vary significantly. A clearer definition of the desired energy performance of an nZEB, incorporating these benchmarks, in the EPBD would support a more coherent approach by national governments. Convergence on methodologies and targets would trigger more innovation in the field and support the technology

leadership of Europe in the field pushing the market forward.

Clarity on the contribution of renewable energy in nZEBs is also needed. In some Member States the share of primary energy consumption that has to be covered by renewable energy sources is explicitly stated, while in others renewable sources are considered indirectly. Specifically, what is meant by nearby-renewable sources also has to be clarified.

A quantitative sound comparison of all current nZEB definitions has not been possible within this project due to very different system boundaries, calculation methodologies, applied factors etc. However, our analysis indicates that a significant share of the currently available nZEB definitions do not meet the intention and spirit of the EPBD according to which the energy consumption of buildings should be “nearly zero or very low amount” and the remaining part “should be covered to a very significant extent by energy from renewable sources” (EPBD recast 2010/31/EU). E.g. some national nZEB definitions allow to achieve nZEB targets by either investing stronger in the building envelope or stronger in RES, which does not reflect the intention of the EPBD.

In EU and national legislation, energy performance requirements should be complemented with appropriate measures to recognise the need for proper indoor air quality, daylight and thermal comfort. It is also important not to overlook the energy use of products used within buildings, the application and evolution of product standards through the Ecodesign Directive must continue and reflect emerging technologies.

**“IN EU AND NATIONAL LEGISLATION, ENERGY PERFORMANCE REQUIREMENTS SHOULD BE COMPLEMENTED WITH APPROPRIATE MEASURES TO RECOGNISE THE NEED FOR PROPER INDOOR AIR QUALITY, DAYLIGHT AND THERMAL COMFORT.”**

<sup>12</sup> ZEBRA 2020 Project, 2016 <http://www.zebra-monitoring.enerdata.eu/>

<sup>13</sup> Commission Recommendation (EU) 2016/1318 of 29 July 2016 on guidelines for the promotion of nearly zero-energy buildings and best practices to ensure that, by 2020, all new buildings are nearly zero-energy buildings

## EU2 - GATHER MORE AND BETTER DATA

Only 50% of Member States have a view on the energy performance of new buildings. A harmonised methodology on an European level for monitoring improvements of the energy performance of buildings should be introduced so the transition towards nZEB can be monitored and understood. The European Commission should provide guidance to Member States on the type and format of the data for monitoring improvement of energy efficiency in all buildings, including new and existing buildings and for the non-residential sector, and provide support for the collection of this data in a central repository. Besides ZEBRA2020, the EU Building Stock Observatory is a great step in this direction, providing open source data on Europe’s building stock, and should continue to be supported. Methodologies and data repositories will need to take into account the future contribution from new and emerging technologies, such as smart meters, to the collection of data.

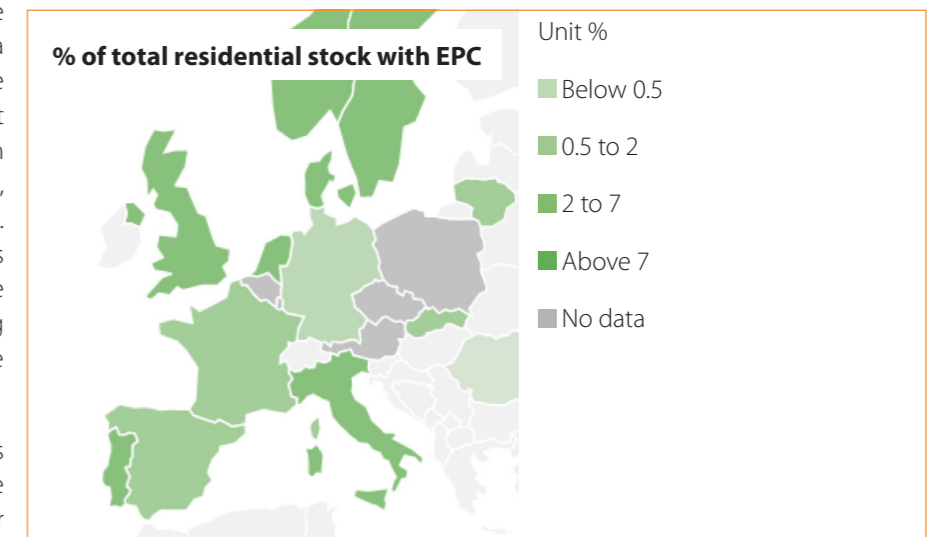
Some data is already collected across Europe, such as from Energy Performance Certificates, but it tends to be rather

piecemeal. The map below illustrates the distribution of EPCs for the existing residential building stock<sup>14</sup>. This shows that at a maximum they only cover a third of the existing building stock. It is evident that existing policies need to be strengthened.

The European Commission should support and guide Member States in developing and strengthening central **Energy Performance Certificate (EPC) registers**, especially in the context of a solution to tackle data protection issues, and tools for data analysis. This would help to ensure that data is gathered at

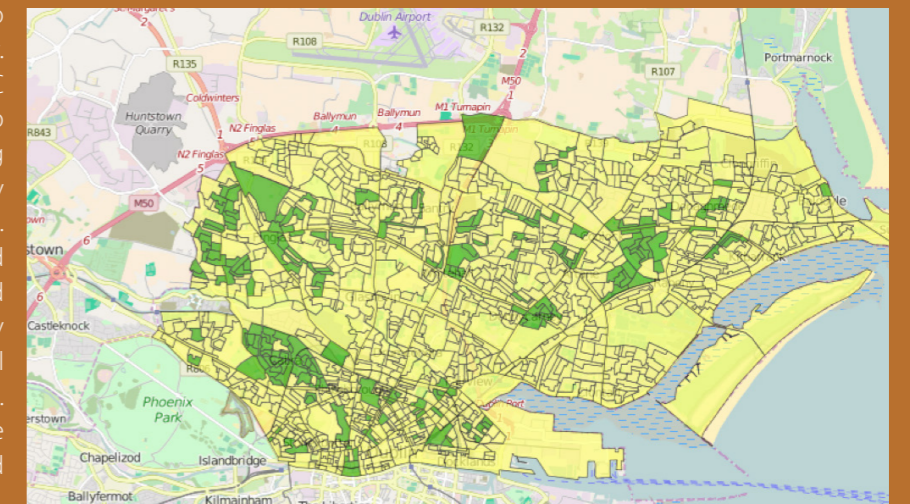
national level, and that, at least, some of this data (all or a selection of it) is linked to a central EU database, such as the EU Building Stock Observatory or ZEBRA’s nZEB tracker.

There is an increasing number of the best practices across Europe that demonstrate the added value of this data for policy making (e.g. to inform relevant renovation strategies) and monitoring, as well as market and research analysis. Therefore, such databases should be publicly available in order to serve the wide range of stakeholders.



### Example: EPC mapping in Ireland

The Irish Energy Action, in partnership with the EU-project Episcopa ([www.episcopa.eu](http://www.episcopa.eu)), have developed an EPC mapping tool. The interactive map of Dublin illustrates different building characteristics (including energy poverty indicators) of different neighbourhoods. The data is aggregated to defined boundaries, namely small areas and electoral divisions (small areas typically comprise 50-200 dwellings and electoral divisions include clusters of small areas). The EU should set up a framework where EPC data is gathered in a harmonised way and made publicly available.



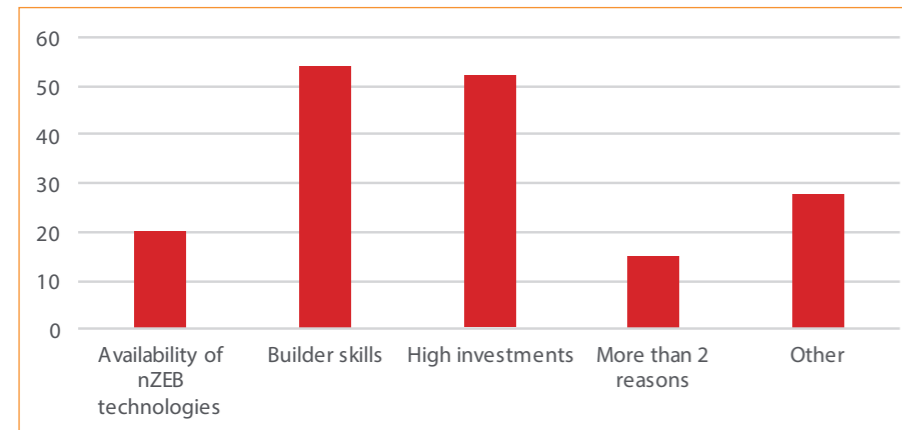
<sup>14</sup> ZEBRA2020 Project, 2016 <http://www.zebra-monitoring.enerdata.eu/>

### EU3 - IMPROVE QUALITY AND COMPLIANCE

The EPBD dictates that Member States set the rules on penalties for non-compliance with nZEB definitions that are “effective, proportionate and dissuasive”, the European Commission must ensure adequate compliance and sanction mechanisms are in place. This is closely linked to the need for more data and better monitoring, as well as improved and compulsory Energy Performance Certificates.

Buildings professionals consider skills to be one of the largest barriers to speeding up the transition to nZEB and other studies showing that poor workmanship (e.g. poor installation of thermal insulation, windows, heating, ventilation, and air conditioning (HVAC), and renewable energy system) can severely affect the performance of nZEBs. This in turn has the potential to seriously damage market trust.

**Figure 14** – Barriers to the nZEB transition in the opinion of building professionals (No. of answers, 169 total respondents).



Establishing **integrated quality frameworks** which address knowledge enhancement (ie. retraining or specialisation) and value of knowledge (ie. certification for skills) would help to ensure high quality workmanship. There needs to be a transparent system across Europe that sets minimum standards for certifiers’ training and their professional experience to allow workers to transfer skills across borders. Examinations of competences or similar instruments such as “declarations of conformity” are crucial and it should be offered by independent certification entities. The European Commission should come forth with a detailed guidance on the necessary competences of certifiers and the system of accreditation.

Demonstration projects that bring together the public and building professionals to illustrate the feasibility of nZEB have been successfully funded by the EU.

**Example: SouthZEB and AIDA**

SouthZEB and AIDA are Intelligent Energy Europe funded projects<sup>15</sup>, which addresses continuous professional development.

With the objective of fostering the energy efficiency of the building sector through the adoption of nZEB concepts in new or existing buildings, the SouthZEB project develops training modules targeted towards professionals in Southern European countries. The training will leverage the experience and know-how from front runner project partners’ countries to be implemented in other countries. AIDA fostered knowledge transfer via study tours to existing frontrunner buildings for building professionals and offered support in nZEB design for municipalities.

**“ESTABLISHING INTEGRATED QUALITY FRAMEWORKS WHICH ADDRESS KNOWLEDGE ENHANCEMENT AND VALUE OF KNOWLEDGE WOULD HELP TO ENSURE HIGH QUALITY WORKMANSHIP.”**

<sup>15</sup> More information is available at: [www.southzeb.eu/training](http://www.southzeb.eu/training) respectively [www.aidaproject.eu](http://www.aidaproject.eu)

### EU4 - IMPLEMENT A LONG-TERM VISION FOR THE BUILDING STOCK

Setting a longer term vision for all buildings for 2050 is necessary to align with the global commitment from COP21 to limit global warming well below 2 degrees, aiming at 1.5 degrees, and recognise the contribution from improving the energy performance of buildings.<sup>16</sup>

Given that least two thirds of existing buildings will still be standing in 2050, there is a need to specifically target existing buildings. While under the EPBD Member States should develop policies in order to encourage the renovation of buildings to reach nZEB levels, so far not

### EU5 - PROVIDE A PATHWAY FOR EXISTING BUILDINGS

Strengthened national renovation strategies (required under the EED) should build on the nZEB definitions at national level and focus on deep renovation of existing buildings to put them on a path towards a high energy performance. These strategies should establish long-term confidence in the market, spur investments and increase the

### EU6 - EVOLVE EPCS INTO BUILDING PASSPORTS

In the ZEBRA2020 survey of real estate professionals many did not think there was a link between EPCs and the improvement of energy efficiency of buildings.

In order to become drivers for renovation, the current Energy Performance Certificates (EPCs) should evolve into building-specific renovation roadmaps, or “building passports”, accompanying a building through its life cycle and include proposals and advice for owners and investors on how to improve the building to become nearly zero-energy (in a step-by-step approach to energy renovation which avoids lock-in-effects and looks towards better solutions).

<sup>16</sup> Twenty-two Member States have reported specific measures for refurbishing existing buildings in their nZEB plans, as of April 2016 (JRC, 2016).

<sup>17</sup> Commission Recommendation (EU) 2016/1318 of 29 July 2016 on guidelines for the promotion of nearly zero-energy buildings and best practices to ensure that, by 2020, all new buildings are nearly zero-energy buildings

<sup>18</sup> BPIE (2016), Building Renovation Strategies under the Spotlight <http://bpie.eu/publication/survey-article-4-eed/>

all nZEB requirements refer directly to existing buildings.

The European Commission’s recent suggestion for benchmarks<sup>17</sup> does not differentiate between new and existing buildings in order to avoid misleading definitions for consumers. However, there is a concern that if the definitions are the same for new and existing buildings, it might, depending on the definition, either be insufficiently ambitious for new buildings or too ambitious for existing buildings. For this reason, **it is important that national regulations distinguish between new building construction and renovation in the targets to be achieved – despite of a common**

renovation rate in the EU. Currently only 14% of stakeholders believe the planned renovation strategies will be successful<sup>18</sup>. Therefore, the European Commission should raise the requirements and push for more comprehensive strategies and support Member States with more guidance in the implementation phase.

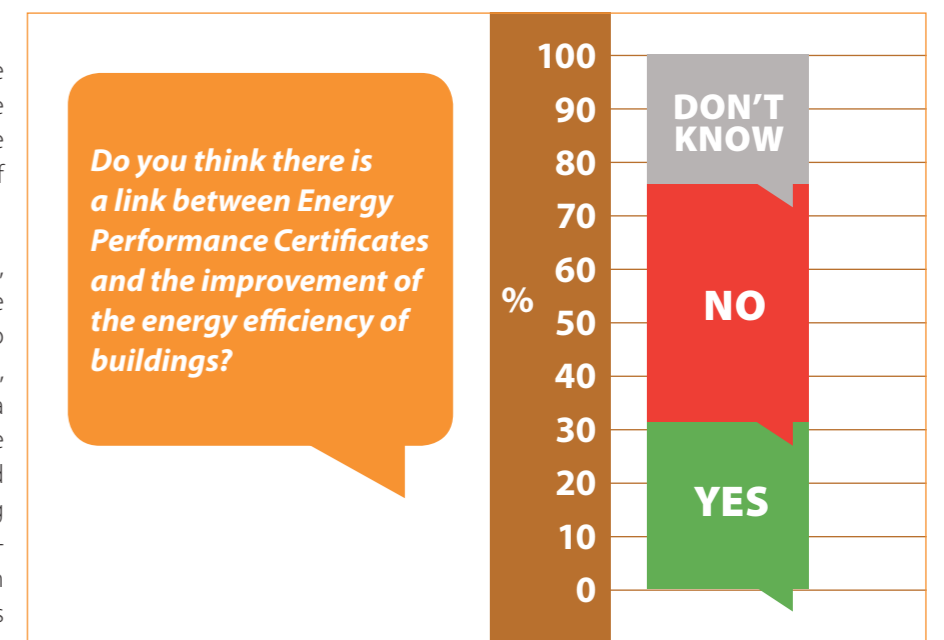
The EPBD should require “trigger points” for energy improvement to be defined. This should provide a push in

**nZEB definition for both cases.** While for new building construction, the nZEB target is mandatory, for building renovation it might not be reasonable in all cases. Cost-optimal performance levels must pave the way towards these targets.

Cost-optimal calculations must also consider co-benefits (energy security, employment creation, reduced air pollution, health and comfort) and use a lower discount rate in the macroeconomic perspective. At the same time, the accepted degree of deviation from the cost-optimal approach should be lowered to foster more bespoke solutions and progress in reducing costs.

the direction of mandatory renovation reaching a high energy performance. Such definitions are common practice in some EU Member States (e.g. Germany, France, the UK, Belgium, Italy and Denmark) where national regulation requires building owners to invest in energy performance improvements under certain circumstances, e.g. in case of a renovation beyond a certain extent, in case of a real estate transaction or after a certain period of time.

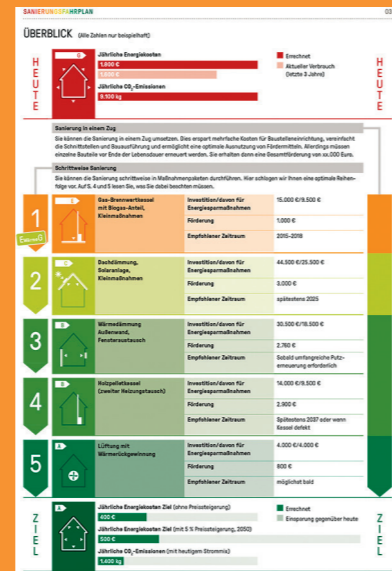
**Figure 15** – The views of real estate professionals on EPCs



### Example: "Sanierungsfahrplan Baden-Württemberg"

The German state of Baden-Württemberg provides a renovation roadmap for individual buildings that summarises for the property owner coordinated packages of measures to achieve a deep energy renovation.

Bundles of measures that should be carried out simultaneously are defined. It also includes before-and-after comparisons of energy costs and CO<sub>2</sub> emissions, and a detailed description of the measures, such as preparatory measures, required U-values, further co-benefits, possible funding opportunities. It is designed to avoid lock-in-effects. For instance, if a roof is renovated, the roof overhang shall be designed in such a way that the future expected façade insulation can be smoothly applied.



### EU7 - PUBLIC BUILDINGS AS ROLE MODELS

Action to improve energy performance in the public sector can be an important trigger for wider stimulation of the market for energy performance improvements. Article 5 of the EED requires 3% of public buildings owned and occupied by central government to be renovated each year to meet minimum energy performance standards<sup>19</sup>. This could be strengthened to apply to all public buildings (including social housing and schools). Although this is not required by the Directive, some

Member States have already extended the scope to include regional government buildings, central government buildings that are occupied (but not owned), schools, and social housing.

This requirement should be implemented with a view towards the renovation of existing buildings towards nZEB, meaning all countries renovate 3% of their public buildings with the nZEB level in mind. This would pave the way towards large-scale renovation of the whole building stock towards becoming nZEB. However, this would require structured financial support

for those, who are responsible for these buildings, especially municipalities. For instance, Energy Performance Contracting is a form of 'creative financing' which allows energy efficiency improvements to be funded by the resulting cost reductions, and can be encouraged by support from EU funds. Current EU rules on public procurement are onerous and create barriers to investment in energy performance improvements, via means such as Energy Performance Contracting. Efforts are needed to streamline this process.

### EU8 - FOCUS ON VULNERABLE GROUPS

In the current EPBD there is only a general statement that "Member States should draw up lists of existing and proposed measures that [...] potentially contribute to reducing energy poverty". As energy poverty is inextricable linked to the energy performance of buildings, it is vital for its alleviation that the problem is clearly addressed in the EPBD and certain actions are proposed including establishing a definition and mapping the problem across Europe. Member States should be required to take specific measures to overcome the issue.

Policies such as energy efficiency obligations may introduce dedicated elements addressing energy poverty and vulnerable consumers; these could be focused on building renovation. The budget for subsidies to energy poor consumers is much higher in some countries than the budget dedicated to building renovation programmes. Such subsidies are not sustainable and only provide a temporary solution. However, shifting these budgets towards renovation of homes aiming to become nZEBs would provide lasting benefits in terms of energy bills, as well as health and the many other benefits brought upon by improved energy performance.

Article 19 EED requires Member States to evaluate and take measures to remove regulatory and non-regulatory barriers to energy efficiency, specifically naming the problem of split incentives. This problem is particularly relevant for low income tenants and addressing it requires an understanding of the causes of fuel poverty and well-designed policies to overcome them. More generally the issue of split incentives is an important hurdle to address so that widespread improvements in building energy performance and the path towards nZEB is secured.

### EU9 - LINK POLICIES AND FINANCING

The European Commission must ensure that Member States adequately identify the funding streams for their National Buildings Renovation Strategies, which should include the pathway towards nZEB for all buildings, with the active inclusion of financial instrument to support investments in buildings. Such National Buildings Renovation Strategies could be

better linked with the establishment of national energy efficiency funds (under the EED) as one possible funding stream. Other policies such as Energy Efficiency Obligations can provide additional support to energy efficiency funds or directly drive deep renovation measures.

In addition, streamlining, blending and optimising the use of European Structural and Investment Funds, Horizon 2020

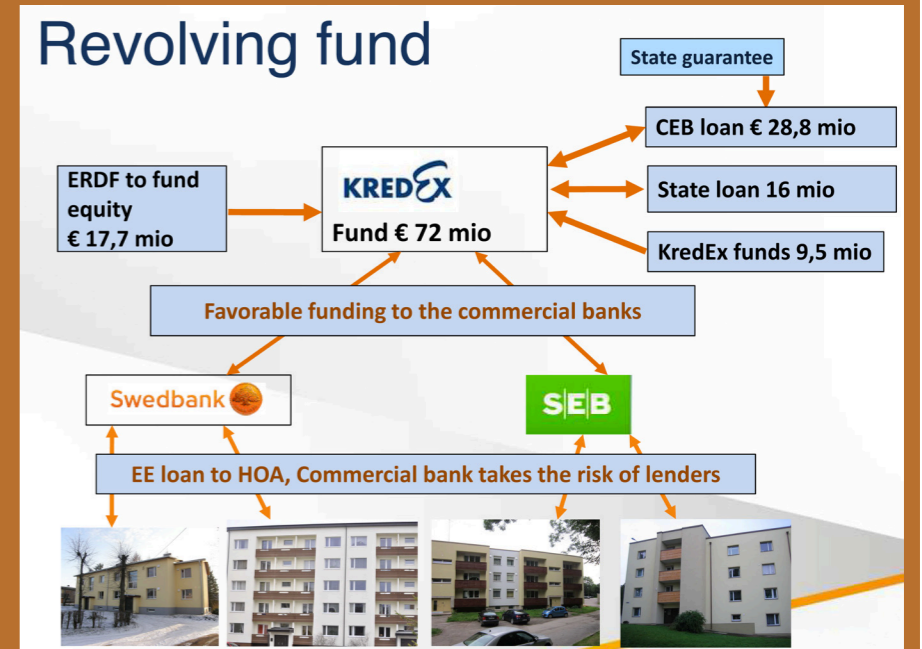
and EU ETS revenues for investments in buildings could provide further support (Energy Efficiency Financial Institutions Group, 2015). Leveraging private sector financing could be stimulated with the use of European Structural and Investment Funds, including funds such as the European Fund for Strategic Investments (EFSI).

### Example: Revolving loan leveraging EU funds – Estonia

The housing stock in Estonia was mostly built prior to 1980, with little attention given at the time to energy efficiency or energy performance requirements. In fact, before 2008, there were no legal obligations to insulate buildings or to provide efficient technical systems in buildings. As a result, Estonian buildings are wasteful in terms of energy use, having an average heating energy demand of around 200-400 kWh/m<sup>2</sup> per annum.

This poor energy efficiency, combined with the fact that the majority of the population lives in cities, with three out of four people residing in apartment blocks, led to the Estonian Government establishing the KredEx Foundation, Estonian Credit and Guarantee Fund in 2001, in order to provide support for improving the energy performance of the housing stock. Originally based on grants, in 2009, KredEx renovation finance changed its structure to a revolving loan fund. KredEx manages the revolving fund, the first of its kind to use EU Structural Funds to provide low-interest loans to housing associations and municipalities.

This funding mechanism provides the housing sector with an opportunity to reuse funds going into the scheme to further renovate the building stock.<sup>20</sup>



<sup>19</sup> More information on Article 5 of the EED is available at: [http://bpie.eu/wp-content/uploads/2015/10/Factsheet\\_BPIE-Article\\_5\\_EED.pdf](http://bpie.eu/wp-content/uploads/2015/10/Factsheet_BPIE-Article_5_EED.pdf)

<sup>20</sup> [http://bpie.eu/wp-content/uploads/2015/12/Renovation-in-practice\\_08.pdf](http://bpie.eu/wp-content/uploads/2015/12/Renovation-in-practice_08.pdf)

## EU10 - FUTURE-PROOF BUILDINGS

Buildings are in a transition phase, moving from being unresponsive and highly-energy-demanding elements to becoming highly-efficient micro energy-hubs consuming, producing, storing and supplying energy. This transition and the new possibilities it could bring must be taken into account in defining nZEB. The nZEB definition should be future-proofed to be smart and district-ready therefore ensuring that the development of the market for nZEB is not hindered.

Many of the technologies required for this transition already exist, but their potential needs to be fully recognised. The development of smart grid requires the integration of buildings with other elements of the energy system such as transport. The role of buildings in the energy system must be reflected in the design of the EU energy market both within the revised EPBD and the new EU Market Design Initiative. Indeed, it is important that this role is recognised in a wide range of policies, including spatial planning that should support the creation of smart building districts and the integration of buildings and transport.

**“BUILDINGS ARE IN A TRANSITION PHASE, MOVING FROM BEING UNRESPONSIVE AND HIGHLY-ENERGY-DEMANDING ELEMENTS TO BECOMING HIGHLY-EFFICIENT MICRO ENERGY-HUBS CONSUMING, PRODUCING, STORING AND SUPPLYING ENERGY.”**

## SOME THOUGHTS FROM ZEBRA2020 PARTNERS



THE DEVELOPMENT OF NEARLY ZERO-ENERGY BUILDINGS DEPENDS ON MANY FACTORS, GOING BEYOND POLICIES OR REGULATIONS. CLIMATE CONDITIONS, INFRASTRUCTURES, BUILDING INDUSTRY AND CULTURE, AS WELL AS THE ECONOMIC CONTEXT ARE ALSO FACTORS TO BE CONSIDERED. LEARNING FROM EACH OTHER AND COMPARING NZEB BEST PRACTICES ARE KEY TO ACHIEVING COMMON GOALS.

*Ramón Pascual,  
EURAC Institute for Renewable Energy*



ENERGY PERFORMANCE CERTIFICATES SHOULD BE FURTHER DEVELOPED TO INCREASE RELIABILITY AND TRUST OF REAL ESTATE MARKET ACTORS.

*Andrzej Rajkiewicz, NAPE*



OUR SCENARIOS SHOW THAT AN ACHIEVEMENT OF 80-90% CO<sub>2</sub>-EMISSION SAVINGS BY 2050 IN THE BUILDING SECTOR REQUIRE MEASURES GOING FAR BEYOND ANY POLICY WHICH IS ASSUMED TO BE AMBITIOUS TODAY.

*Agne Toleikyte, TU Wien (EEG)*



OUR ANALYSIS INDICATES THAT A SIGNIFICANT SHARE OF NZEB DEFINITIONS DOES NOT MEET THE INTENTION OF THE EU DIRECTIVE ON ENERGY EFFICIENT BUILDINGS. THUS, THE RECAST OF THE DIRECTIVE REQUIRES CLEAR DEFINITIONS OF TERMS AND PRECISE THRESHOLDS.

*Maarten De Groot, BPIE*

## SOME THOUGHTS FROM ZEBRA2020 PARTNERS



THOUGH MARKET CONDITIONS ARE IMPROVING, NEARLY ZERO-ENERGY BUILDINGS ARE STILL RARE IN MOST EU MEMBER STATES. EVEN IF THEIR SHARE IS EXPECTED TO INCREASE, SUPPORTING POLICIES AND HARMONIZED STANDARDS ARE CRUCIAL FOR A SUCCESSFUL MARKET DEVELOPMENT.

*Sven Schimschar, Ecofys*



MOST BUILDINGS OF TODAY WILL STILL BE STANDING IN 2050, REQUIRING A LONG-TERM STRATEGY FOR RENOVATION. MOREOVER, SHIFTING SUBSIDIES (OR SUPPORT) FROM FUEL TO ENERGY EFFICIENCY WILL BE NECESSARY TO REDUCE ENERGY POVERTY EFFECTIVELY.

*Jose Santos, CIMNE*



AMBITIOUS ENERGY UPGRADING IN THE RESIDENTIAL SECTOR NEEDS MORE THAN REGULATORY REQUIREMENTS AND ECONOMIC INCENTIVES. FOR MOST PEOPLE A COMBINATION OF MOTIVATION FACTORS SUCH AS SUSTAINABILITY, CLIMATE CHANGE MITIGATION, THERMAL COMFORT AND INDOOR ENVIRONMENT WOULD BE IMPORTANT.

*Åsne Lund Godbolt, SINTEF*



EVEN IF MORE DETAILED AND COMPLETE DATA WOULD BE DESIRABLE, THE ONLINE DATA TOOLS OF ZEBRA2020 PROVIDE UNIQUE INFORMATION ON THE MARKET DEVELOPMENT OF NEARLY ZERO-ENERGY BUILDINGS IN EUROPE.

*Carine Sebi, Enerdata*



**ZEBRA2020**

**[WWW.ZEBRA2020.EU](http://WWW.ZEBRA2020.EU)**