LAYING DOWN THE PATHWAYS TO NEARLY ZERO-ENERGY BUILDINGS

A toolkit for policy makers

ENTRANZE

Written by the ENTRANZE consortium

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THE ENTRANZE PROJECT

The objective of the ENTRANZE (Policies to Enforce the Transition to nearly Zero-Energy Buildings in the EU-28) project was to actively support policy making by providing the required data, analysis and guidelines to achieve the fast and effective penetration of nearly Zero-Energy Buildings (nZEB) and renewable heating and cooling (RES-H/C) within the existing national building stocks. The project intended to connect building experts from European research and academia to national decision makers and key stakeholders with a view to building ambitious and reality-proof policies and roadmaps.

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EXECUTIVE SUMMARY

A very low energy consuming building stock in the EU can become a reality. ENTRANZE[1] has created a policy 'laboratory' to develop and analyse the potential impact of national strategies and policy sets so that buildings can achieve this target. Thus, the core mission of ENTRANZE (Policies to Enforce the Transition to nearly Zero-Energy Buildings in the EU-28) was to assist policy makers in developing integrated, effective and efficient policy packages to achieve a fast and strong penetration of nearly Zero-Energy Buildings (nZEB) and renewable heating and cooling technologies (RES H/C) – with a focus on the refurbishment of existing buildings.

This report provides an overview of the activities and the results of ENTRANZE. The project covers the whole EU-28. However, not all activities were carried out at the same level of detail for all Member States (MS). The key target countries (Austria, Bulgaria, Czech Republic, Finland, France, Germany, Italy, Romania, Spain) cover more than 60% of the EU building stock and all important climate regions.

The research conducted over several years covered the following topics:

- Filling information gaps related to the EU building stock;
- Analysing stakeholder behaviour and acceptance of various technologies;
- Identifying cost-optimal technology configurations of renovation activities;
- Developing scenarios for the development of energy demand in buildings up to 2030;
- Deriving policy recommendations for local, regional, national and EU policy makers.

One of the outstanding elements of ENTRANZE was the in-depth communication process with policy makers through the setting up of policy group meetings and expert dialogues in all target countries. The main conclusions and recommendations of the project are:

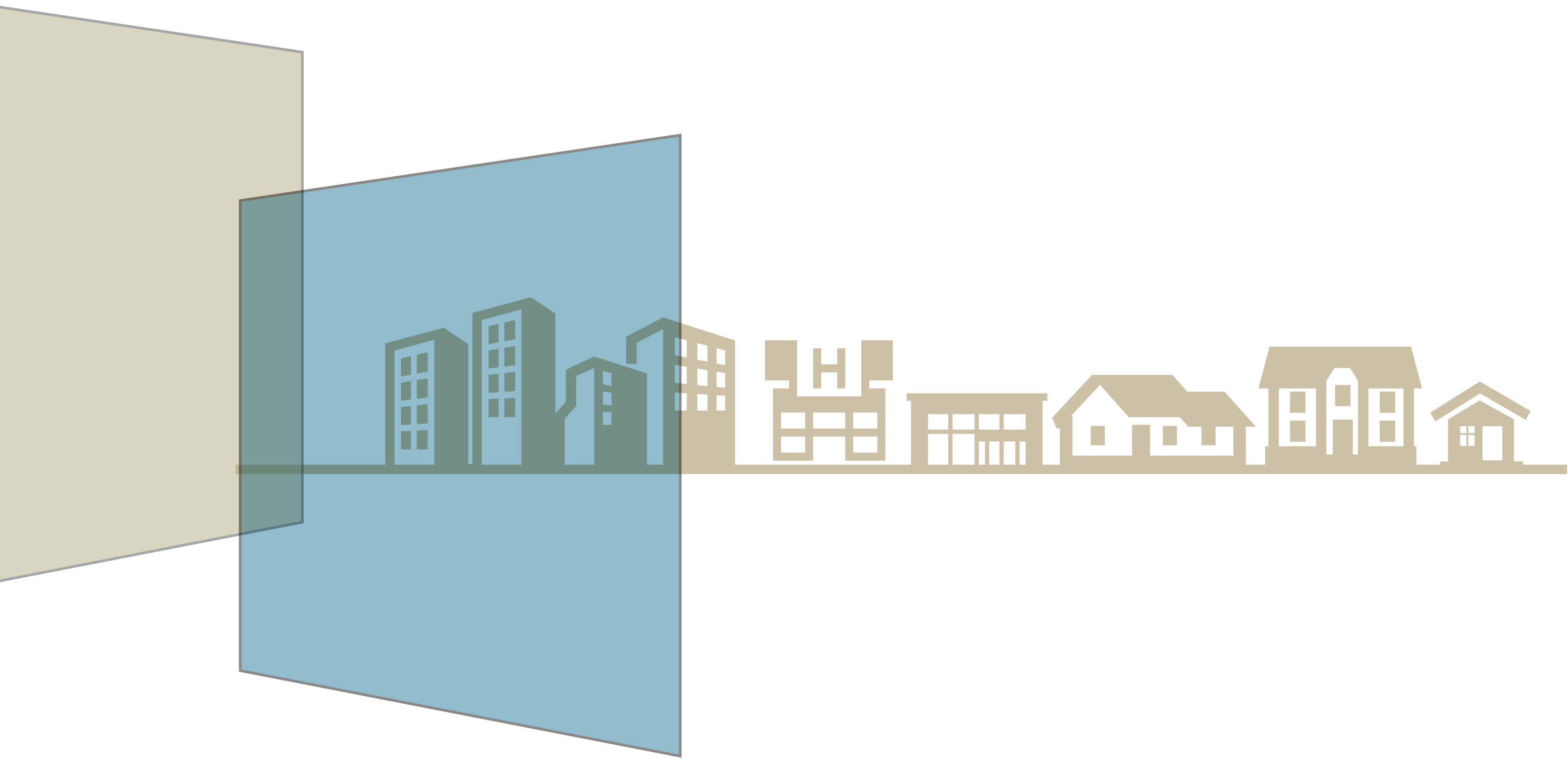
- Clear targets until 2050 for the energy performance of the building stock are required for the development of target-oriented policy packages. Up to now only a few countries have adopted such targets.
- A bundle of instruments is needed to properly address the heterogeneous target groups and technology-specific barriers. The focus on a single instrument is not sufficient.
- While a strengthening of regulatory measures is essential, there is at the same time the need for much stronger focus on compliance.
- There is a huge lack of data regarding renovation activities and the energy performance of buildings. There is a need for a building data observatory, in particular for monitoring policy impacts.
- The EPBD (recast)[2] was a first attempt to create a comparable framework for EU MS, however, further enhancement of the legislation is necessary.

[1] Policies to Enforce the Transition to nearly Zero-Energy Buildings in the EU-28, www.entranze.eu
[2] Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings (recast).

- In particular, an enhanced EPBD framework should make clear that cost optimality has to represent the absolute minimum requirements for existing regulations in the building codes. While nZEB energy performance levels should be cost-effective, they still have to be more ambitious than cost-optimal energy performance levels. Thus, an enhanced EPBD has to be very precise in asking MS to present plans to close the gap between nZEB target levels in 2020 and the cost-optimal levels of current building codes.
- The EPBD should also gradually increase the binding character of nZEB requirements for existing buildings. Thus, a clear definition of nZEB or deep renovation is also required.
- Consistency in terminology and timing between Directives and CEN standardisation procedures should be further enhanced.

In the end, the research conducted during the project offers policy makers a valuable toolkit and the know-how on how to use it effectively so that they can improve the situation of the EU building stock by achieving ambitious long-term energy savings and CO_2 reductions.

This report is a non-exhaustive source of information regarding the results of the research conducted during this project. It mostly offers hints and guidelines with respect to the project results. More information can be found on the project website and in the report “Policies to enforce the transition to nZEB: Synthesis report and policy recommendations from the project ENTRANZE.”[3].



[3] Available at http://www.entranze.eu/pub/pub-scenario

INTRODUCTION

The recast EPBD requires that from 2019 onwards all new buildings occupied and owned by public authorities are nearly Zero-Energy Buildings (nZEBs) and that by the end of 2020 all new buildings are nZEBs. Acknowledging the variety in building culture and climate throughout Europe, the EPBD does not prescribe a uniform approach for the implementation of nZEBs. Member States (MS) should draw up specific national roadmaps reflecting national, regional or local conditions. While it is necessary to improve the energy performance requirements of newly constructed buildings to nearly zero-energy levels, it is of key importance to deeply renovate the existing building stock towards highly ambitious levels, which are in line with long-term energy policy and climate mitigation targets. The EPBD requires that MS stimulate the progressive transformation of buildings that are refurbished into nearly Zero-Energy Buildings, though without a clear definition of nZEB renovation.

The intelligent design of integrated policy packages will be crucial for achieving ambitious energy and CO_2 savings in the building sector. Thus, the objective becomes to provide data, analyses and guidelines to design ambitious and reality-proof policies and roadmaps to renovate the building stock towards nZEB levels.

The final results of ENTRANZE's work addressing nZEB requirements and recommendations based on in-depth communication with policy makers, experts and other stakeholders are now available in this publication. The aim is to showcase innovative policy sets supporting nZEB and RES-H/C carried out in an integrated, effective and efficient way. The following chapters also contain valuable guidelines on how to provide favourable conditions and a framework for high-quality deep renovation measures.

Part I of this report lays out a somewhat detailed picture of the European building stock, its thermal efficiency, its energy consumption for space heating, hot water, cooling, lighting, the split between different heating and hot water systems and applied energy carriers. Furthermore, the structure of stakeholders, investors and users is presented alongside their preferences and interests with respect to building-related energy issues and their tendencies towards accepting nZEB technologies. All these elements establish a sort of profile of these actors. Finally, policies that foster the transition to nZEB should be based on a sound cost-optimal approach. An analysis of this approach was undertaken in order to identify cost-optimal levels for the refurbishment of residential and public buildings.

Part II goes further by showcasing the tools and models developed to support policy makers by filling the data gaps on the building stock and offering reliable parameters for an effective transition to nZEB. As such the Data Tool contains an in-depth description of building characteristics and related energy systems. The Cost Tool analyses the impact of a large number of renovation packages for specific building types in terms of costs and primary energy demand. It is a flexible tool for deriving cost-energy curves to assess cost optimal solutions which take into account specific climate zones, various energy price scenarios, and renewable energy generation. The Online Scenario Tool provides the outcomes of applying different sets of national policy packages on the refurbishment of existing buildings.

Part III focuses on policy analyses and policy scenarios for the transition to nZEBs both at EU and MS levels. A cross-country comparison also highlights the diversity of the cases analysed and the common ground on which to build future legislation at EU level.

Part IV derives policy recommendations for the target countries, in general at MS level, as well as for a further enhancement of the policy framework at EU level.

PART I:
DRAWING THE MAP OF THE EU BUILDING STOCK

FROM STAKEHOLDERS TO COST-OPTIMAL RENOVATION SOLUTIONS

Status-quo and dynamics of building stock and related energy systems

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 the building sector and its energy consumption. After years of research and by integrating relevant sources like Odyssee, the BPIE Data Hub, Tabula, Eurostat and other studies and country specific, national data, we are able to depict a fairly detailed picture of the European building stock, its thermal efficiency, its energy consumption for space heating, hot water, cooling, lighting and the split applied between different heating and hot water systems and energy carriers.

The results of these in-depth analyses of the dynamics, activities and challenges in the building sector and its energy consumption were used to build up a data foundation and inputs for modelling exercises.

As is well known, the EU building stock is quite heterogeneous. Nevertheless, the aim was to cover the whole building stock including different types of residential and non-residential buildings. However, there are still huge data gaps in some of these sectors, in particular in non-residential buildings. Moreover, in some countries the data might not be as complete as in others. The current situation reveals the following gaps in data streams which are essential when assessing the potential savings and effectiveness of national policies and measures:

- Data related to renovation activities are badly covered in MS official statistics. For instance, this is the case for the rate of renovated stock/area per year with their corresponding level of retrofit (annual expected savings, type of building components renovated, age of buildings retrofitted…) which are not well estimated.
- The level and quality of data related to non-residential buildings is significantly lower than the data on the residential stock. Non-residential buildings still represent on average 25% of the stock making them a crucial part of the equation. However, basic data, such as the breakdown of stock according to the age of construction or to branches and their corresponding U-values, are missing in several countries.
- Data on Building Energy Management Systems (such as the diffusion of smart metering or smart devices) are difficult to collect and we lack comprehensive statistics on their diffusion.
- Data on space heating and cooling systems are only partly covered to an acceptable extent. In particular there are uncertainties and data gaps regarding secondary heating systems, the use of biomass in particular in single stoves and the diffusion of air conditioning in the building stock.

Despite of these barriers and insufficient data sources, ENTRANZE built on all relevant existing sources to collect and present data on the EU building stock. Thus, relevant data which can impact the design of policies are available, so it is possible to trace some of the main characteristics of the current stock situation. For instance, one piece of the puzzle is the average age of buildings and the share of new buildings in the total stock (see Figure 1). This is a good indicator of the average efficiency of the building stock since the higher the share of recent dwellings, i.e. those built with more efficient standards, the higher the energy performance of the stock. Figure 1[4] shows that up to 40% of dwellings were built before 1945 in the UK or Belgium. In most EU countries, half of the residential building stock was built before 1970, i.e. before the first thermal regulations. Only in a few countries does the stock of recent dwellings, i.e. built after 2000, represent a significant share (e.g. over 30% for Cyprus or Ireland).

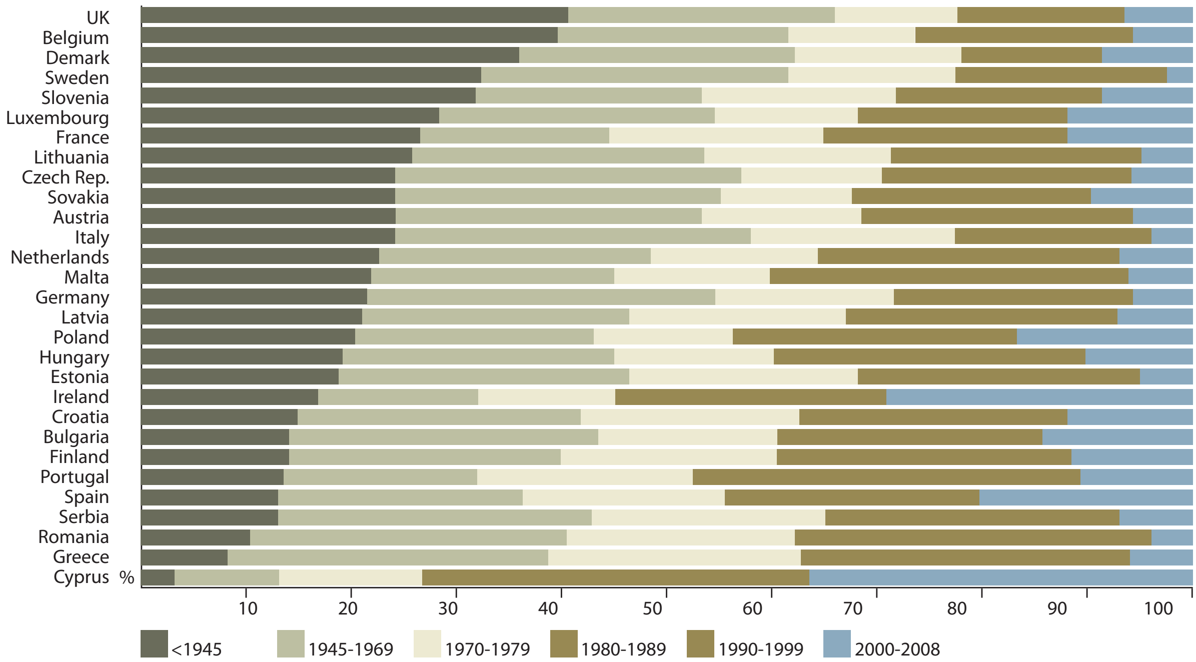


Figure 1. EU building stock by age, dwellings according to construction date.

Another piece of information that completes the picture is the type of dwellings which vary significantly across the EU. In the UK or Ireland, single-family dwellings are dominant (above 80%), while in Italy or Estonia multi-family dwellings represent more than 70% of the residential stock. At EU level, there is almost an equal share of both types of dwellings, with on average 47% of multi-family dwellings.

The penetration of heating systems also differs across the EU. Almost the entire housing stock in the majority of countries is heated by central heating systems, except in Southern countries where room heating is more frequent as the climate is more moderate (e.g. Malta, Cyprus, and Croatia). At EU level, 78% of the stock is heated by collective or central heating systems, and the remaining 22% corresponds to room heating.

[4] Base year of the data collection is 2008. This is due to the fact that when the database was set up, 2008 turned out to be the latest year available with a high reliability of data not too strongly affected by the economic crisis.

More than 75% of dwellings are heated by gas in the Netherlands or the UK, and by oil in Greece. Other countries have a more balanced distribution of dwellings by energy used for space heating. At EU level, 26% of the stock is heated through district heating, 23% by gas, 21% by electricity, 18% by oil, 10% by biomass and 2% by coal.

Total energy demand per m^2 is heterogeneous among countries in the residential sector: from 69, respectively 90 kWh/m^2 in Malta or Portugal, to almost 294, respectively 301, kWh/m^2 in Finland and Latvia, which is significantly higher than the EU average. These differences are partly due to climatic differences and partly due to the different energy performance levels of the building stock.

On the other hand, the distribution of floor areas by service sub-sector is quite homogeneous between countries. Offices (including private and public ones) represent on average a quarter of non-residential floor areas, as well as wholesale and retail trade buildings.

As for residential buildings, energy consumption per m^2 in services is also heterogeneous between countries: below 200 kWh/m^2 in Bulgaria or Denmark and above 500 kWh/m^2 in Belgium, Italy or Slovakia, with the average EU consumption reaching 360 kWh/m^2.

All these elements are taken into account when simulating the impact that some policy measures could have on energy consumption and are featured in an interactive data mapping tool[5]. Moreover, reports[6] briefly describing the building stock and other framework conditions (rate of new building construction, documentation of previous refurbishment activities, U-values, age of buildings, geometry, energy efficiency class, type of use, etc.) in each target country are available for consultation on the ENTRANZE website.

Profile of stakeholders: behaviour, preferences and interests

A picture of the EU building stock would not be fully complete without looking at the human factor. This section investigates the structure of stakeholders, user and investor groups and their behaviour, preferences and interests in nine target countries. These preferences relate to their willingness to invest in improving the energy performance of their dwellings through renovation. These behaviour patterns are important when developing successful policies because stakeholders react differently to policy measures and because behaviour-based energy saving programmes are the next natural step in achieving our energy demand-reduction targets. While primary data pertains to the countries mentioned above, the analysis of barriers and decision criteria indicated that differences in barriers and drivers are in many cases greater between building owner groups than between countries.

Our research[7] further pointed to some differences between countries, as well as between owner types, when considering their decision-making processes regarding energy saving measures targeting buildings. Mapping the decision-making processes of stakeholders requires a series of intertwined factors such as the structures of ownership, building types and level of professionalism with which buildings are managed. Research also highlights the existence of stakeholder-specific barriers and drivers which play a significant role in the decision-making process.

The barriers to energy renovation which need to be taken into account vary from financial considerations to organisational problems. Co-ownership of multi-family buildings is an issue that needs more attention because the measures taken so far to encourage energy renovation have proven to be ineffective. Owners are put in the situation of having to take collective decisions that might affect them in different ways. Before dealing with the lack of incentives, large-scale energy renovation plans should address

[5] More information on the tool in the following chapter and at http://www.entranze.eu/tools/interactive-data-tool
[6] http://www.entranze.eu/pub/pub-data
[7] Documentation on this topic can be further consulted at: http://www.entranze.eu/pub/pub-policies

organisational issues by putting in place step-by-step technical and organisational support moderated by external and unbiased professionals. Of course the situation with different types of stakeholders creates different conditions for the decision-making process but, overall, high initial costs and perceptions of a long payback time are common barriers.

A wide variety of criteria upon which stakeholders base their decisions concerning energy investments was also considered. Country case studies demonstrate that almost all building owners prioritise the initial cost in their decision-making process. This is due both to the lack of reliable and accessible financial analysis and to genuine uncertainties about other financial indicators for which there are no guarantees. On the other hand, energy cost savings and, even more so, improved comfort are major drivers of renovation in several countries. But by adding government support programmes into the mix there is a possibility to influence even more the type and scope of energy improvements.

The differences in ownership structure are still much greater in multi-family buildings. This variety is displayed below and highlights the fact that some countries have a predominant share of owner-occupancy in apartment buildings (Table 1). Moreover, the structure of decision-making within owner-occupied apartment buildings varies greatly.

Table 1 Share of owner-occupancy in multi-family housing and required majorities for decisions

	Share of owner-occupied, % of multi-family dwellings	Type of ownership[8]	Required majority for decisions on renovations, %	Other factors influencing renovations
Austria	23	unitary system	>50% of shares, but minority rules	Mandatory renovation fund usually not big enough. Joint loans have a big administrative burden.
Bulgaria	90	condominium ownership/ unregulated	>67% (of area)	Almost all buildings do not have a homeowners' association. When no homeowners' association exists, each owner needs a separate loan.
Czech Republic	79	condominium ownership	>75% of votes	Banks usually require that all apartment owners mortgage their apartments for the loan.
Germany	24	condominium ownership	>50% of shares	Mandatory renovation fund (1% of value of building). Taking out a loan can require a mortgage by all residents.
Finland	50	housing company (similar to unitary system)	>50% of shares	The housing company can take out a loan of its own, once the majority of owners have agreed to it.
France	26	condominium ownership	>50% of shares	Taking out a loan can require a mortgage by all residents.
Italy	65	condominium ownership	>50% of shares (for energy investments)	Dissenters can move to delay the implementation of decisions with significant financial consequences.
Romania	96	condominium ownership	>67%	Taking out a loan can require a mortgage by all residents.
Spain	86	condominium ownership	> 50% of shares	Can be less for renewable energy (1/3), but those voting against cannot be charged. Taking out a loan can require a mortgage by all residents.

[8] The unitary system refers to an undivided apartment building, in which owners own shares. Condominium ownership refers to a system where the owners own their dwelling and all owners jointly own the common parts and the land (Lujanen 2010).

Considering these discrepancies in decision-making processes, possible solutions for dealing with these at the policy making stage are suggested. For example, the engagement of owner-occupants is necessary and further legislation should be drafted in this regard. But in order to really improve the current situation there is a need for a combination of well-designed advice schemes and the establishment of local and regional networks of qualified service providers. Furthermore, public advice should be strengthened through public-private finance schemes which at this moment pose a problem. Currently, owners do not consider investing in renovation due to the long return rates with no guarantees.

However, financial support schemes are only part of the solution, because they must be mixed with advisory services, technical support and supplier certification in order to give particularly good results. Moreover, policy measures should take advantage of "windows of opportunity" such as a change of ownership, the end of a tenancy, or when other work is being done on a property. Timing is of the utmost importance in planning renovations.

Cost-optimal analysis of renovation solutions towards nZEB standards

The research carried out within this project includes a comprehensive analysis of cost optimal renovation levels of residential and public sector buildings. To be consistent with the EU process of the EPBD implementation (Directive 2010/31/EU), the research adopted a comparative methodology framework established by the European Commission to calculate cost-optimal levels of minimum energy performance requirements.

For each building type in the different countries, cost-energy curves (representing global cost versus (net) primary energy demand of a large variety of renovation options) were established and thoroughly assessed, based on a selection of renovation packages leading to cost-optimal and nZEB levels (covering both energy efficiency measures and renewables). One of the main outcomes of this research, the *Report on Cost-Energy curves calculation*[9], presents an assessment of curve sensitivity with respect to the main economic input data and the calculation period. The report analyses possible targets of (net) primary energy demand relating to cost-optimal and nZEB solutions. From a deep analysis of all cost-energy clouds, complete refurbishment solutions were selected, suitable for the considered energy performance targets.

To generate the cost-energy clouds, a major effort was made to pull together all the required data. An important number of national experts contributed to the definition of reference characteristics for buildings. For each target country a technology choice was made for the building envelope and building system, taking into account widespread renovation practices. For each considered technology, a cost database was built[10].

Another database[11] was also set up containing all techno-economic data of technologies and building solutions variants, including 20 to 30 packages of energy efficiency measures selected according to cost-optimal calculations. These energy-cost matrices allow a comparison in terms of the initial investment cost and (net) primary energy consumption of the most suitable packages of energy efficiency measures for each climate and building type. The results of cost-optimality calculations were used to define the level of light, medium and deep renovation as renovation options in the model-based scenario development, where deep renovation corresponds to a level which is in the minimum energy zone (i.e. could represent the nZEB standard), medium is in the cost-optimality zone and light represents current practice.

Hence, for every target country and building type, the main results consist of the definition of possible targets of (net) primary energy representative of the "cost optimal" (a) and "nZEBs" (b) solutions for

[9] http://www.entranze.eu/files/downloads/D3_3/131015_ENTRANZE_D33_Cost_Energy_Curves_Calculation_v18.pdf
[10] Cost Tool accessible at http://www.entranze.eu/pub/ pub-optimality
[11] http://www.entranze.eu/pub/pub-optimality

building renovation. In addition to these two energy/costs targets, two further levels (c and d) of possible renovation were defined and expressed as fixed percentages of reduction in (net) primary energy with respect to the base refurbishment level[12] with minimum performance thresholds. More precisely, the following four targets were considered:

a. Minimum global cost: possible cost-optimal target,

b. Minimum (net) primary energy: possible nZEB target,

c. 50% of reduction of (net) primary energy with respect to base refurbishment level with a threshold of 100 kWh/(m²y),

d. 75% of reduction of (net) primary energy with respect to base refurbishment level with a threshold of 50 kWh/(m²y).

For each target a complete refurbishment solution was selected, which corresponds to one building variant among all calculated ones (in other words, to one dot in the cost/energy clouds developed) like in the example below.

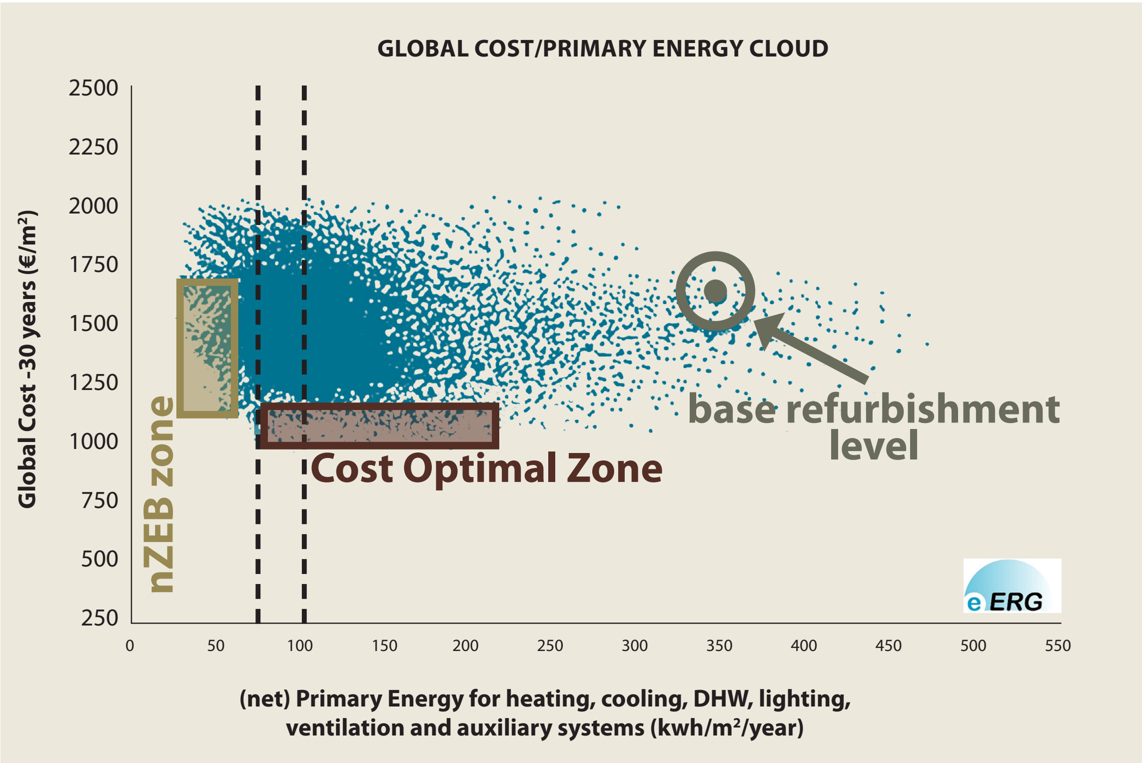


Figure 2. Example of cost/energy cloud with some target zones indicated

[12] The base refurbishment level (BRL) corresponds to the adoption of renovation measures only for aesthetic, functional and safety reasons of the same building components considered for renovation packages. In BRL the old generators and systems are replaced by components with the same technology and with the efficiency of the current state of the market."

Following this analysis we can spot some very general lessons learned in all countries and for all types of buildings.

In general, the minimum global cost zone is characterised by a medium level of efficiency for envelope strategies, probably due to a better balance between initial investment costs and energy savings. The cost-energy curve is very flat in the cost-optimality area. This means that the cost-optimality criteria as such generates only a moderate stimulus to increase the requirements of the building codes, if not solutions in the left part of the cost-optimal zone are selected. Thus, it is highly important to shift the requirements to the left hand side of the cost-optimality zone in order to provide a real impact on the energy performance of buildings with no or very limited additional costs.

For the single family houses it is quite evident that, also within the minimum global cost zone, the penetration of renewable energy technologies is more effective in Mediterranean climates (characterised by higher solar radiation) than in other target countries. A similar trend applies to office buildings, but with fewer differences between the South and North of Europe. This is due to a more relevant role played by photovoltaic systems in a building type characterised by higher electricity consumption for auxiliary systems and mechanical ventilation.

Furthermore, net primary energy saving percentages for cost-optimal and nZEB targets are closer together in residential buildings than in office and school buildings. Multi-family houses show lower energy saving potential in respect to single houses, due to geometric limits (e.g. lower available roof surface for solar systems with respect to total floor area relative to a single house).

In many cases, the global costs of selected nZEB solutions (minimum net primary energy) are lower and more advantageous than global costs of corresponding base refurbishment levels. Generally, for the buildings selected in the cost-optimal zone and the nZEB zone, the initial investment costs are higher with respect to base refurbishment levels. This means that the building with a minimum global cost (over a time lapse of 30 years) and a higher initial investment energy savings, plays a fundamental role.[13]

The research developed in order to improve the cost-optimal methodology is also meant to provide input for the next recast of the EPBD and to push for more innovation on the subject. This topic is further developed in Part IV of this study which gives some guidance to all relevant stakeholders.

[13] For more details on the cost-optimal methodology and the results of the calculations consult http://www.entranze.eu/pub/pub-optimality

PART II:
TOOLS AND MODELS

During the ENTRANZE project several databases and tools were developed in order to facilitate a quick, easy and tailor-made access to national and comparative international indicators. The databases and modelling tools can also act as a comprehensive basis for decision-making processes both for policy makers and other stakeholders.

As such three tools were developed:

- The **Data Tool**[14]: contains an in-depth description of the characteristics of buildings and related energy systems in the EU-28 and Serbia.
- The **Cost Tool**[15]: is a powerful, flexible instrument to analyse the impact of a large number of renovation packages for specific building types in terms of costs and primary energy demand.
- The **Online Scenario Tool**[16]: provides the results of alternative scenarios for the development of the building stock and its energy demand in the EU-28 (+ Serbia) up to 2030.

[14] Available at http://www.entranze.eu/tools/interactive-data-tool
[15] Available at http://www.entranze.eu/tools/cost-tool
[16] Available at http://www.entranze.eu/tools/scenario-results

Data Tool – Mapping the EU building stock

As described in the first part of this report, the required background data was strongly built on existing studies and surveys from statistical offices. The EU-wide typology includes data for building construction characteristics and installations in the residential buildings, which is a valuable source of initial data for further generalisation and the energy assessment of the building stock. For instance, building typology and climatic data were used to carry out detailed building related analyses and investigations of the cost-optimal levels of nZEB technologies. Maybe the key function of this tool was the support for the policy assistance process and the role it played in communicating results to various stakeholders. In the end the tool depicts a clear picture of the European building stock.

Figure 3. Data Tool showing total unit consumption per m² in buildings

Cost Tool – Defining a cost/energy balance

This spreadsheet allows assessment of the policy impact of renovation packages in existing buildings, by cost/energy curves and clouds. This tool focuses on building renovation and provides a comparative analysis expressed as a dot plot (cloud) graph of global cost versus (net) primary energy of various renovation options. It produces both graphical and numerical outputs.

Furthermore, the Cost Tool considers different variables in its calculations of the cost/energy cloud for a specific building in different climatic contexts. These variables range from choosing the timeframe, taking into account different economic perspectives and allow a comparison of primary energy with the minimum limits for energy performance requirements in force.

The tool also integrates default energy price scenarios over the period of calculation in the different countries considered within the cost-optimality calculations of the project. Moreover, compiled data set files are provided containing all input data of the reference buildings for the various climate conditions considered within the cost-optimality calculation.

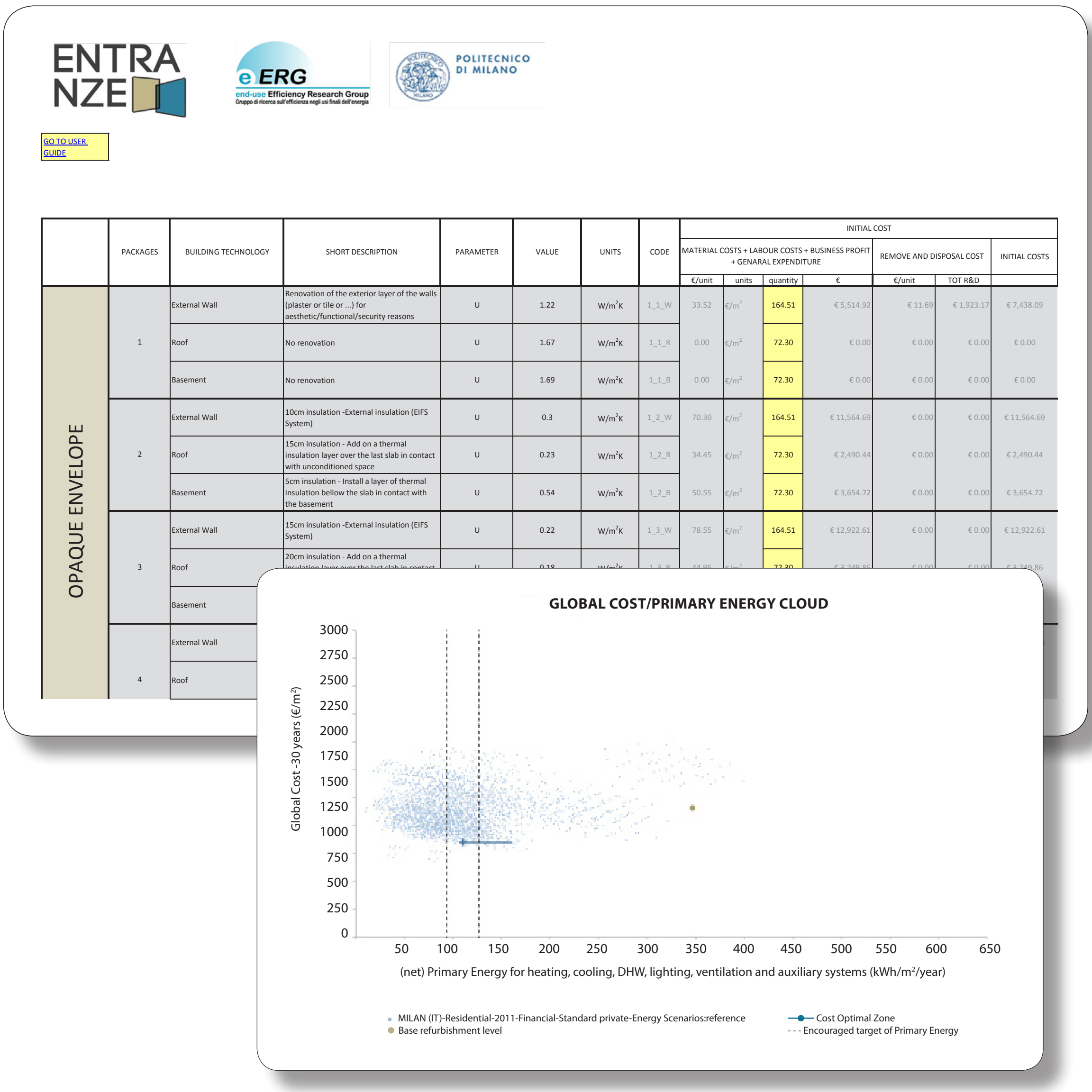


Figure 4. Illustration of the Cost Tool

Online Scenario Tool – From design to implementation

This tool presents model-based scenario results about the future energy performance improvement and RES-H/C in the EU building stock while also assessing the corresponding costs, expenditures and benefits. The overall objective of the scenario development was to analyse the effects of different policy packages on the diffusion process and the building-related energy demand, taking into account economic, technical, non-technical and institutional barriers and rebound-effects. The scenarios were developed up to 2030 with a particular focus on the year 2020, according to the targets set by the EPBD (recast), the RED[17] and the EED[18].

The national policy scenarios were defined according to the specific needs, ideas and suggestions of the policy makers and stakeholders included in the national discussion processes that took place at every key stage of the project in the target countries.

The scenario calculation was done by a coupling of the well-established models POLES[19] and INVERT/EE-Lab[20]. Thus, POLES delivered the projection of key input data concerning the overall energy system like end-user energy prices and of the power mix, so as to derive the average primary energy and emission factors of power generation in each country (respectively, toe/kWh and gCO_2/kWh). Invert/EE-Lab was used to derive scenarios for the space heating, hot water cooling and lighting energy demand scenarios and corresponding technology mix.

Figure 5. Illustration of the Online Scenario Tool

[17] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

[18] Directive 2012/27/EU of the European Parliament and of the Council on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, 2012.

[19] The POLES model provides a complete system for the simulation of world energy demand and supply and can be used for the long-term economic analysis of energy markets, power sector investments or sectorial impacts of climate change mitigation strategies. The model is driven by two macro-economic parameters as inputs (regional GDP and population growth) and provides forecasts for regional and sectorial energy balances, energy prices and key energy and economic indicators.

[20] The model INVERT/EE-Lab has been used in several European and national projects for scenario analyses of the RES-H/C sector in various EU countries. The model is based on a detailed disaggregated description of the building stock and its heating, cooling and hot water systems.

PART III:
POLICY ANALYSIS: STATUS-QUO AND SCENARIOS

The starting point for deriving recommendations was a thorough analysis of the status quo of energy efficiency policies in the building stock and in particular the related implementation of the EPBD, RED and EED in different Member States. A special focus was put on the nZEB national plans according to Article 9 EPBD. This led to a comprehensive report entitled "Overview of the EU-27 building policies and programmes and cross-analysis on Member States' nZEB plans"[21].

One of the main objectives of ENTRANZE was to elaborate policy packages for the target countries. These packages were created within policy groups[22] and analysed in scenarios derived by the model Invert/EE-Lab. The results were played back to the policy groups and revised according to the discussions. The resulting scenarios and corresponding discussions were a key element for deriving recommendations.

In the following chapters the nZEB plans of Member States are summarised; secondly an overview of scenario results and derived recommendations in the target countries is given; and finally the scenario results for EU 28 are described.

nZEB plans: definitions and instruments

The approaches in defining the nZEB targets (i.e. the interim target by 2015 and the 2020 target) vary largely among the national plans. Some EU MS define nZEB in terms of minimum energy performance requirements (e.g. Brussels Region-Belgium, Cyprus and Denmark), other MS decided to set requirements on the basis of energy labels (e.g. Bulgaria, Lithuania, Czech Republic). In some cases, the nZEB national definitions include additional minimum requirements for the renewable energy share (e.g. Bulgaria, France and Cyprus), while in a few countries the nZEB target is defined as the minimum requirement for carbon emissions of the building (e.g. the United Kingdom and Ireland, the latter having two indicators, one on carbon emissions and the other on energy consumption). Furthermore, in several national plans, the nZEB targets are based on or compared to the cost-optimal levels resulting from the implementation of Art. 3 from the recast of the EPBD.

A summary of cost-optimal calculations and nZEB approaches in the ENTRANZE target countries is provided in chapter 5 of the ENTRANZE report *"Policies to enforce the transition to nZEB: Synthesis report and policy recommendations from the project ENTRANZE".*

14 Member States had published the national plan by October 2013, and only 12 MS did so in the English language[23]. These plans have been evaluated in terms of policies and instruments. All MS include in their

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[21] Available at http://www.entranze.eu/pub/pub-policies
[22] "Policy groups" have been set up in all target countries. Members have been political decision makers and relevant experts. They met regularly and contributed to all project-phases, especially to the policy sets and to the recommendations.
[23] Belgium, Bulgaria, Cyprus, Denmark, Finland, Germany, Ireland, Lithuania, the Netherlands, Slovak Republic, Sweden and the UK

national nZEB plans measures to support the renovation of the existing building stock. These measures vary from one country to another and include one or more of regulatory, economic (and financial), Energy Performance Certificates (EPCs), information and advice, educational and training or demonstrative measures. To enrich and structure the discussion about policy instruments ENTRANZE provided a toolbox of policies and described various types of instruments and their main characteristics (see chapter 5 of *"Policies to enforce the transition to nZEB: Synthesis report and policy recommendations from the project ENTRANZE".*

The instruments and measures listed in the national plans do not mainly focus on nZEB, but on energy efficiency in the building sector in general. The majority of these measures will be reasonable steps towards more nZEB in the future. However, by October 2013 only three out of 12 MS reported measures and activities suitable for increasing the energy performance of buildings towards the nZEB standard (Belgium, the Netherlands, and Germany). In most of the plans evaluated, the measures named so far will not be sufficient to increase the number of nZEB significantly. Some instruments might even create lock-in effects that hamper the transformation of buildings toward nZEB. The latter may happen if the refurbishment of buildings is supported without a clear requirement to meet certain high energy standards.

The full and more detailed results are documented in the ENTRANZE reports "Policy pathways for reducing energy demand and carbon emissions of the EU building stock until 2030"[24] and "Policies to enforce the transition to nZEB: Synthesis report and policy recommendations from the project ENTRANZE".

Scenario results for target countries

The following pages summarise the key results and recommendations for each target country. The results and policy recommendations below were derived from the modelling exercises conducted within the ENTRANZE framework and consider input data from the tools already mentioned and the discussions within the policy and expert dialogues.

The description of country results below shows that policy sets chosen by the ENTRANZE target countries differ widely according to the country-specific needs and their current political framework. For each target country, three specific policy sets have been developed. The first policy scenario reflects more or less a business-as-usual scenario with implementation of the existing policy framework. The second and third include a more innovative and more ambitious implementation of policies leading to a stronger reduction of energy demand, a higher share of deep ("nZEB")[25] renovation and faster reduction of CO_2-emissions due to a stronger penetration of RES-H technologies. Since the three policy sets derived are based on very concrete policy suggestions and stakeholder discussions, they should definitely not be understood to be the maximum possible ambition level. Instruments from various categories have been investigated in the different scenarios. Many countries included information and/or coaching of building owners in their policy sets. Also the tightening of the building code and the enhancement of the financial support have been selected in many cases.

Examples for innovative instruments selected for model-based analysis are:

- Energy efficiency dependent property tax (AT),
- Energy and/or CO_2 taxation (FI, FR),
- Mandatory renovation in case of real estate transaction, energy refurbishment obligation (FR, ES),
- Implementing enforcement and compliance measures (DE),
- RES-use obligations (DE, IT).

[24] Available at http://www.entranze.eu/pub/pub-scenario

[25] The term "nZEB" renovation is not yet clearly and unambiguously defined. In "Overview of the EU-27 building policies and programmes and cross-analysis on Member States' nZEB plans", an approach with different layers of "nZEB" renovation is proposed. In ENTRANZE, we followed this idea by taking into account the results from the cost-optimality calculations for defining different levels of renovation, including an ambitious one, which could be called "nZEB" renovation.

It can be seen that different types of instruments have been selected for further analysis. Instruments focusing on information and the coaching of building owners in a new dimension are among the most often taken into consideration. Regulatory instruments considered for recommendation are, besides tightening the building code (ES), instruments implementing mandatory renovations (ES, FR). Economic instruments mentioned are tax-based as well as grants and soft loans. Among the tax-based instruments are the increase of the energy tax or the implementation of a CO_2-tax (FR) as well as tax deductions (IT). Another important group of instruments are cross-cutting instruments. Examples are the introduction of a scheme for nZEB renovation of public buildings (RO) and the implementation of a long-term dialogue between relevant stakeholders (CZ). Recommendations that are applicable for all Member States are presented in more detail in the following pages.

We can see that the maximum reduction of final energy demand reached in the more ambitious policy sets 3 in 2030 compared to 2008 is about one third. Moderate ambitions in most countries only lead to energy savings from 2008-2030 below 23%, and in four out of five target countries even below 15%. Ambitious instruments as usually chosen in Policy Set 3 are needed to reach significant reductions of final energy demand of the building sector. However, since for some countries no clear policy targets are available, it is not clear whether policy set 3 may lead to achieving ambitious long-term targets. Rather, at least for some countries we consider that even policy set 3 is not sufficient.

Austria

All nine federal states in Austria, which have the main responsibility for building codes and RES-H, have implemented substantial, mostly financial support programmes for residential building construction. Within these programmes, the application of energy efficiency criteria has increased in recent years. Moreover, efforts to harmonise building codes have led to some progress and also to a joint agreement on the national nZEB action plan. However, despite these efforts and a substantial increase of RES-H in some regions, building renovation activities have remained at a moderate level for years.

The Austrian policy group decided to investigate the potential impact of innovative policy packages mainly based on the following elements, in addition to the existing ones:

- A **property tax** depending on the energy efficiency of buildings;
- **Intensified coaching of building** owners before and during a thermal building retrofit;
- **Innovative financing** of thermal building retrofit by initiating public/private funds providing the financial support for building renovation at low interest rates. Partly, increased tax revenues from the property tax could also be used as a source for this fund.

Three model-based scenarios were developed: (1) a business-as-usual (BAU) scenario with the current schemes remaining constant, (2) a scenario with a new policy approach described above, however, with a low intensity and (3) a new policy approach with a higher policy intensity.

Figure 6 shows the results of the ENTRANZE policy scenario modelling. While the BAU scenario leads to about 20-24% reduction of final energy demand and almost 25-30% of delivered energy demand (under moderate and high energy prices) from 2008-2030, the additional measures in scenario 2 induce only a very moderate additional reduction of energy demand. Thus, new policies as such do not guarantee substantial progress. They have to be designed and implemented in an ambitious way. The third scenario indicates a significant increase of renovation activities and related energy performance. However, it has to be taken into account that the implementation of a property tax related to the energy efficiency of buildings would require a comprehensive building registry and corresponding energy performance certificate registry. Thus, corresponding activities have to be enhanced. Moreover, there is a need for further work and the elaboration of coaching of building renovation activities. Corresponding pilot projects should be intensified. The options on how to initiate funds to finance building renovation needs to be investigated more concretely. Although building codes and the regulatory framework were not the focus of the scenario work, the comparison with other countries revealed that the Austrian nZEB definition is not at the forefront of the European standard. Thus, stricter regulatory measures would be required to achieve ambitious long term climate and energy policy targets.

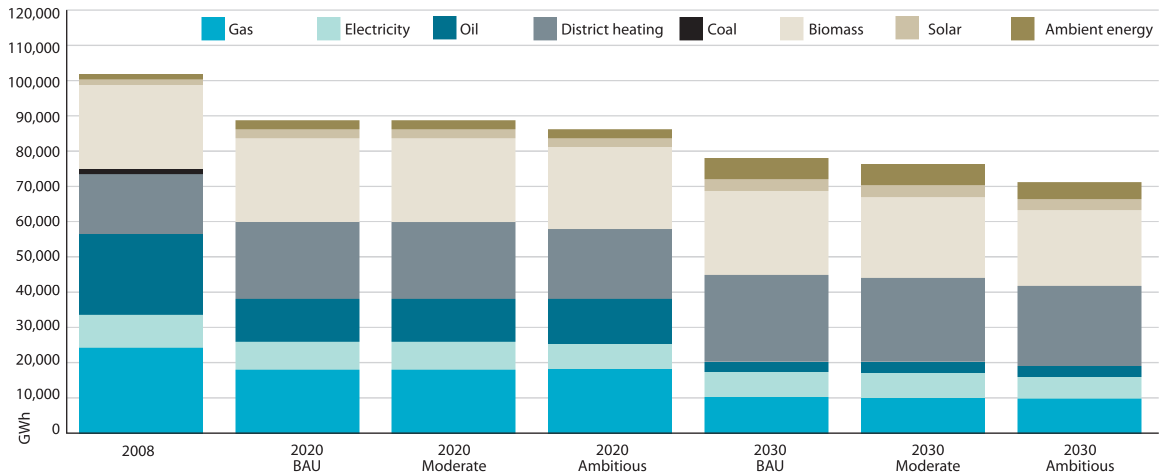

Figure 6. Building energy demand for space & water heating. Austria, high price scenario

Bulgaria

The building stock in Bulgaria has had a very high level of energy consumption for heating and also for cooling in the recent years. First legislative initiatives for heat energy conservation were introduced in 1961, strengthened for the panel buildings in 1979 and for all buildings subsequently in 1987, 1999, 2004 and 2009. The official approval of the national definition for nZEBs and an additional increase in the energy efficiency requirements for new buildings and also in the event of a major renovation are expected by the end of 2014. The economic incentives to support the national policy for energy efficiency and the use of RES in the building sector up to now were limited mainly to public buildings and multi-family apartment blocks. The current legislation does not address barriers relating to the renovation of condominiums.

The main issues discussed during the policy group meetings were related to problems of the renovation process (such as the quality of the renovation work) and the importance of introduction of green building design practices and principles into the national legislation. The issues of financial support and incentives for the renovation of buildings were also highlighted as a critical factor for accelerating the rate of rehabilitation of the existing stock. The main focus of the policy sets were on the existing building stock and how to ensure good quality and quantity of renovated buildings.

The Bulgarian ENTRANZE Policy Group elaborated the following policy principles to be proposed for the national policy for the building sector:

- Introduction of **building codes with stronger requirements** for energy performance characteristics and use of RES in one stage in 2015 or in two stages – in 2015 and in 2020.
- Ensuring **financial support** – the use of currently available local, national and EU funds and in addition the mobilisation of public private partnership initiatives (ESCO and others), soft bank loans and further tax reduction measures. As the Bulgarian government decided to implement a white certificate scheme and it is stated in the draft energy law, the effective employment of the system of energy saving obligations for the energy suppliers was also considered to be an important financial factor and stimulus. The white certificates for measures in the building sector could provide additional financial resources for renovation of the existing building stock.
- **Capacity building and training for professionals** were also proposed to guarantee the quality of the construction and installation process and ensure sustainability of the results.
- **Information and awareness rising campaigns** are important to overcome many market barriers for some modern and advanced technologies and to ensure the good quality of renovation work.

Figure 7 shows the results of the ENTRANZE policy scenario modelling for Bulgaria. Compared to the existing policy scenario (PolSet1), the "medium term policy" scenario (PolSet2) and "policies in two steps+" (PolSet3) show good results for the period up to 2030. It is expected that less electricity will be used for heating and DHW as the share of natural gas, solar thermal and ambient heat will increase. The scenarios foresee investments between EUR 6 and EUR 14 billion in the building sector for the period 2030.

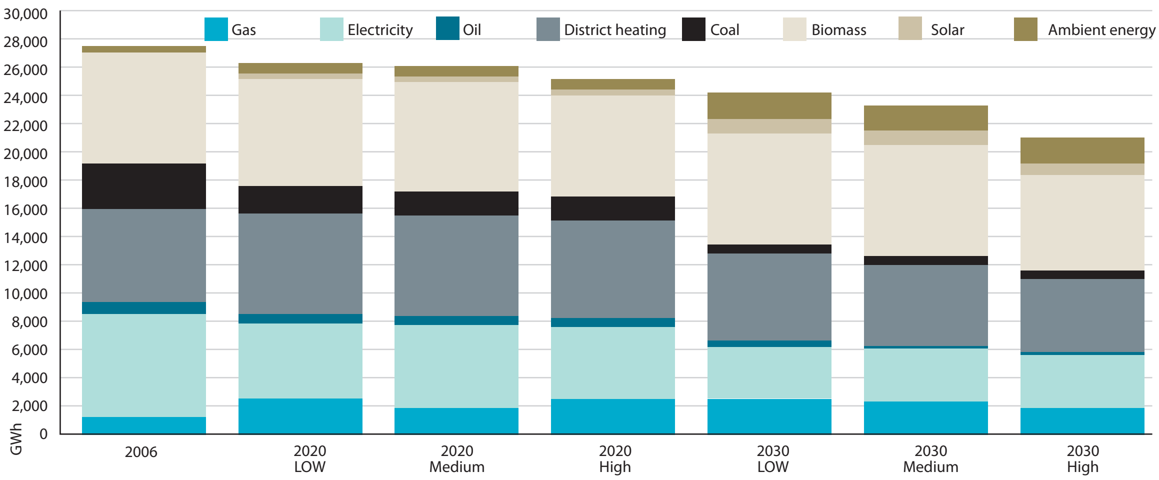

Figure 7. Building energy demand for space & water heating. Bulgaria, high price scenario

The policy recommendations for Bulgaria include the introduction of building codes with stronger requirements for energy performance characteristics and use of RES for new buildings and also in the event of major renovation. This should be implemented in two phases in 2015 and in 2020. The financial support from the EU funds is limited and additional resources should be mobilised – national funds, private resources (through public private partnership) and bank resources (soft loans), as tax reductions are a workable option which are already giving some results. Important policy instruments are related to ensuring the quality of renovation, and information and awareness-raising campaigns targeted at the relevant stakeholders.

Czech Republic

In the Czech Republic, energy efficiency in buildings requirements are being revised since their introduction in late 1960´s. Hand in hand with implementation of the recast EPBD into national legislation, the strengthening of minimum standards for buildings has been done within updates of the energy efficiency law as well as providing a regulation in 2013. The introduction of requirements on nZEBs was a part of this update. Future updates are expected after gaining relevant experience under the existing legislation.

These crucial conclusions were developed:

The consistency of detailed model outputs with the **National Energy Efficiency Action Plan[26] and the State Energy Policy[27]** in terms of input data used for the modelling and validated results on consumptions for past years from 2008 are important for further policy making processes. The modelled scenarios well reflect this point.

Although keeping the present system of supporting schemes for a wide range of building types and keeping the volume of funding (scenario 2) can lead to fulfilment of EED requirements, still higher savings and efficiency can be achieved by implementation of a more ambitious approach (scenario 3) by the earlier introduction of the nZEB standard. Such acceleration would be feasible because the legal national requirements on nZEBs are not as strict in the country at present. Figure 8 shows the development of final energy demand in the Czech Republic by energy carriers that relates to the different policy scenarios defined. The three policy sets relate to basic regulatory framework fulfilment without the involvement of support schemes (Scenario 1), "business as usual" that takes into account existing support schemes in the same intensity (Scenario 2) and the third policy set (Scenario 3) that involves mandatory requirements[28] for nearly Zero-Energy Buildings in 2014 already, in addition to the previous scenario. The decrease in natural gas and coal demand is visible as well as the increase in the share of ambient energy (i.e. renewable sources). The policy sets reflect mainly the direct subsidy programmes as these already have a considerable tradition.

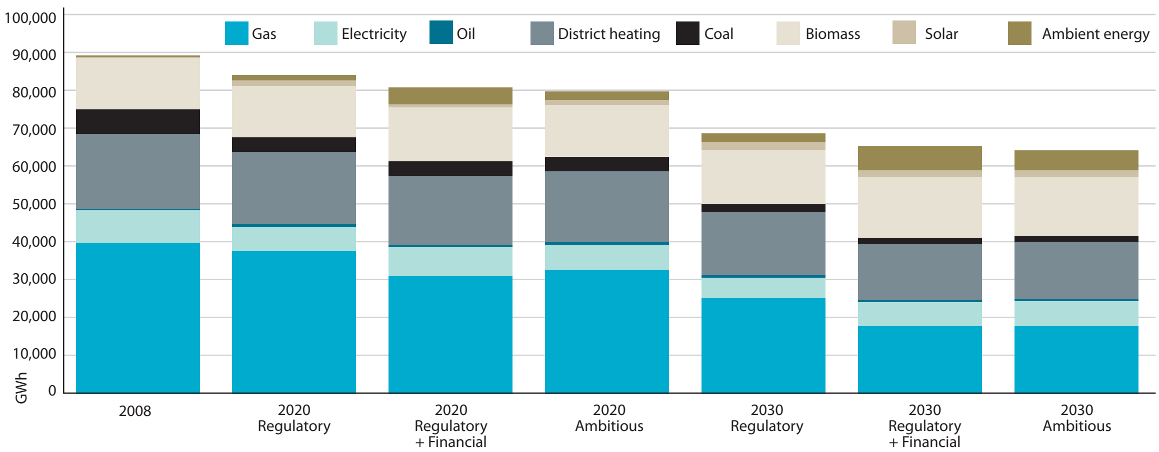

Figure 8. Building energy demand for space & water heating. Czech Republic, high price scenario

The differences in the scenario results defined above lead to two main recommendations:

- Focus shall be put on increased renovation of the existing building stock in order to intensify it and support complex solutions.
- Revision of requirements on nearly Zero-Energy Buildings as their effect on energy performance (compared to present requirements on buildings) is quite low and the nZEB level is not ambitious enough.

Further, continuous awareness-raising through information campaigns among the general public and experts will help to support demand-side to spur on energy-efficient solutions and quality. The energy performance contracting method for energy efficiency measures should be broadened. Additionally, a data collection system (e.g. from energy performance certificates) has to be established.

[26] http://ec.europa.eu/energy/efficiency/eed/neep_en.htm
[27] Update of the State Energy Policy is being prepared in 2014
[28] Energy Management Act 406/2000 Coll. and Regulation 78/2013 Coll. on energy performance of buildings

Finland

Finland was one of the first countries to introduce stringent energy standards in the building code in 1976, with several revisions in the subsequent decades. The most recent revision has been the introduction of specific energy efficiency standards for buildings undergoing renovation in 2013. Because of this, policy makers would like to first test the effects of this regulation before introducing new regulatory instruments.

However, the Finnish ENTRANZE Policy Group was eager to evaluate two new ideas:

- A **target-group specific approach**, where separate instruments are implemented for single-family homes (most outside the district heating system) and multi-family homes and other larger buildings (most served by the district heating system). Single-family home owners gain support for changing their heating system from electric and oil to heat pumps or biomass, which are cost-effective. Multi-family buildings gain tailored advice when approaching the time for major renovations. Both groups are offered private finance with loan periods that correspond to the lifetime of the renovated building components. Technology procurement is used to reduce the cost of certain measures.
- The other idea evaluated was a **tax on fossil fuels, district heat and electricity**, which raises the price paid by the consumer by 50%. Economic instruments are popular in Finland and it was considered interesting to see what they can deliver in principle with an extreme scenario.

Figure 9 shows the results of the ENTRANZE policy scenario modelling. Compared to the existing policy scenario (PolSet1), the target-group specific scenario (PolSet2) shows good results. Energy demand is reduced and a large share of purchased energy is replaced with ambient energy, i.e., energy gained from the ground and air via heat pumps. However, this requires technology procurement to develop cost-effective solutions for single-family homes lacking central heating. Scenario 3 also reduces energy demand, but is not feasible in practice and could lead to social problems. Moreover, this scenario outcome also requires additional measures to restrict the use of biomass in urban areas, which can cause local air pollution.

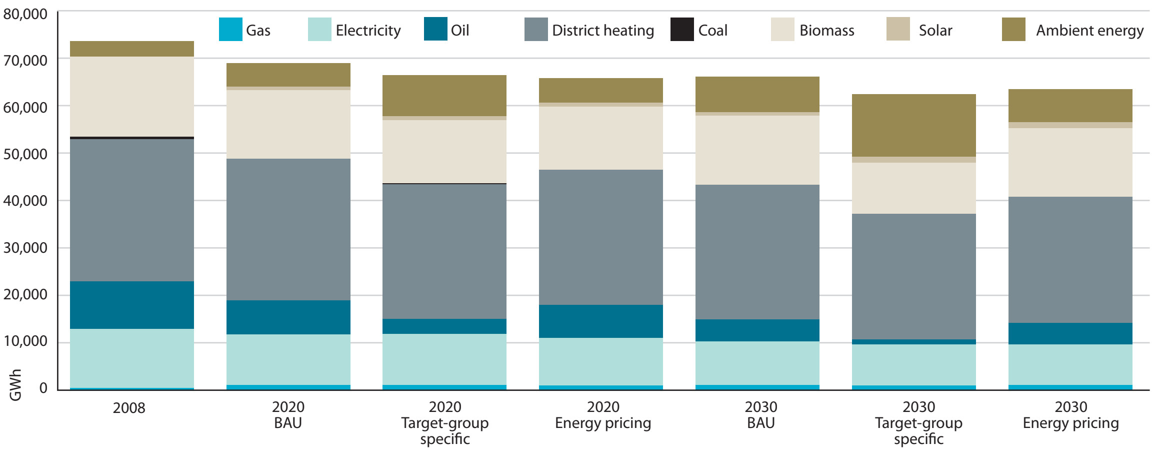

Figure 9. Building energy demand for space & water heating. Finland, high price scenario

The scenario exercise was helpful in showing what additional measures are needed to reach the desired policy outcomes, such as technology procurement to bring down the cost of solutions. It also highlighted the importance of renovation funds, considering the future needs for renovation.

France

Despite five updates of building codes since 1974 for new construction and the fact that the last building code implemented (RT2012) is one of the most stringent in EU[29], the specific energy consumption per m² and per heating degree days in buildings in France is still significantly higher than in other EU countries. Indeed, buildings built before the first regulation still represent today 64% of the stock. Many economic incentives for building renovation have been implemented, such as subsidies or tax credits, and still the renovation rate remains very low. Therefore, the scenarios mainly considered are measures targeting existing buildings. Beyond a BAU scenario including existing measures as of end of 2012, two scenarios with additional measures have been considered[30]:

- The implementation of a progressive **energy or CO_2 tax reaching 100 €/t CO_2** (CO_2/energy tax scenario), **with reallocation of the tax revenue as a priority to low income households** to provide additional resources to subsidise energy efficiency investments, reduce fuel poverty and increase the cost-effectiveness of the investments.
- A **mandatory thermal retrofitting** of the least efficient dwellings during real estate transactions and major transformations (when economically feasible) (Proactive scenario).

Figure 10 shows the results of the ENTRANZE policy scenario modelling. The energy demand for space and water heating is expected to decrease by up to 32% in 2030 compared to the 2008 level in the proactive scenario. The CO_2/energy tax scenario would allow an intermediate reduction of 20%[31]. As the proactive scenario implements more stringent measures on existing buildings, the renovation dynamics are significantly higher: in 2030 around 30% of the stock would be renovated with a strong share of deep renovation.

The following recommendations have been derived from these results. Mandatory renovations (when economically feasible) are an effective measure to boost renovations in badly insulated dwellings[32]. Coaching is a key measure for boosting renovation activities. It should be addressed to several actors in order to increase (i) household information and (ii) professional training and financial engineering. The impact of the tax on energy consumption is really effective above a certain threshold; however any tax should be accompanied by complementary measures to alleviate the immediate effect on low income households.

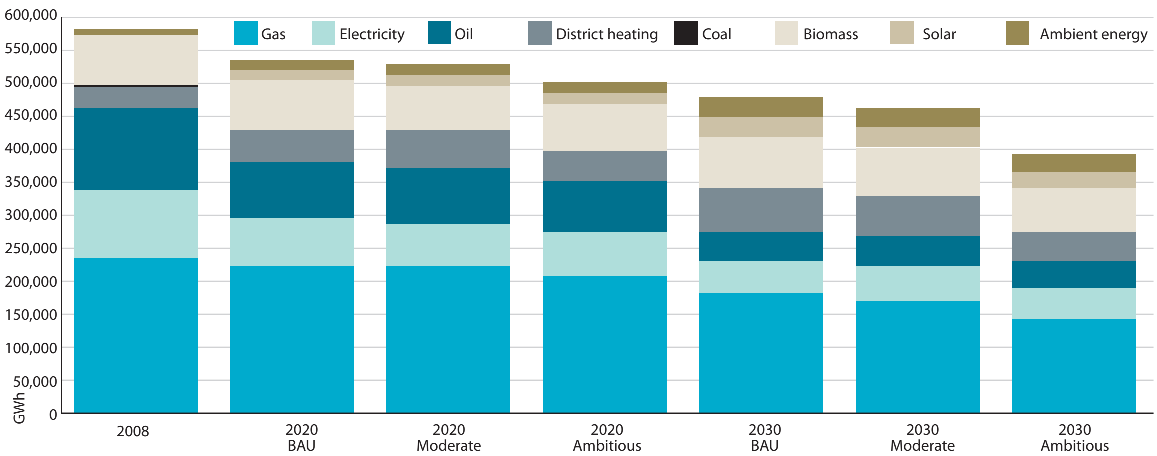

Figure 10. Building energy demand for space & water heating. France, high price scenario

[29] Limit of 50 kWh/m² in primary energy (kWhep) since January 2013 for all new dwellings for 5 end-uses (space and water heating, air conditioning, lighting and auxiliaries (ventilation, pumps). With the next update in 2020, all new buildings will be energy positive (consumption below 0 kWhep/m2, or 12 kWhep/m² for heating).

[30] Both CO2/energy tax and proactive scenarios include an increased effort on information for households.

[31] A sensitivity analysis showed that increasing the CO_2/energy tax from 100 to 200€/tCO_2 in 2030 will reduce energy consumption by an additional 20% and would have the same result as the proactive scenario.

[32] However, the design of this measure should also take into account the potential drawbacks: risk of unconstitutionality of an obligation only on the most energy consuming dwellings, significant impact on the real estate market , etc...

Germany

In Germany there is already a well-established instrument portfolio addressing the energy refurbishment of buildings. The main policy instruments are: the energy efficiency requirements defined in the building code; low-interest loans and a repayment bonus for energy efficient refurbishment and new buildings depending on the energy standard achieved; investment grants (existing buildings) and use obligation (new buildings) for the implementation of RES-H; and a variety of instruments for information and motivation as well as supply side measures.

However, calculations about the expected future development of energy consumption in the building sector show that the impact of the existing instruments will not be sufficient to reach the targets set for energy consumption. These results have also been validated by the scenario calculation within the ENTRANZE project.

A business as usual (BAU) scenario - assuming a continuation of current policy design – and two additional policy sets – considering further policy measures – have been analysed. The second policy set (regulatory) considers a tightening of the building code requirements as well as an expansion of the RES-H use obligation for existing buildings. In addition to the regulatory policies, enforcement and information measures to improve compliance are included in the third policy set (regulatory & information). The final energy demand for space heating and hot water declines in the period 2008 to 2030 by 24% in the BAU scenario and by 27% in the regulatory policy set. The combination of tightened regulations and additional measures to improve compliance results in a decrease of 30% by 2030. Driven by the RES use obligation for existing buildings, RES-H accounts for 33% and 36% of total final energy demand in 2030 in the second and third policy set, respectively. In the BAU scenario, a RES-H share of 28% is achieved by 2030.

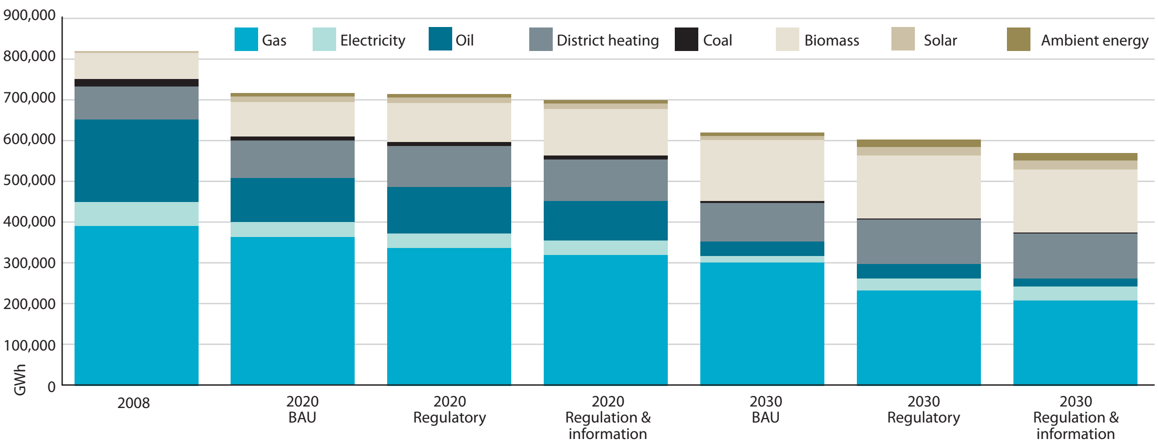

Figure 11. Building energy demand for space & water heating. Germany, high price scenario

The results clearly show that the enforcement of regulatory instruments and the improvement of information in combination with an ambitious tightening of the building codes and the implementation of use obligations for RES-H will have the highest impact on energy efficiency and the RES-H share.

From these results and also from the previous research conducted within the project, the following recommendations have been derived:

- Development of a **long-term transfer strategy** with long-term and intermediate targets and sufficient monitoring;
- Creation of suitable and **cost-efficient enforcement instruments for the Energy Conservation Regulations (EnEV);**
- Improvement and extension of information tools;
- Implementation of a **use obligation for RES-H** in the event of boiler replacement in existing buildings;
- Changes in the financial support scheme;
- Improve the role of public buildings as best practices.

Italy

Three possible policy sets were developed for Italy in strong collaboration with the national policy makers and experts involved in the dialogue groups. In line with EPBD requirements, the focus was put on cost-optimal solutions to determine **regulation limits for refurbishment.** In those few cases where the cost-optimal solutions have been already incorporated in the current regulations, we selected more ambitious renovations levels to keep on the regulation improvement process.

With these goals in mind the following regulations were suggested:

- Renovation has to reach savings greater than 50% in total net primary energy (excluding electrical appliances), compared to base refurbishment level.
- Total net primary energy has to be lower than the maximum threshold of 100 kWh/m^2/y.
- Alternatively the most cost-optimal solutions have to be adopted if it is calculated that they lead to lower net primary energy demand.
- And in general the indicated minimum percentages of primary energy demand have to be covered by renewable energy systems.

In more ambitious policy sets selected solutions and performances for nZEB were considered as limits to take advantage of proposed incentives. In the three policy sets for renovations, indicated respectively as BAU Plus, Medium and Improved, the policy measures considered consist of: **regulatory instruments, tax deductions, economic incentives, preferential loans and information campaigns**. Also a regulation for new buildings has been proposed, mainly focused on nZEB levels in regulations, starting from 2020.

Among the main recommendations which the process led to we can highlight:

- the need of more complete indices (e.g. energy needs, load matching indices, long-term comfort indices, etc.) for description / ranking of buildings and nZEBs as foreseen by EPBD;
- policy instruments which will remain in force certainly for long periods, mainly giving financial support to initial investments, integrating private and public sources; and there is need for investment in quality control over renovation interventions;
- the crucial importance of information campaigns particularly for the demand side;
- adopting solutions of progressive tariffs with unitary energy price growing with consumption and making real time consumption data available to customers.

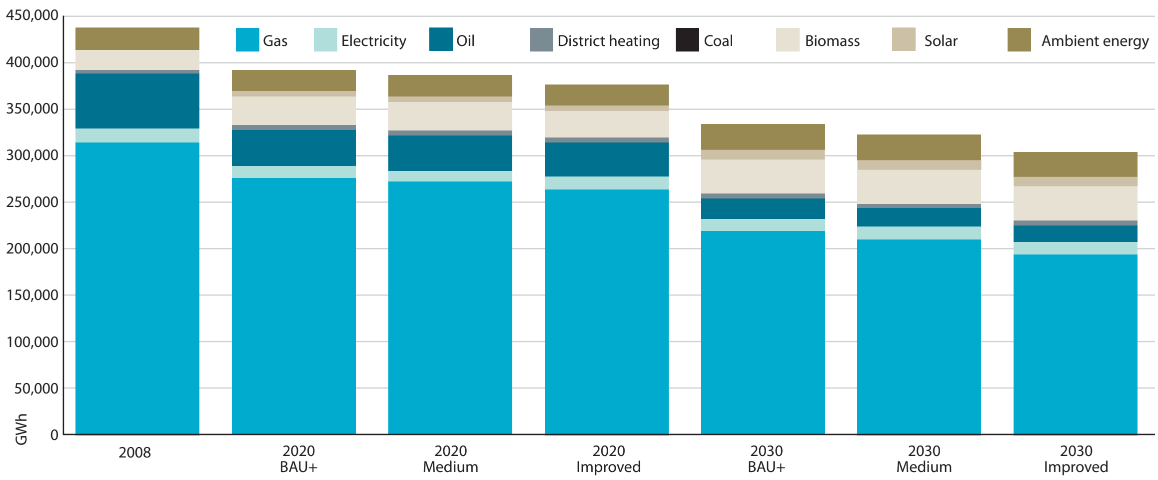

Figure 12. Building energy demand for space & water heating. Italy, high price scenario

Romania

As a result of the discussion process, the following subjects stood out as being in need of improvement:

- Dynamic buildings regulations;
- Predictability of support programmes;
- Quality of works in construction;
- Information and technical advice;
- Horizontal measures and measures targeting primary energy.

Based on the continuous dialogue with Romanian stakeholders, three policy sets were defined, exploring different levels of policy ambition. The modelling results confirmed that it is, on one hand, important to have a comprehensive legislative framework including regulations, support programmes, information, training and coaching measures, while, on other hand, these measures have to be predictable longer-term and vigorously implemented in practice. Based on the results of the modelling exercise, the following policy recommendations are provided for securing the transition to nZEB in Romania:

- The need to further improve the **strategic planning and dynamic regulation** based on a periodical evaluation of policies in close cooperation with the main stakeholders;
- The energy performance and thermal requirements in building **regulations** have to be **stricter and properly enforced** in order to ensure a high level of compliance in construction work;
- The need to further improve **measures for information** and the provision of guidance to buildings owners and stakeholders;
- The need to introduce workforce **qualification training** and to improve the education curricula from high schools and universities in order to prepare the workforce to properly implement nZEB construction;
- The need for **financial support programmes**. These programmes can be built on existing ones, but with increased predictability (through cross-party support, multi-annual budgets, transitioning from high intensive grants to more commercial instruments);
- Buildings renovation programmes have to be undertaken in close coordination with **complementary programmes and measures on urban development** and district heating in order to avoid inconsistency between them, to minimise costs and therefore to increase their effectiveness.

The following graph shows the projections of energy demand for heating and domestic hot water in Romania up to 2030 under the three different scenarios. The modelling results show a decrease of final energy demand for heating and domestic hot water leading to energy savings of up to 31% (as compared to 2008) in the most ambitious scenario. The share of renewable energy will also increase from about 41.6% in 2008 to 51-56% by 2030 in the most ambitious policy scenario. In all policy scenarios modelled, the contribution of oil, coal and district heating to final demand decreased by 2030.

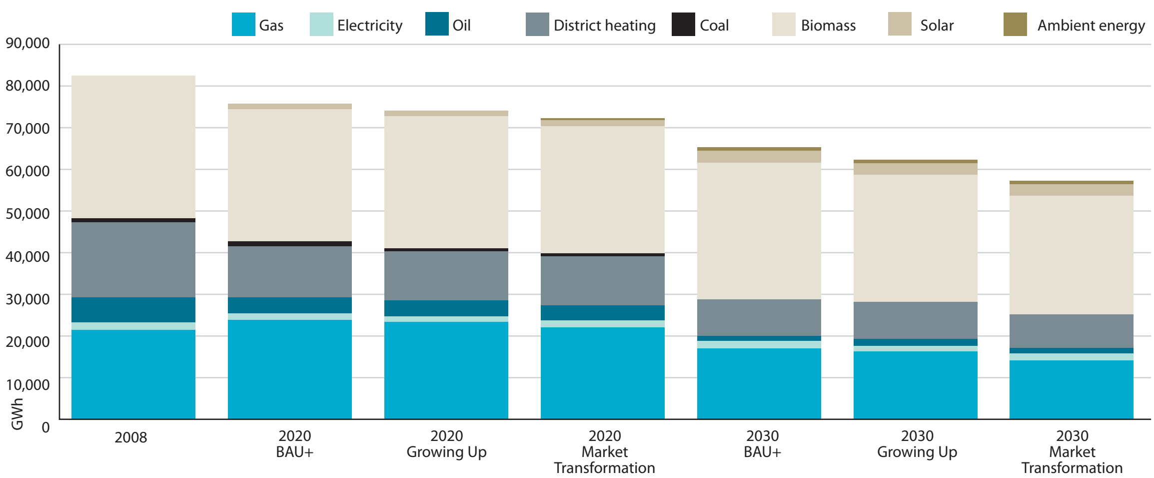

Figure 13. Building energy demand for space & water heating. Romania, high price scenario

Spain

The current Technical Building Code (TBC-updated in 2013) is in line with the minimum requirement for energy efficiency associated with the cost-optimal analysis that has been submitted to the European Commission by Spain. The purpose of this work has been to define a possible scenario which could form the basis for a future revision of the TBC towards the definition of nZEB for Spain. There are already quite attractive subsidies for building renovation and yet the renovation rate remains very low. Three policy sets have been chosen and their impact calculated with Invert/EE-Lab: (1) business as usual, (2) focus on regulatory measures and (3) ambitious scenario.

The following graph shows the projections in Spain under the three different scenarios.

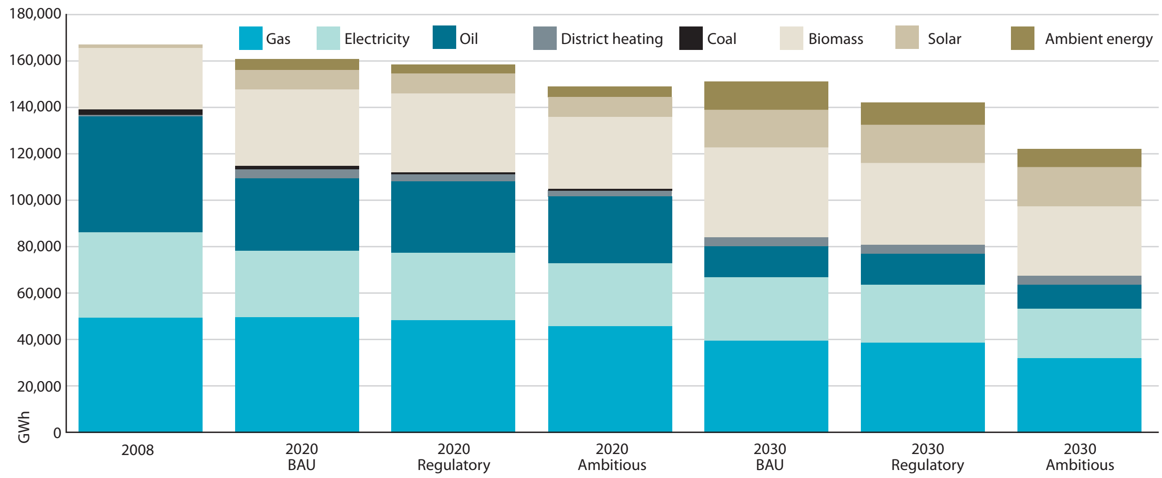

Figure 14. Building energy demand for space & water heating. Spain, high price scenario

The graph shows that the most ambitious policy set 3 leads to the highest energy saving (around 27% in 2030 compared to 2008). In addition, the following main findings have been identified:

- It is estimated that the **current policies** regarding the energy efficiency of buildings implemented in Spain will result in energy savings (for heating and hot water) of between 2% and 4% in 2020 compared to 2008.
- Achieving more **ambitious savings** (e.g. 15% -25%) in 2020 and 2030 necessarily requires the implementation of more ambitious policy instruments. In some cases the currently implemented policy instruments can be strengthened or improved (e.g. strengthen minimum requirements of regulatory instruments), in other cases new and innovative instruments are needed (e.g. related to building owners' information/motivation to invest in energy efficiency in order to strengthen the impact of financial support programmes).
- A **market transformation** is needed in order to meet the quality assurance requirements of the implemented energy efficiency measures. Several experts point to the development of an effective surveillance system which will ensure the quality of the whole process (from project design to implementation and maintenance) in order to ensure compliance with the TBC[33] requirements.

[33] Technical Building Code (updated in 2013)

Scenario results for EU-28

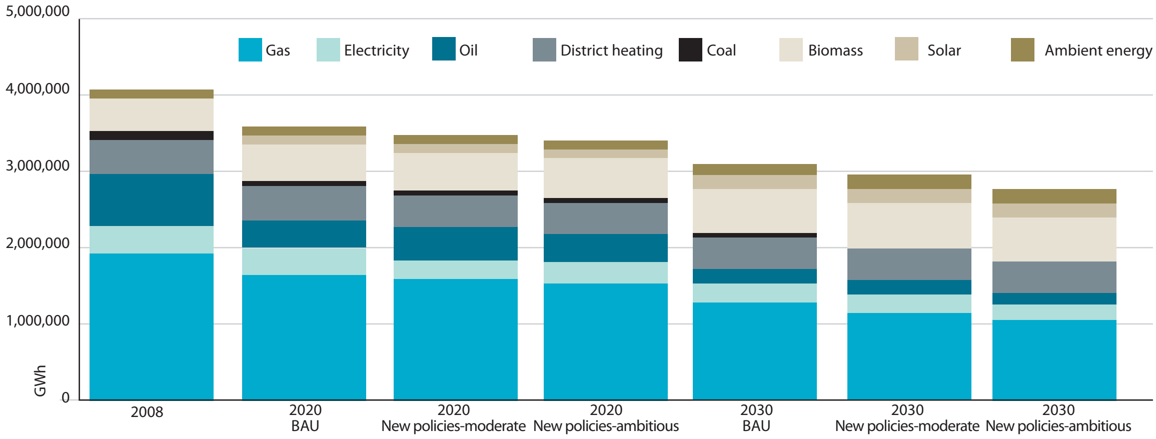

Figure 15. Building energy demand for space & water heating. EU-28 high price scenario

The scenario results build on the policy packages and results from the target countries, which cover in total about 60% of the overall EU-28 building stock. For the other countries, generic policy sets were applied, with the same logic as for the target countries: Scenario 1 refers to a moderate scenario according to current national and EU legislation, Scenario 2 and 3 presume more ambitious, innovative and stringent policy packages.

According to the model results for EU-28, the current policy framework could lead to savings of about 20%-23% of final energy demand and about 25-30%[34] of delivered energy[35] from 2008-2030. In contrast, policy scenario 3, with more ambitious policies, but still not the maximum of achievable effort and policy innovation, would lead to savings of 29-31% in final energy and 36%-39% in delivered energy. Due to high fuel costs, heating oil systems are more and more being phased out in all scenarios. However, natural gas still plays a crucial role up to 2030, though with different intensities. Almost 50% of final energy demand for heating and hot water is covered by natural gas in 2008, (about 1900 TWh or 165 Mtoe). According to Invert/EE-Lab scenarios, the business-as-usual framework could reduce natural gas demand in 2030 by about 21-31% and under policy scenario 3 by almost 36-45%.

In particular, for consistency with long-term targets, a high renovation depth is crucial. The share of deep ("nZEB") renovation in the renovation activities increases in our scenarios to only about 25% under BAU-policies and to about 50% under policy scenario 3. Although 50% of deep ("nZEB") renovation would be a strong improvement compared to the current state, we want to emphasise that the remaining 50% are locked-in for more substantial improvements until the middle of the century. Thus, the activities to improve high quality renovation, leading to substantial savings per floor area, have to be substantially increased.

The current policies implemented for lighting energy efficiency is expected to reduce lighting energy consumption in our scenarios by about 20% from 2008 to 2030. These savings however could be more than doubled with even more stringent and more ambitious measures. In contrast to the considerable savings in space heating and lighting energy demand, cooling energy demand is increasing in all scenarios (by more than 110% from 2008 to 2030). This is mainly related to an expected increase in comfort demand. However, with a stringent implementation of efficiency measures, this increase could be reduced.

The strong phase-out of heating oil and coal in the building sector, which could occur in the coming decades and the expected move towards the decarbonisation of the electricity sector[36] leads to a reduction of total CO_2-emissions for heating cooling and lighting from 43-50% in policy scenario 1 and 50-57% in policy scenario 3 from 2008 to 2030.

[34] Ranges indicated in this paragraph refer to the two energy price scenarios. For more details see the reports on http://www.entranze.eu/pub/pub-scenario.
[35] Where delivered energy is defined as total final energy demand minus solar thermal and ambient energy.
[36] CO_2-emission factors for electricity generation have been developed with the model POLES and corresponding scenarios. For more details see the ENTRANZE report "Policy pathways for reducing the carbon emissions of the building stock until 2030".

PART IV:

POLICY RECOMMENDATIONS AT EU AND MEMBER STATE LEVEL

These policy recommendations have been derived from the numerous results and experiences of the different work packages in ENTRANZE. They address political decision makers and aim at increasing the number of nZEBs in the European building stock. They address two political levels: there are guidelines applicable to all Member States, and recommendations to the European Commission. Specific recommendations for target countries are indicated above and more detailed ones in the country reports on policy scenarios and recommendations[37].

Guidelines applicable to Member States

There are two general guidelines for creating policy instruments targeting at increasing the number of nZEBs:

1. Creating an **effective target-oriented policy environment** with a clear focus, and
2. **Effective set-up, implementation and monitoring** of policy packages

1. Creating an effective target-oriented policy environment with a clear focus

- **Policies** should be **target-oriented**.

The policy intensity and the specific design of instruments should be in line with and sufficient to reach mid- and long-term targets regarding CO_2-emissions, primary and final energy demand in the building sector. However, currently only a few countries have implemented unambiguous targets up to 2050, which is a considerable barrier for target-oriented, effective policy making.

[37] http://www.entranze.eu/pub/pub-scenario

- **Long-term and ambitious targets** for the building sector up to 2050 are needed that provide targets on nZEB-buildings with intermediate steps.

  To design efficient policy instruments, the targeted CO_2-emissions or the targeted energy consumption of the building stock has to be defined. The target definition should be properly balanced between indicators like CO_2-emissions, primary and final energy demand or RES deployment. Moreover, the targets for the building stock should be embedded in a coherent target scenario and vision of the overall energy system's development. In many MS there are no targets at all, or often they are not consistent with long-term climate mitigation targets. Targets are also necessary to evaluate the impact of a policy instrument. Interim targets are necessary to design suitable instruments and to monitor their attainment. For example in Germany there are clear targets for the reduction of the energy demand of the building stock: by 2050 a reduction of primary energy consumption by 80% shall be achieved. Moreover, intermediate targets have been set.

- **Focus on deep renovation of the existing building stock** and avoid lock-in effects

  So far some MS have mostly targeted new buildings, e.g. by building codes. There should be more emphasis put on policies addressing efficiency and RES-measures in existing buildings. Deep renovation activities targeting high energy standards up to the nZEB-standard should be stimulated. This is necessary to reach the long-term target for CO_2 emission-reduction in the EU for 2050. The simulations showed that the current policy instruments do not provide sufficient incentive for high renovation depth. Even in ambitious scenarios a considerable share (about 50%) of renovation activities up to 2030 does not represent a renovation level which could be called "nZEB renovation". We have to be aware that these buildings are locked for further efficiency improvement for the next decades. Deep renovation should also include long-term compatible staged renovations. Building-specific renovation roadmaps are an effective means for ensuring a target-oriented execution of staged renovation over a longer period.

- **Long term signals** to the market are necessary.

  Policy and regulatory framework should be stable and predictable (avoiding stop and go). This is important not only to ensure investment security but also for developing know-how and trained staff.

2. Effective set-up, implementation and monitoring of policy packages

Guidelines for the effective design of policy packages

- **A bundle of instruments** is required to properly address the often heterogeneous target groups and/or technology specific barriers at the same time. The focus on a single instrument is not sufficient.
- **Tailored instruments** are strongly recommended for increasing their effectiveness, limiting market distortions and fostering the market uptake.
  Policies need to reflect the national context including the building stock and ownership structure, target group specific barriers, climate conditions, demographic and migration, energy poverty aspects etc. in order to increase their efficiency and acceptance. Target group specific policies are required. Instruments addressing non-residential buildings should also consider different uses of the buildings.
- The mix of instruments must be adapted to the **maturity of market conditions**, the investment potential and environment in the specific country. The policy mix has to be adapted to changes in the market, public budget available, and cost structure. The mix of instruments also needs to be coordinated (e.g. different legislation, different funding programmes). Since the market conditions change over time, policy makers face the challenge of adapting policy packages to

market conditions and at the same time creating a stable and foreseeable policy environment.

- **Innovative / good practices from other MS**, and local/regional authorities should always be considered. While they are not entirely transferable, elements of them can provide good solutions.
- Measures that address the **behaviour** of the user have to be implemented with the same priority as technical ones. Especially, information instruments could also focus on behavioural aspects influencing energy consumption in residential buildings such as taking shorter showers, selecting lower indoor temperatures, properly airing-out rooms during the heating period etc. Comfort requirements and rebound effects should be considered.
- MS should implement regulations that **distribute the costs in a fair way between landlord, tenant and society.** "Fair" means, that refurbishment measures should not lead to a social misbalance, or to energy poverty, while it should be ensured that there are sufficient incentives in place to conduct deep renovations.

Guidelines for the effective implementation of policies

- Proper implementation of policies is essential: **enforcement/compliance check** of energy regulations must be strengthened. The ENTRANZE scenario results, particularly for the case of Germany, have shown the high relevance of compliance for effective policies. A special budget should be dedicated to improving compliance and quality control.
- The **commitment of all relevant stakeholders**, and proper information and advice to all market actors including building owners, strongly influence the effectiveness of policies and regulations. Thus, a strong involvement of stakeholders in the policy design and implementation process is important, while it must not lead to a weakening of targets due to particular interests.

Guidelines for monitoring and evaluating policies

- **Monitoring and evaluation** are key elements for enabling the policy sector to improve implemented instruments and react to undesirable effects if necessary. That's why the policy measures should always include impact monitoring and evaluation.
- **Macro-economic benefits** of building policies should be acknowledged and included in policy evaluation and monitoring processes.
- **Data availability about renovation activities** including data on costs has to be improved. The current state of data availability to track the effectiveness of policies, in particular regarding renovation activities, is not satisfactory by far. Suitable instruments to collect data must be implemented; comparable data should be exchanged at EU-level.

Recommendations by type of instruments

Besides the general policy guidelines listed above, the following general recommendations by type of instrument have been derived from the ENTRANZE results. As indicated above, policy packages always need a proper balancing between all these different types of instruments:

Economic instruments

- **Incentive schemes** for thermal building renovation should be adjusted to the achieved energy efficiency standard, possibly combined with the amount of energy saved. The policy scenario modelling has shown that deep, high quality renovation needs higher incentives than standard renovation to be effectively stimulated. Thus, technology-specific support levels reduce free rider effects and overall support programme costs.
- **The level of support** should be oriented towards the market maturity of a region. High initial levels of support always need to be accompanied by staff training activities, technology and market development. A dynamic decrease in these support schemes should be envisaged as soon as the market allows. For instance, the policy scenarios for Romania have shown how the dynamic, stepwise shift of high support levels to more target-oriented measures and soft loans

can lead to substantial progress in building renovation and more effective and efficient policies.

- **Energy/CO_2 taxes** and cost-intensive instruments (such as renovation obligations etc.) should be accompanied by complementary measures to alleviate the effects especially for low income households. In particular, the policy scenarios for France and Finland revealed that technology-specific incentives are required in order to avoid lock-in effects by short-term reaction to carbon prices where investors might not reflect on the long-term horizon of the targeted improvement of energy performance.

Regulatory instruments

- **Building renovation roadmaps** could be suitable for triggering renovation activity. For instance, owners of old buildings (e.g. older than 40 years) which have not yet been renovated could be obliged to set up a renovation roadmap which has to be implemented. Building-specific renovation roadmaps can also serve as information instruments. Finally two levels of obligation could be introduced: (1) an obligation to develop a renovation roadmap and (2) an obligation to implement the content of the roadmap.
- At the local level, building policies (both for new and renovation) should be inter-linked with **spatial planning** and other community level policies (such as for district heating, expansion of gas distribution networks, urban heat island mitigation effects, cool surfaces, green areas etc.)
- The relationship between **building codes** (regulatory schemes) and requirements to receive support schemes has to be properly balanced.
- The tightening of **building code**s should be combined with compliance instruments.
- **Renewable heat obligations** (in line with Art 13 of the Renewable Energy Directive) should be enhanced. Substitution measures for improving the energy performance of the building can be foreseen.
- Building codes could and should also integrate the installation of low-temperature **central heating systems** (for new buildings and stepwise also for building renovation) since this is a precondition for efficient, modern RES-H supply.
- There could be mandatory renovation requirements in the event of a change of ownership. The policy scenarios for France showed that this can be a very effective instrument.

Information / Motivation / Advice Instruments

- **Coaching building owners** during building renovation is essential and should last until the renovation is completed. Coaching should go beyond the usual advice and should be more intensive.

Supply side / Qualification Instruments

- **Training and qualification** of all 'blue and white collars' involved in the building sector is a must (i.e. from workers to engineers and architects) and a key factor for the success of policies.
- Investment in **R&D** to reduce the cost of the technologies is necessary
- **Public procurement** for RES-H and energy efficiency technologies can help to reduce the costs, e.g. when it comes to technologies for passive house refurbishment.

Recommendations at EU level

A result of the work in the ENTRANZE project was the conclusion that the EU framework for the improvement of energy efficiency in buildings and the increase in the number of nZEBs is not sufficient yet. The project conclusions of the different tasks and the recommendations in the ENTRANZE target countries revealed quite a few shortcomings at MS level resulting from an insufficient and partly ambiguous framework at EU level. Differences between MS are high, and in general policies should accommodate genuine differences. The EU legislation should also try to highlight the opportunities in common policies more strongly. The reporting effort in MS could be reduced by providing sufficient, clear and harmonised reporting templates. This would also reduce the effort for evaluating the reports.

The recommendations shown in the figure below have been elaborated.

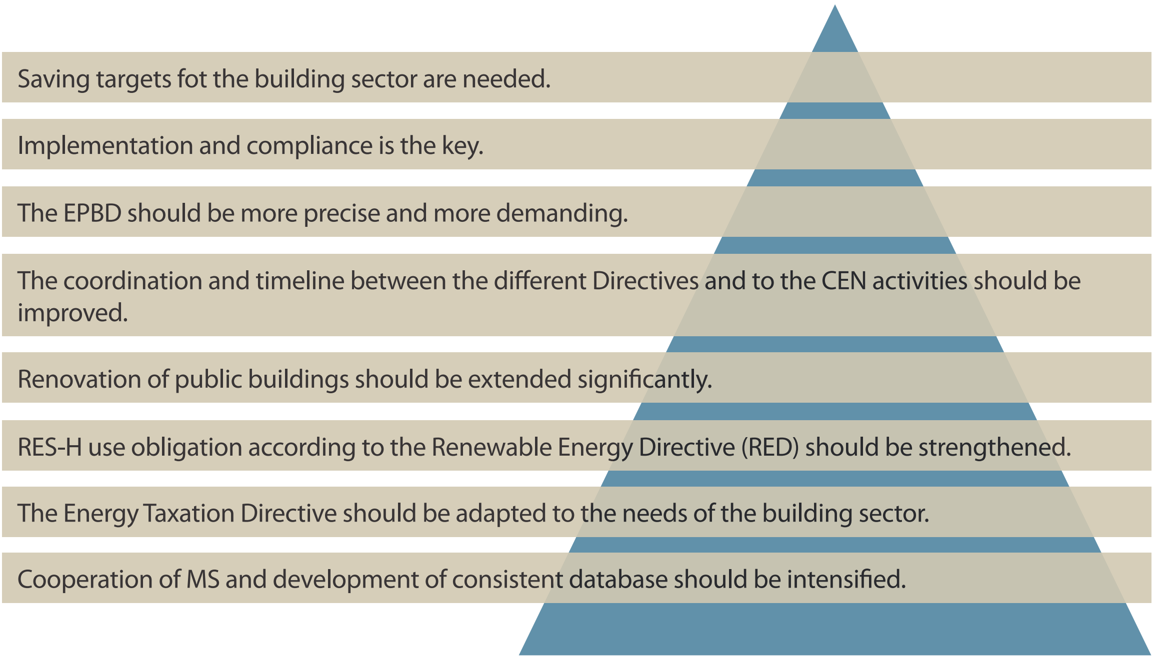

Figure 16 Recommendations at EU level

Savings targets for the building sector are needed

Quantitative savings targets for CO_2-emissions, primary and final energy demand including intermediate targets for the building sector are needed to specify what level of efficiency should be targeted by the policies. There should be a close link to the existing 2030 efficiency target and the 2050 climate mitigation target. Clear targets by 2030/2050, potentially binding, will provide more motivation and guidance to the policy making process from the EU MS and may stimulate positive ambitions and shared actions.

Implementation and compliance is the key

Proper implementation of policies such as EPBD, EED, and RED is vital for ensuring their impact. While formal transposition of the EU legislation is pursued by the European Commission, the implementation and real impact of specific requirements is mainly in the jurisdiction of the EU MS. Additionally implementation and impact are not always sufficiently monitored. Therefore, while the EU legislation increases complexity and currently includes many necessary 'ingredients' for boosting the buildings towards higher energy performance, in almost all EU countries there are failures in properly implementing the requested measures. Consequently there is a serious risk of falling short in reaching the anticipated impact of EPBD and EED. Therefore the country-reporting to the Commission should be improved: it should include more evidence on the existence of viable capacity and control mechanisms at country level and on the actual delivery of energy and carbon savings, e.g. also an indication of the budget spent for compliance and monitoring measures. A clear and EU-wide harmonised monitoring scheme is recommended.

The EPBD should be more precise and more demanding

With the 2010 recast of the EPBD (2010/31/EU) the concept of cost-optimality has been introduced. Member States had to set their energy performance and thermal requirements for buildings and components in accordance with cost-optimal levels determined by applying a harmonised EU methodology. As a consequence, the cost-optimal calculations reveal that no changes are necessary in some MS with a history of integrating energy requirements in their building codes. However, in other MS with less experience in implementing energy related requirements for buildings, the cost-optimal calculations show more important deviations compared to actual regulations.

In a brief analysis of the nZEB reports for the EU Commission we found that most of the EU MS equate the cost-optimal level with the nZEB level. Following this rationale, the impact of the nZEB requirement in the EPBD is reduced significantly and does not present a breakthrough for more ambitious standards for new buildings. We, however, believe that the EPBD[38] should be interpreted in such a way that nZEB levels should be at least cost-optimal, and not be limited to cost-optimal levels.

This means that whereas nZEB-levels which are based on a very low to almost zero energy consumption may not be cost-effective today, but by 2020 they could be. Therefore, the EU MS should aim at more ambitious nZEB levels and measures to achieve their cost-effectiveness by 2020 should be presented in the nZEB plans.

Thus, an enhanced legal framework should make clear that **cost-optimality has to represent the absolute minimum requirements for existing regulations in the building codes. While nZEB energy performance levels should be cost effective, they still have to be more ambitious than cost-optimal energy performance levels.** Thus, an enhanced EPBD has to be very precise in asking MS to present plans to close the gap between nZEB target levels in 2020 and cost-optimal levels of current building codes. Examples from, for example, the Brussels-region have shown that strict building codes, combined with comprehensive advice and coaching instruments may lead to a closing of this gap.

The definitions and conditions in the EPBD under which renovations underlie certain requirements should be clarified; for example a clearer guidance for 'major renovation' and a definition of nZEB renovation should be given. Net yearly primary energy use is insufficient to characterise nZEBs; it is proposed to implement several indices for a more complete and correct description and ranking of nZEBs[38].

Also to be considered is a gradual increase of the binding character of nZEB requirements for existing buildings, too. A clear **definition of nZEB or deep renovation** is required[39].

A clear framework stimulating renovation should be developed within the EPBD. One could think of implementing requirements to ensure that staged renovation measures have to be compatible with the modernisation of adjacent components and in particular with the long-term goals. Building specific renovation roadmaps or building passports could also be instruments which could be more strongly embedded in the EU legislation.

More attention should be given to non-residential buildings. The legal requirements applying to residential buildings should be adapted to the specific use and characteristics of non-residential buildings.

There is a growing interest in having an harmonised EU methodology and framework for setting the energy performance requirements for buildings properly considering the cultural, climatic, economic and historical differences between MS. Whereas the EPBD (recast) was a first attempt to have a comparative framework within the EU MS, further enhancement of the legislation should go beyond that. Common monitoring activities of nZEB progress and market maturity, e.g. as currently developed in the IEE project ZEBRA2020[40], should be further enhanced.

With the common template for national plans, elaborated in Hermelink et al., (2013)[41], there is a profound basis for a better comparability and quality of national plans. This should be further and continuously checked in the next round of national plans to be submitted.

Renovation of public buildings and renovation plans according to the EED should be enhanced

The results of the ENTRANZE project showed that the 3% renovation target of public buildings has a very

[38] Hermelink, A., Schimschar, S., Boermans, T., Pagliano, L., Zangheri, P., Armani, R., Voss, K., Musall, E., 2013. Towards nearly zero-energy buildings. Definition of common principles under the EPBD. Final Report. Ecofys by order of the European Commission.[40]http://www.entranze.eu/pub/pub-scenario

[39] B. Atanasiu, S. Kunkel, I. Kouloumpi (2013). nZEB criteria for typical single-family home renovations in various countries. Report for the IEE project COHERENO and available at www.cohereno.eu

[40] www.zebra2020.eu

[41] Idem 39.

limited impact. The weak definition of "public buildings" according to the Energy Efficiency Directive (EED) leads to the fact that in most countries only a small share of the building stock may fall under this definition. Therefore, a further extension of the scope of Art. 5 to all public buildings owned by the public sector, both at central and regional level, is necessary. In addition, Art. 5 EED indicates that the renovation of public buildings has to meet the minimum energy performance requirements in place. The minimum energy requirements in place are the ones required by EPBD Art. 7, i.e. in case of major renovations. Therefore, the renovation of public buildings may not be sufficiently ambitious to have 'an exemplary role'. In the next EED recast the Art. 5 of EED should clearly specify that renovations of public buildings have to be undertaken at nZEB levels.

Article 4 of the EED asks the EU MS to further elaborate long-term plans to support deep renovation of the existing building stock. Therefore, these plans can play a major role in fostering nZEB renovation if they are designed and take into consideration measures tailored towards or aiming at nZEB levels. Hence, more attention should be paid to and more guidance offered to MS to properly implement the long-term renovation plans as required by Art. 4 EED. In view of the long investment cycles, renovation plans should have a 2050 perspective and include a strategy for how the sector could be transformed in the long-term.

Moreover, there is a lack of consistency in the terminology, e.g. the term deep renovation should be clarified and quantitatively defined. At the moment there are two terms used: 'deep renovation' in EED and 'major renovation' defined and regulated by EPBD. Due to the lack of a definition for deep renovation in the EED, confusion often happens between the two terms[42]. Consequently, in the next EED recast the term 'deep renovation' has to be properly defined or, alternatively, replaced by 'nZEB renovation' which can be immediately linked to the national nZEB definitions already in place.

RES-H use obligations according to the Renewable Energy Directive (RED) should be strengthened

The integration of renewable energy generation in buildings is requested by Article 13 of the Renewable Energy Directive (2009/28/EU) which stipulates that by 2014 all EU MS should consider specific minimum requirements in their building codes. So far some of the EU MS have implemented RES requirements in their building regulations. Most of the requirements address new buildings and mainly RES heating. For example, in Cyprus and to a certain degree in Portugal, solar thermal installations are mandatory for all new residential buildings and there are additional obligations for power generation from RES for new buildings. In some EU MS, solar thermal is compulsory for buildings with floor area or heat and water-consumption bigger than a certain threshold (e.g. Denmark, Belgium-Wallonia).

The scenario results show that the impact of RES-H use obligations remains very small if it is restricted to new buildings. A further strengthening of the implementation of Art. 13(4) RED for renovated buildings could increase the impact if one-off early effects and restrained investment behaviour can be minimised.

Thus, there is a strong need to **further enhance the requirements for RES-H in the building code, in particular for major renovation**, as required in the RED. Moreover, proper implementation shall be strengthened. At the current stage, it can be expected that this requirement will only be partly implemented in MS by the end of 2014. The EC should foresee special attention to the proper implementation of this article.

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[42] A good example of the confusion between 'deep' and 'major' renovation is the revised work programme of Horizon 2020 on Secure, clean and efficient energy (an official document of the European Commission). Therefore, in the footnote 27 from page 15 it is mentioned that 'deep renovation should lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-renovation levels (c.f. Directive 2012/27/EU on Energy Efficiency). In the footnote 31 from page 18, it is mentioned that 'Deep (or major) renovation means 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 (Energy Performance of Buildings Directive)'. More at: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-energy_en.pdf

The Energy Taxation Directive should be adapted to the needs of the building sector

Energy taxation may contribute positively to the reduction of energy consumption in buildings. However, the scenario results for the cases for France and Finland showed that energy or CO_2-taxes alone are not expected to provide sufficient incentive. Rather, it also needs additional measures (as shown in the other recommendations). Moreover, at least a share of the revenue of energy and environmental taxation should be clearly dedicated to the support of end-use energy efficiency and renewables in buildings. This budget may furthermore finance an Energy Efficiency Fund as recommended by Art. 20, EED, a buildings renovation fund or schemes such as energy savings obligation for suppliers indicated by Art. 7, EED.

In particular, progressive energy taxation (e.g. per capita or per dwelling) should be checked strongly in order to avoid undesirable social imbalance and at the same time provide effective incentives for renovation of those buildings with a high energy consumption[43].

The coordination and timeline between the different Directives and to the CEN activities should be improved

An improved and harmonised framework of indicators should be based on common CEN definitions and calculation procedures. As has been mentioned above, there are currently inconsistencies in the terminology used in the relevant Directives. It is necessary to further strengthen the synergies and convergence between EU Directives addressing buildings from different perspectives, such as energy, environmental, industrial, or social ones. Otherwise there is the risk of negative impacts, such as slowing down market development and creating a negative perception at policy and social levels.

Cooperation of MS and development of consistent database should be intensified

In the sense of the Concerted Actions, the EC should further increase efforts to better support the MS. So it could be helpful for the MS to provide more data about energy efficiency measures already implemented by all MS, or best practices respectively. So far there is no knowledge about the quality of the implementation of energy efficiency measures. Information from collected energy performance certificates could lead to a wider knowledge on the quality of renovation activities regarding energy efficiency and renewable energies, the number and quality of renovations as well as information about the current state of existing buildings.

Moreover, there is a need to establish a transparent EU database reflecting the status and progress of energy performance of buildings and update it periodically on a statistic basis. In this way, the monitoring processes of implementing buildings legislation and longer-term planning will be consistently improved and simplified. Currently there are several EU projects dealing with the topic such as Odyssee-Mure, TABULA/EPISCOPE and ENTRANZE, but none of them is legally supported. Therefore the Commission should establish a transparent EU Buildings Observatory (including an online tool), which could be supplied by similar national observatories. The establishment of such observatories should be further considered at the next EPBD recast. Using a common methodology for the evaluation of supporting schemes and EU-wide close cooperation of responsible stakeholders would improve the quality of the policy evaluation process. Options for a common evaluation methodology in EU MS could be further explored.

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[43] Pagliano, L., Alari, P., Pindar, A., Ruggieri, L., 1999. The use of progressive tariff structures to align the interest of utilities and of individual customers with the societal goal of enhanced end-use efficiency., in: eceee Conference 1999 and Pagliano, L., Alari, P., Irrek, W., Leprich, U., Thomas, S., 2001. Price regulation to remove EE-DSM disincentives and pressure for increased energy sales in monopoly segments of restructured electricity and gas markets - The Multiple Drivers Target (MDT) tariff scheme. Presented at the eceee 2001.

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