World Sustainable Energy Days 2014

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World Sustainable Energy Days 2014

OOENERGIESPARVERBAND

11.30

- *Russia: the Russian state plan*
  Olga Rakitova, The Bioenergy International
- USA: market and policy trends
  David Dungate, BTEC
- Australia: Tasmania's bioenergy opportunities
  Hon Adriana Taylor MLC, Parliament of Tasmania
- Ukraine: pellet supplier and domestic demand
  Tetiana Ignatenko, Ukrainian Pellet Union
- Closing remarks
  Karin Krondorfer, OÖ Energiesparverband, Austria

12.30 End of the European Pellet Conference

19.30 Evening programme & dinner **(Minoriten)**

Thursday, 27 February 2014, Welios

09.00 High efficiency - low emissions
Session co-organised with Bios Bioenergiesysteme (in English only)

Chair: Ingwald Obernberger, Bios Bioenergiesysteme, Austria

- Keynote and introduction to the EU project "UltraLowDust" (FP7)
  Ingwald Obernberger, Bios Bioenergiesysteme, Austria
- State-of-the-art of small-scale biomass combustion
  Thomas Brunner, Graz University of Technology, Austria
- Emission limits, measurement methods & factors influencing emissions
  Hans Hartmann, Technologie- und Förderzentrum, Germany

10.10 Coffee break

10.40 Technologies and results achieved by the EU project "UltraLowDust"

- New ultra-low emission wood pellet and wood chip boiler technology
  Jürgen Brandt, Windhager, Austria
  Thomas Brunner, Graz University of Technology, A
- New low emission logwood stove
  Marie-Laure Rabot-Querci, Supra SA, France
  Christian Schraube, EIFER, Germany
- New rooftop small-scale electrostatic precipitator (ESP) technology
  Peter Launsky, Ruftec AG, Germany
  Heike Oehler, Technologie- und Förderzentrum, Germany
- Contribution of ultra-low emission technologies to pollutant reductions in the EU & policies for market transformation
  Thomas Götz, Wuppertal Institute, Germany
- Discussion & closing remarks

13.00 End of the European Pellet Conference

19.30 Evening programme & dinner **(Minoriten)**

Energy Efficiency Policies

Thursday, 27 February 2014, Stadthalle

09.00 Opening & welcome

Chair: Gerhard Dell, OÖ Energiesparverband, Austria

- *Rudi Anschober, Regional Minister for Energy, Upper Austria*
- Implementing the European Energy Efficiency Directive
  Claudia Canevari, European Commission, DG Energy
- The importance of ambitious energy efficiency policies, *Jan Geiss, Eufores*
- Energy efficiency - boosting Europe's competitiveness
  Marc Ringel, University of Applied Economics and Environmental Sciences, Germany
- European projects supporting EU energy policies
  Vincent Berrutto, European Commission, EASME

10.50 Coffee break

11.20 Examples and instruments

Chair: Jan Geiss, Eufores

- Good practice examples for national energy efficiency policies
  Lucinda Maclagan, CA EED Coordinator, Energy and Climate Change, NL Agency
- Energy advice & audits - a driver for change
  Christiane Egger, OÖ Energiesparverband, Austria
- Is the public sector taking its leading role?
  Veronika Czakó, European Commission, Joint Research Centre
- The market for smart energy services
  Wolfram Moritz, MPW Institute LLC, D/USA

12.45 Lunch break

12.00 – 14.00 B2B-Meetings Energy Efficiency in Buildings, CATT, Hall 20, 1st floor

Nearly Zero Energy Buildings

Thursday, 27 February 2014, Stadthalle

14.00 NZEB Policies & Market overview

Chair: Christiane Egger, OÖ Energiesparverband, A

Opening & welcome
- *Rudi Anschober, Regional Minister for Energy, Upper Austria*
- Transition to sustainable buildings - strategies and roadmaps to 2050
  John Dulac, International Energy Agency (IEA)
- Progress in implementing the EU Buildings Directive
  Claudia Canevari, European Commission, DG Energy
- The implementation of the EU Buildings Directive in Austria
  Gerhard Dell, OÖ Energiesparverband, Austria
- Is cost-optimality driving buildings towards NZEB?
  Bogdan Atanasiu, Buildings Performance Institute Europe
- Oral presentations of selected posters

16.05 Coffee break

16.35 NZEB Market transition - how to make it happen?

Chair: Jackie Jones, sustainable energy communications, UK

- CEN building standards in practice
  Jaap Hogeling, CENTC 371 Programme Committee on EPBD, ISSO, The Netherlands
- NZEB Renovation in the building stock: policies, impact and economics
  Lukas Kranzl, Vienna University of Technology, A
- Turning energy efficiency into sustainable business - a European roadmap, *Luc Bourdeau, E2BA-Energy Efficient Building Association*
- European financing programmes for building efficiency, *Reinhard Six, European Investment Bank*
- Business models for upscaling building renovation, *Paul Kenny, Tipperary Energy Agency, Ireland*

18.30 End of the conference day

followed by drinks reception, evening programme & dinner **(Minoriten)**

Friday, 28 February 2014, Stadthalle

08.45 NZEB Strategies and Technologies

Chair: Christiane Egger, OÖ Energiesparverband, A

- The European Building Policies
  MEP Fiona Hall, Member of the European Parliament, Vice-President Eufores
- The city of the future - research & technology development, *Theodor Zillner, Federal Ministry for Transport, Innovation & Technology, Austria*
- Do smart meters create smart consumers?
  Francisco Puente, ESCAN, Spain
- Energy technology concepts for NZEB neighbourhood, *Hans Erhorn, Fraunhofer Institute of Building Physics, Germany*

10.20 Coffee break

10.45 Working Group: key factors for successful NZEB policies
Stadthalle, 1st floor (in English only)

Chair: MEP Fiona Hall, Member of the European Parliament, Vice-President Eufores

- National Plans - a comparison
  Andreas H. Hermelink, Ecofys, Germany
- The Danish National Plan
  Kirsten Engelund Thomsen, Danish Building Research Institute, Aalborg University Copenhagen, DK
- "Nearby use of renewable energy sources"
  Jarek Kurnitski, Tallinn University of Technology, Vice-president REHVA, Estonia

Project flash – Perspectives & Initiatives

- Boiler exchange programme
  Johannes D. Hengstenberg, co2online, Germany
- Legal and economic aspects of cross-building energy exchange, *Markus Schwarz, Energieinstitut a. d. JKU, Austria*
- Energy development plans - spatial planning for more energy efficiency, *Tobias Wagner, Technische Universität München, Germany*

12.40 Conference end

13.30 Technical site-visits "Nearly Zero Energy Buildings"

Meeting point: 13.30 in front of the Stadthalle
Return: 17.00 Airport Linz
17.30 Train station Wels
17.40 Stadthalle

‘NZEB Renovation’ in the Building Stock: Policies, Impact and Economics

Lukas Kranzl[a], Bogdan Atanasiu[b], María Fernández Boneta[c], Veit Bürger[d], Tanja Kenkmann[d], Andreas Müller[a], Agne Toleikyte[a], Lorenzo Pagliano[e], Marco Pietrobon[e], Roberto Armani[e]

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[c)] CENER, National renewable energy center C/ Ciudad de la Innovación, 7 -31621, - Sarriguren (Navarra) Spain

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Summary

Achieving ambitious GHG mitigation targets will require substantial effort in effective thermal building renovation and increasing share of RES-H/C in the existing building stock. Previous studies show that the uptake of deep renovation measures will strongly affect the level of energy demand for heating and cooling in the coming decades. The objective of this paper is to investigate (1) the impact of ‘nZEB-renovation’ on heating and cooling energy demand in the coming decades and (2) the impact of policies on the uptake of ‘nZEB renovations’. We start with a discussion of the concept and options to characterize ‘nZEB renovation’. We suggest a harmonised approach of ‘nZEB renovation’ for our analysis, at the same time taking into account country specific issues. Subsequently, we analyse current and possible future options for increasing ‘nZEB renovation’ and investigate the impact in a bottom-up model of the building stock for the countries AT, BG, CZ, DE, ES, FI, FR, IT and RO. The results, which will be presented in the presentation, show (1) the share of different renovation quality levels, including ‘nZEB renovation’ levels on the whole renovation activities in the building stock in different scenarios, (2) the effect on heating and cooling energy demand and (3) the impact of different policy sets by a comparative analysis of different policy scenarios. For a high share of nZEB-renovation levels and in order to avoid lock-in effects, strong, consistent and target group oriented policy packages are required.

1. Motivation and objective

The building sector is the largest consumer of energy in Europe, accounting for nearly 40% of the total consumption and 36% of the greenhouse gas emissions (EC, 2013). While new buildings can be constructed with high energy performance levels, the existing stock is predominantly of poor energy performance and will still have the predominant share in 2050. Consequently, there is a high need of renovation work. With their potential to deliver high energy and CO_2 savings, measures to increase the energy performance of existing buildings can play a pivotal role in a sustainable, low carbon future. At the same time, building renovation provides a number of societal benefits, including fuel poverty alleviation, health benefits, increased energy security, increased employment, higher rental and resale values and air quality improvement.

The Energy Performance of Buildings Directive (EPBD, 2002 & EPBD, 2010) introduced in 2002 and reinforced by the 2010 recast, introduces the requirement of implementing energy efficiency measures in case of major renovation of a building[1] and all EU Member States (MS) transposed it into national legislation. At the same time, the EPBD asked EU Member States (EU MS) to introduce cost-optimal energy performance requirements for renovation activities as well as to eliminate the market barriers and to introduce economic support instruments to stimulate the renovation of the existing building stock.

While the EPBD requirement for nearly zero-energy buildings (nZEB) addresses only future standards by 2020 that will influence new constructions, the EU MS have to prepare implementation plans that should also comprise measures to move the existing building stock towards nZEB levels.

The IEE project ENTRANZE integrates the different levels of the EPBD requirements, i.e. taking into account the requirements for new buildings and building refurbishment. The project provides data, develops innovative policy settings and investigates the impact of different policy implementations. By these activities, the project supports policy makers in several EU-member states in the implementation of EPBD requirements. This paper summarizes main outcomes of the project, focusing on the impact of 'nZEB-renovation' and how to link challenges and options for defining 'nZEB-renovation levels' with the cost-optimum calculations according to the EPBD (recast).

Thus, the core research questions of this paper are:

- What is the impact of deep renovation in scenarios for EU-28 countries on heating, hot water and cooling energy demand until 2030?
- What is the role of policies to increase the amount of deep renovation activities?

The question will be examined with the following sub-questions:

- How to define nZEB renovation? International (and national) approaches? How to derive a pragmatic definition, which can be operationalized in a scenario modelling approach with relevant policy implications?
- How is the economic comparative performance of different sets of renovation measures? (and the link to cost-optimality?)
- Which policy instruments are suitable to motivate deep renovation measures in the building stock. Which detailed policy design is necessary to stimulate a sufficient rate of deep renovations.

[1] According to the EPBD, major renovation is defined as one affecting 25% of the building envelope or where the total cost related to the building envelope or the technical building systems is 25% or more of the value of the building.

In our paper we will deal with these questions for a selected number of EU-countries.

The paper is based on the work done in the IEE projects ENTRANZE (www.entranze.eu). Our approach to define nZEB-renovation levels is closely linked to the work in the IEE project COHERENO (www.cohereno.eu, (Atanasiu et al., 2013a).

2. Methodology

The approach of this paper consists of the following steps:

- Development and comparison of policies to support thermal building renovation and in particular ambitious renovation levels
  In this step we start with an investigation of current policies in EU member state to support building renovation. In particular, we focus on those measures incentivising ambitious levels of thermal building renovation. As far as possible, we also integrate the national plans of EU member states in the framework of the EPBD in our comparative analysis (although their comparison is hard due to the lack of a harmonised structure up to now). Consequently, we develop innovative policy sets to support thermal building renovation. These policy sets have been discussed with policy makers within the nine target countries considered in our analysis.
- Comparison of approaches to define nZEB- and deep renovation and deriving an approach to operationalize a definition for nZEB renovation in scenario simulation with policy relevance
  There is a wide range of different approaches to define nZEB renovation or deep renovation. We document these different approaches and suggest a methodology to define nZEB renovation with a relative and an absolute indicator, linking the absolute indicator to country specific conditions. The latter aspect is taken into account via the cost-optimality calculations carried out in the frame of the EPBD (recast).
- Scenario simulation for renovation activities with Invert/EE-Lab
  We use the disaggregated bottom-up model Invert/EE-Lab for developing scenarios for renovation activities in the building stock of the investigated countries. The model describes the building stock (both residential and non-residential buildings) on a highly disaggregated level and takes into account policy settings by a simulation of decision making processes of building owners. For the description of the model Invert/EE-Lab see e.g. Müller, (2012), Kranzl et al., (2011), Kranzl et al., (2013), www.invert.at. The data is based on the development of the database in the project ENTRANZE and presentation in an online datatool (www.entranze.eu).
- Derive conclusions
  Based on these analyses, we derive conclusions regarding the impact of nZEB renovation on energy demand and on the impact of policies on the uptake of nZEB renovation.

3. Policy analysis for building renovation

For each of the target countries several policy sets have been defined and quantitatively assessed in order to learn about the impact of different policies on deep renovation activities. The definition of policy sets was based on three elements:

- In order to ensure continuity those policies that are currently in place in the different countries (especially building codes or other building related regulations, financial support instruments)
- Member States' plans to develop their building regulations towards the nZEB standard
- A comprehensive list of different generic instrument options all of which are targeting at deep modernisation measures in the building sector

The EPBD was the first major attempt requiring all EU MS to introduce a general framework for setting building requirements based on a whole building performance. Examining the requirements set by each EU MS, it is clear that large variations exist in terms of the approach each country has taken in applying buildings regulations. In general in the EU MS two approaches exist in parallel, one based on the building's energy performance and the other one on the specific performance of single elements. In some EU MS, the requirements for whole building's performance act as a supplementary demand or alternative to single element requirements. A short summary of building's energy requirements in case of renovation in the ENTRANZE countries is presented in Table 1.

Table 1. Summary of builidng's energy requirements in case of renovation in selected countries
Sources: Atanasiu et al., (2013b), BPIE, (2013)

AT	Specific maximum heating energy demand requirements for major renovation of residential and non - residential buildings. Values for renovated buildings are around 25-38% higher than new build requirements. Heat recovery must be added to ventilation systems when renewed. Maximum permitted U values for different elements in case of single measure or major renovations. Prescriptive requirements to limit summer over-heating.
BG	Regulations requiring performance-based standards of existing housing and other buildings after renovation. Requirements for new and renovated buildings are the same.
CZ	Performance-based requirements when a building over 1 000 m 2 is renovated. Requirements for new and renovated buildings are the same. Individual parts of the building envelope and systems in the buildings have to fulfil minimum requirements. If it is not possible to achieve the minimum performance criteria, this has to be proven by means of an energy audit. There are also minimum requirements in case of major renovation of individual building elements such as for U -values, internal temperature at the internal leaf of envelope structures (which has to be higher than dew point temperature), thermal bridging limits to avoid condensation, thermal stability of the room in summer and in winter, minimum efficiency of boilers, etc. Furthermore, buildings shall achieve a healthy indoor climate.

DE	Both energy performance and specific component-based requirements. For renovations of single components or systems, there are specific requirements for these components/systems. Alternatively the building owner can choose to prove that the primary energy demand requirements for retrofitted buildings are met (140 % of the demand for a comparable new building). Building surface components and building system components must not be changed in a way that decreases the energy performance of the building. There are additional cost-effective obligations that need to be fulfilled by the building owners within a specific time-frame for: insulation of hot water pipes and top floor ceilings, retrofit of HVAC systems and replacement of electrical heat storage systems.
ES	Existing buildings over 1000 m^2 must comply with the same minimum performance requirements as new buildings if more than 25% of the envelope is renovated. There are additional energy efficiency requirements for building elements, heating and lighting systems, minimum solar-thermal contribution and in certain cases also for minimum solar photovoltaic contribution.
FI	Shift from requirements concerning the heat loss of individual components to one indicator (the E index) describing the total calculated energy use of the building. New regulations came into effect on 1 June 2013 introducing minimum energy performance requirements for energy efficiency concerning renovations. There are three ways to achieve these requirements: a) improving the heat retaining capacity of building parts that need reparation or renewal, b) improving the energy efficiency of the building by examining the whole building's energy consumption in relation to its surface area, c) reducing the building's E - number, by reducing the total energy consumption of the buildings Technical systems (like heating and ventilation) have their own requirements and should be checked when insulation is added to the building, when air - tightness is improved, or when systems are renewed.
FR	Performance-based requirements for buildings undergoing renovation apply for residential buildings and values depend on the climate and type of heating (fossil fuel/electricity). Requirements for components also apply during building renovation. New renovation requirements for all buildings are expected to come in 2013. For major renovations (>1000 m^2): the overall energy performance target for renovated buildings built after 1948 is in the range 80-165 kWh/m^2/year since 2010. For renovations <1000 m^2: element-based requirements for replacement or renovation of elements (for heating, insulation, hot-water production, cooling and ventilation equipment). For large renovations, a minimum summer comfort level is required in order to avoid the use of cooling systems. Smart systems should be installed every time there is major renovation work on a building.
IT	Energy performance requirements are based on single components, with the same requirements as new buildings. There are also minimum energy efficiency requirements for boilers.
RO	Regulations requiring prescriptive component-based requirements of existing housing and other buildings after renovation. After renovation, the building have to fulfil certain minimum requirements for the individual components and systems.

There is a major challenge to improve the energy performance of Europe's buildings stock. Policies and roadmaps are moving fast to a longer time horizon, focusing on the years 2020, 2030 and 2050. With Europe's overall policy aiming to significantly decarbonise its economy by 80 to 95 % by 2050, the building's sector, with 40% of the region's energy consumption and almost the same level of CO_2 emissions, must play a key role.

However, any strategy to tackle the challenge in the buildings sector will require significant economic support and mainly in terms of funding – funding that continues throughout the entire time period.

In 2012, BPIE undertook a review of the financing instruments in Europe evaluating financial instruments in place (Economidou et al., 2011) and their effectiveness and impact. This BPIE review has led to the following findings:

- In general, all 27 MS have on-going programmes to support the energy performance of buildings, in the form of conventional or innovative or through the help of external funding.
- Most of financial instruments have targeted existing buildings, mainly in the residential sector.
- Grants and subsidies are used more than other financial instruments. They are followed by preferential loans. Fiscal instruments (e.g. tax credits) are widely used but not to the extent of financial instruments such as grants.
- Many of the new Member States are more highly reliant on external funding (e.g. EU structural funds or support through international financial institutions such as the European Investment Bank) than most of the EU-15.
- While there are many programmes in place, the understanding of their overall effectiveness is unclear. Relevant information on different programmes evaluation is often hard to collect and even harder to compare because there is no standardised way to monitor and evaluate the individual programmes and Member States using different key performance indicators. Very few programmes have set ex-ante goals and objectives, and few have an evaluation of their effectiveness. Few of the programmes have identified an on-going monitoring (feedback) process along the programme implementation.
- Few financial instruments target deep renovations or low energy buildings in general.
- Many financial instruments target specific technologies or building aspects although about one-third of the financial instruments support a holistic approach.
- Non-government instruments such as Energy Performance Contracting and Energy Efficiency Obligations (white certificates) have important roles to play because they can mobilise private funding.
- European-wide and international funding streams (EU Structural Funds, European Investment Bank and the like) are increasingly important and can play an even greater role in the future. There is some concern that some Member States are almost entirely dependent on such funding for their "national" programmes.
- There is no single solution. Funding a major retrofit strategy will require the use and possible bundling of all of the financial instruments available because of the overall cost of a deep retrofit.
- There is much more to know and learn from existing programmes. New ways are needed to better understand the existing programmes in order to learn how to achieve better implementation and impact.

A great variety of economic instruments are available throughout Europe to support the improved energy performance of buildings. The way Member States use them vary from country to country, mostly depending on the political context.

These economic instruments can be divided into two broad categories: **"conventional"** and **"innovative"**. The conventional financial instruments that have been used since the oil crises of the 1970s include: grants and subsidies, loans, and tax incentives. Levies have been used to a much lesser extent. There have also been funds (such as from international financial institutions) that

often provide the financing for loans or grants. There are also funds coming from the selling of Assigned Amount Units (AAUs), also known as carbon credits, under the Kyoto Protocol that have been used for the funding of subsidy schemes.
Each support instrument contributes in a different way to overcome the significant market barrier which is financing. As it was mentioned in several previous studies, while over the lifetime of the building it is cost-effective, the investments in low-energy buildings are high and this is very often a major barrier for undertaking major improvements of buildings' energy performance. Overall, the most common economic instruments used in Europe are:

- **Direct grants or subsidies**: can be offered from public funds and are directly allocated by the authorities or, more typically, accessed through banks or foundations.
- **Preferential loans schemes** encourage energy efficient practices by subsidised interest rates or credit risk support. Typically, national and local authorities support these schemes by regulatory measures, by sharing the risks with the banks and/or by covering a share of the loan interest.
- **Value Added Tax (VAT)** normally affects the final consumer but not the producer – who passes the cost onto the consumer. Differential VAT rates can be used to influence the choice of energy efficient technology or energy performance upgrade measures by householders.
- **Taxes, tax incentives or tax rebates** which can take three forms: a) a tax on energy, b) sales tax incentives to promote market penetration, or c) tax rebates given in recognition of energy savings investments. These are accessed either through the tax office or at point of sale. The energy and/or climate taxes may be used for creating a fund for financing measures that contributes to the reduction of the energy consumption and associated GHG emissions (e.g. a levy on electricity sales to fund renewable energy schemes)

Less common economic instruments include energy supply obligations (white certificates) or energy performance contracting (and energy services companies-ESCOs). They are considered innovative even if, for example, energy performance contracting has been around since 1980s and energy supply obligations since 1990s, at least in Europe. There is another distinction, which is important for policymakers: these innovative instruments normally rely on private financing and not government budgets, although there are exceptions.

For an overview of the policies planned by Member States to comply with the nZEB related requirements of the EPBD a cross-analysis was done of the National Plans for increasing the number of nZEB which Member States were required to submit mid 2012.
The analysis indicates that the planned policies do not reflect sufficient effort of many Member States to reach the nZEB requirements. In particular regarding deep renovations the degree of ambition is rather low in most countries. A more detailed description of this comparative analysis will be given in the full paper.
In order to broaden the sometimes narrow discussion about instrument approaches in the building sector (which often is restricted to building codes and governmental grant or soft loan schemes) a comprehensive overview of different environmental economic approaches has been added. The introduced policies range from regulatory measures, different types of economic approaches, market transformation (supply side) measures to "soft" policy instruments. A certain priority was given to innovative measures, for instance instruments that are independent from public budgets by

mobilising alternative funding sources. In addition a set of measures has been identified that aim at overcoming the rather specific barriers of different target groups such as homeowner associations, rental homes, low income homeowners or the public sector.
Instruments are covered that either target insulation measures at the building envelope or aim at increasing the efficiency or reducing the carbon-intensity of the active heating and cooling systems in a building.

4. Challenges and examples of characterising 'nZEB renovation'

Since nZEB-definition is a national issue and we want to draw conclusions beyond the national level, a core objective of this chapter was to derive a harmonised approach of nZEB-renovation definition allowing to develop comparable scenarios of nZEB-renovation in different EU member states.

The recast EPBD requires EU MS that all new buildings have to be nearly zero-energy buildings (nZEB) from 2021 onwards (and from 2019 onwards for public buildings). Acknowledging the diversity of the European buildings sector, EPBD requires MS to draw up specifically national nZEB approaches and national plans reflecting national, regional or local conditions. These plans must translate the nZEB requirements into practical and applicable measures and definitions to steadily increase the number of nZEB.
In order to prepare the first progress report as requested by the EPBD, the EU Commission asked the EU MS in autumn 2012 to show the status of the nZEB implementation.
So far, 14 MS reported to the EU Commission their plans towards implementing nZEB[2], but only few of them presenting an officially assumed national nZEB approach for 2020. The other MS which didn't report yet are in different stages of the elaboration of nZEB preparatory studies or didn't arrive yet at an official agreement.
Analysing the already declared nZEB definitions and implementation plans, it becomes clear that the approaches vary largely among the EU MS in terms of methodologies and ambition and therefore it is impossible to coagulate them in a single pan-European definition. Moreover, this makes even more difficult the efforts to define a more or less consistent definition of what nZEB renovation means and what should be in order to lead to important energy and carbon savings.
An ambitious, more consistent and better defined nZEB renovation can be a passive house renovation.
However, when renovating a building towards passive house standards, practice has shown that is sometimes difficult to reach the requirement for space heating demand ≤ 15kWh/m^2/yr as requested for new build passive houses (Mlecnik, 2013). In practice many buildings that have undergone large-scale renovation using passive house recommendations can end up with a space heating demand of about 25-30 kWh/m^2/yr. The Passive House Institute itself suggested an 'EnerPHit' standard for renovations[3] requiring a space heating demand ≤ 25 kWh/m^2/yr, but it remains unclear whether this requirement fits all types of existing houses. For example, building

[2] Available at: http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm
[3] See also the IEE project "Improving the energy performance of step-by-step refurbishment and integration of renewable energies (EUROPHIT)":

regulations might restrict the renovation of building components and listed architecture and sometimes existing thermal bridges are difficult to solve in a cost-effective manner.

Deep renovation of buildings is a wide-used term for defining renovations measures that deliver consistent energy savings. However, even deep renovation has many meanings and in order to identify existing definitions for deep renovation, Global Buildings Performance Network (GBPN, 2013) conducted in 2013 a study on current state of the play and looked at existing approaches worldwide. The main part of the experience was found in European Union (EU) and the United States (US).

This definition identifies a 'window of possibility' for a 'deep renovation'. The minimum energy requirement will be set by the individual MS; however, this must be based on the EPBD Article 4 that states a minimum energy performance requirements 'are set for building elements that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are replaced or retrofitted, with a view to achieving cost-optimal levels'. This does not prescribe deep renovation but provides an opportunity to renovate with energy performance as a priority, including for building envelope elements that are retrofitted or replaced. Deep nZEB Renovation is, however, mentioned in the Article 5 of the Energy Efficiency Directive (EED). The EED asks EU MS to renovate 3% of the total floor area of public buildings. These renovations must meet at least the minimum energy performance requirements that it has set in application of Article 4 of the EPBD (stated above). This applies to all buildings over 250 m^2. Article 4 in the EED requires member states to establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private. This strategy must encompass 'policies and measures to stimulate cost-effective deep renovations of buildings, including staged deep renovations'.

On the 30th of July 2012, the European Parliament published a report on the proposal for an energy efficiency directive (EUP, 2012) where deep renovation is defined as 'a refurbishment that reduces both the delivered and the final energy consumption of a building by at least 80% compared with the pre-renovation levels'.

Through an extensive survey all around the world, GBPN study (GBPN, 2013) coagulated several more widespread definitions for deep/nZEB renovation such as in the followings:

- **Deep Renovation** or **Deep Energy Renovation** is a term for a renovation that captures the full economic energy efficiency potential of improvement works, with a main focus on the building shell, of existing buildings that leads to a very high-energy performance. The renovated buildings energy reductions are 75% or more compared to the status of the existing building/s before the renovation. The primary energy consumption after renovation, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting after the deep renovation of an existing building is less than 60 $kWh/m^2/yr$ (GBPN / definition often used in Europe).
- **Deep Retrofit** or **Deep Energy Retrofit** implies replacing existing systems in a building with similar ones that are of higher quality and performance, which leads to a better energy performance of an existing building. The primary energy consumption includes energy used for heating, cooling, ventilation, hot water, lighting, installed equipment and appliances. After the deep retrofit the buildings energy reduction is 50% or more compared to the status of the existing building/s the retrofit (GBPN / definition mainly used in US).

- **Deep Reduction** or **Deep Energy Reduction** is a term used in US for a deep renovation or a deep refurbishment, which aims at more than 75% reduction in energy use in comparison with that prior to the improvement.
- **Zero-Carbon-Renovation:** A deep renovation with large-energy consumption reductions, where the energy needed to supply the resisting need is carbon neutral
- **Zero-Energy-Renovation:** A deep renovation with large-energy consumption reductions, where the energy needed to supply the resisting need is supplied as renewable energy on site.
- Some definitions based on relative targets can support the clarification of deep renovation projects and can help to separate the level of ambition in deep renovation projects.
    - **Factor 2 Renovation**: A renovation with energy consumption reductions of 50% compared to pre-renovation performance.
    - **Factor 4 Renovation**: A deep renovation with energy consumption reductions of 75% compared to pre-renovation performance.
    - **Factor 6 Renovation**: A deep renovation with energy consumption reductions of 84% compared to pre-renovation performance (GBPN, 2013).
    - **Factor 10 Renovation:** A deep renovation with energy consumption reductions of 90% compared to pre-renovation performance

Based on the above mentioned findings and according to a report recently released within the IEE project COHERENO (Atanasiu et al., 2013a) a potential definition of nZEB renovation of a house seems to be defined as having one or more of the following characteristics:

1. The energy performance of the building after renovation fulfils the nZEB requirements for new buildings as they are defined at level of the EU MS and regions or/and
2. The primary energy consumption of the building after renovation is reduced by 75% as comparing to the pre-renovation status or/and
3. Potentially an additional primary energy minimum requirement of not more than 50-60kWh/m^2/yr energy consumption (GBPN, 2013) for heating/cooling, domestic hot water, ventilation energy consumption of auxiliary building's systems and
4. Potentially an additional minimum requirement for renewable energy share (proposed to be at least 50% of the remaining energy demand of the building as it is suggested in (BPIE, 2011) taking into account the nZEB definition from EPBD and
5. Potentially an additional minimum CO_2 requirement of no more than 3kg CO_2/m^2/yr as it is suggested in (BPIE, 2011) based on the needs to meet the long-term decarbonisation goals for residential and services sectors as resulted from the EU 2050 Roadmap for a low-carbon economy.

However, the above tentative definition for nZEB renovation seems to be more ambitious than many declared national nZEB approaches for new buildings of this report. In addition, while primary energy consumption of a building is the obvious indicator for defining nZEB, the differences between countries methodologies for evaluating the energy performance make all efforts for having a widely accepted nZEB definition almost impossible.

Hence, in order to identify in nZEB renovations it is necessary to develop a set of harmonised criteria, able to deal with all national approaches and existing definitions and to provide a consistent evaluation framework. Following these criteria, it will be possible to compile nZEB renovations, using national approaches based on existing instruments and standards on a given market. Moreover, the nZEB renovation criteria should not be “too ambitious” and strictly represent the forthcoming national nZEB definitions, since those will be for new buildings, and since this is not always possible to be reached by so called nZEB renovations. Therefore the set of criteria should act as radar and to be able to identify a wide range of activities, clearly identifying what is likely to be accepted as a holistic nZEB renovation but also revealing renovation activities near nZEB levels for new buildings. Therefore, the above mentioned report proposed a so called ‚nZEB radar‘ for tracking nZEB renovations and relative developments on a given market.

The ‘nZEB radar’ will allow to cover a broader range of standards, which are all close to nZEB but do not necessarily rely on absolute values. The “nZEB radar” will be accompanied by already existing tracking instruments on a national market, which are suitable to track best practice examples. Among these instruments, the most common are Energy Performance Certificates, nZEB demonstration projects, award winning refurbishments, government funded projects or high performance projects that have obtained a certificate (e.g. passive house), net zero energy buildings etc. In that way, it can be ensured that ‘marketable nZEBs’ will be identified.

To this end, the ‘nZEB radar’ as it is defined in Atanasiu et al., (2013a) consist in several layers/circles each of them identifying different ‚degrees‘ of nZEB renovation. The layers define the ambition of nZEB activities based on existing instruments on one market.

The concentric circles of the proposed ‘nZEB radar’ provide the opportunity to identify several levels of nZEB and ‘nearly nZEB’ renovations, taking at the same time into consideration the credibility and accuracy of the instruments used for spotting these.

Without being an ultimate definition, but an evolving concept to be adjusted during project’s implementation, (Atanasiu et al., 2013a) proposed a generic “nZEB radar” which is defined by 4 layers such as in the figure 1.

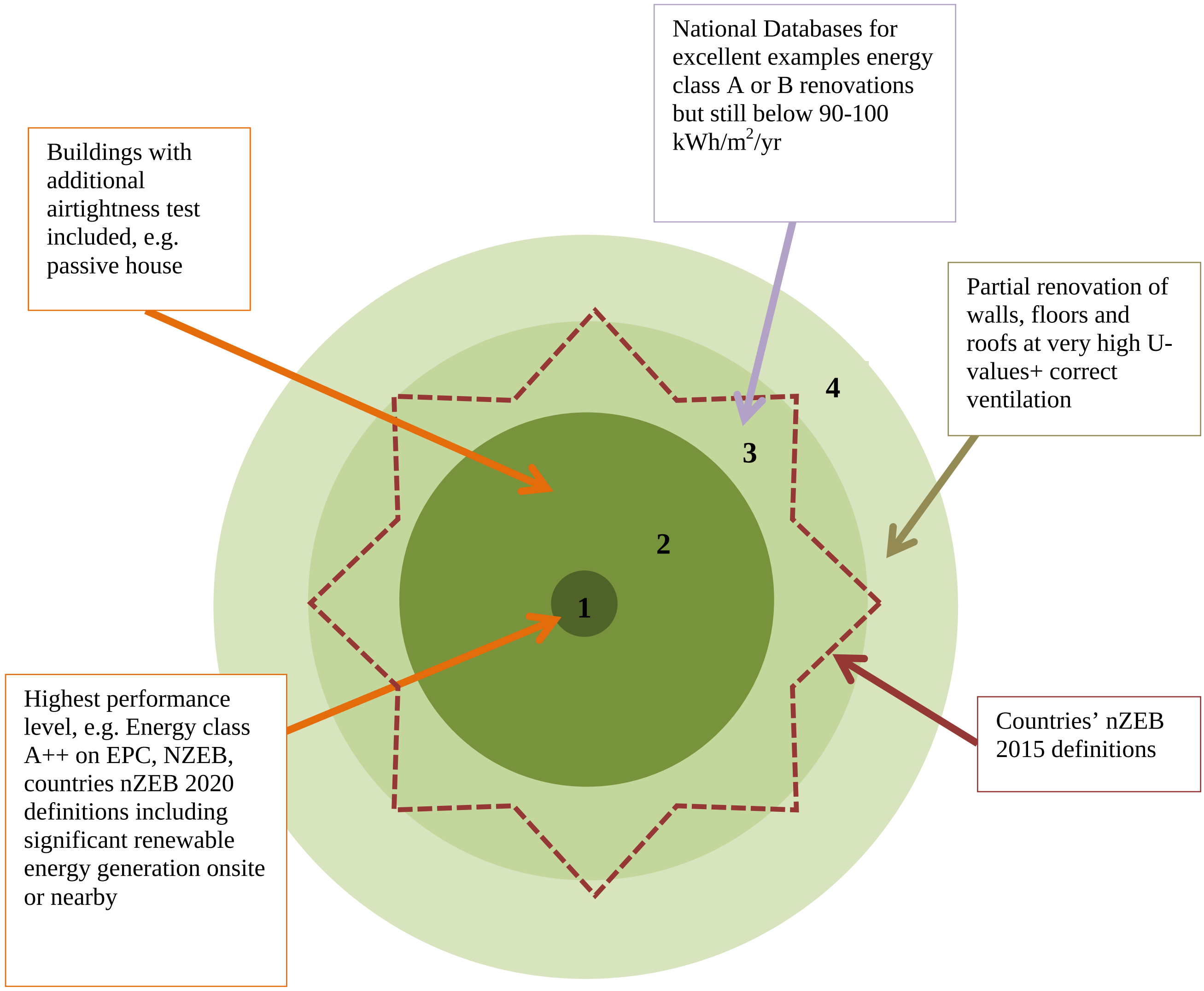

Figure 1: Example of nZEB radar which was created to depict different methodologies and standards for defining nZEB buildings

Based on the above, within this paper we decided to define two layers 'nzeb renovation radar' using a percentage reduction of primary energy demand (compared to the state of the building before renovation) and an absolute threshold in kWh/m²/yr. Both for the sum of space heating, hot water, cooling, ventilation, lighting, auxiliary energy. Therefore, the nZEB renovation activities will be organised initially in following categories:

- **Layer 1 (more ambitious nZEB): Reduction by 75% + threshold of 50 kWh/m²/yr (values may change subject to country specific issues, see below)**
- **Layer 2 (less ambitious nZEB): Reduction by 50% + threshold of 100 kWh/m²/yr (values may change subject to country specific issues, see below)**

However, while it is important to distinguish between different building types and climatic conditions (in particular for the absolute threshold), within this paper we will take into account country specific characteristics. This will be done by taking into account absolute threshold values for each country considering the results of the cost-optimality calculations. This means that we will consider two points in this paper for each of major building types analysed, i.e. the cost-optimal renovation and the nZEB renovation points. According to the results of cost-optimal calculations undertaken within ENTRANZE, if cost-optimal renovation will result to be rather a shallow renovation (i.e. below 50% and close to 25%) then we may choose a third point from cost-optimal curves which will reflect the moderate renovation (i.e. around 50% savings or 100kWh/m2/yr) and will be somewhere between the cost-optimal point and the nZEB point (see figure 2 below).

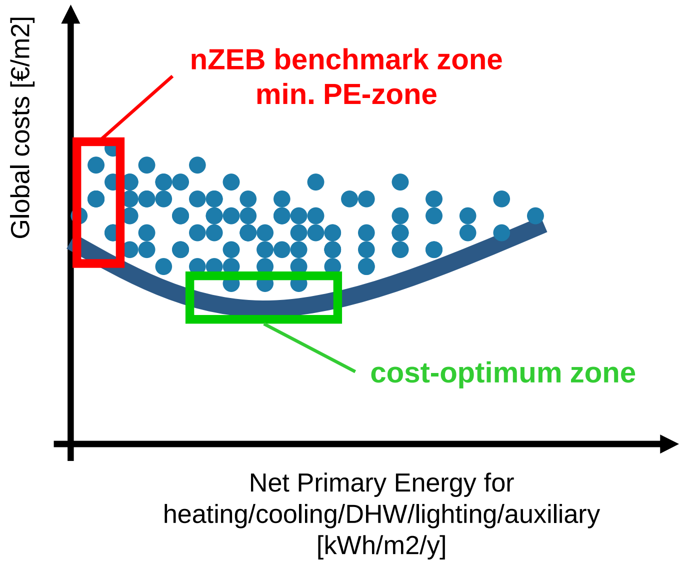

Figure 2: Cost-optimum and nZEB benchmark zone in the calculation of different building variants, see also Atanasiu et al., (2011), Hermelink et al., (2013)

5. Policy scenarios of uptake of renovation measures

The conference presentation will include policy scenarios for the uptake of renovation measures. They will be based on (1) the definition of nZEB renovation levels described above, (2) the existing policy settings and measures laid out in the nZEB plans and (3) possible future, additional policy sets. For each investigated country, a frozen-policy scenario will be the starting point. This frozen policy scenario will assume that current policies will remain in place in the coming decades. In addition to this frozen policy scenario, two policy scenarios will be presented with different types of policy packages, including economic incentives, regulatory measures and training, information campaigns, quality management etc.

The scenarios will show for selected EU-Member States (1) the rate of thermal building renovation, (2) the share of different quality levels of renovation (including the two nZEB renovation levels), (3) the impact of these renovation measures on overall energy demand for heating, hot water preparation and cooling and (4) economic indicators like overall costs (investments, energy) and public costs in case of economic policy incentives.

6. Conclusions

Based on the analysis described above, the presentation includes conclusions regarding the following aspects:

- Level of achievable energy demand reductions with different policy sets and different uptake of renovation measures
- Role of different type of measures (target group oriented policy bundles, regulatory measures, economic incentives, …)
- Aspects to be considered for the effective and efficient design of policies for nZEB renovation
- Outlook and discussion on possible options to define 'nzeb renovation'. To which extent is the approach chosen for the scenario development in this paper suitable for policy implementation on the EU level?

Preliminary results and related other work (e.g. Müller et al., (2010), Jochem et al., (2012), Kranzl et al., (2012)) show that energy demand for space heating, hot water and cooling may be reduced by about 70% until 2050 with an efficient uptake of nearly-zero energy renovation compared to a reduction of about 40% until 2050 with lower ambitious renovation activities. Due to the long lead times, early action is required and at the same time, lock-in effects should be avoided. Regulatory measures in combination with innovative economic incentives and target oriented information, training, coaching, quality management and R&TD are able to provide conditions for an ambitious uptake of nZEB renovation activities.

Complete scenarios for heating and cooling energy demand of the European building stock for different policy settings will be available until Autumn 2014 (www.entranze.eu).

7. References

Atanasiu, B., Boermans, T., Hermelink, A., Schimschar, S., Grözinger, J., Offermann, M., Thomsen, K.E., Jorgen, R., Aggerholm, S., 2011. Principles for nearly Zero-energy Buildings. Paving the way for effective implementation of policy requirements. Buildings Performance Institute Europe (BPIE).

Atanasiu, B., Kunkel, S., Kouloumpi, I., 2013a. Criteria to track nZEB housing renovation, COHERENO Collaboration for housing nearly zero-energy renovation.

Atanasiu, B., Maio, J., Staniaszek, D., Kouloumpi, I., 2013b. Building policies and programs in the EU-27 -EU overview and nine factsheets on ENTRANZE countries. Deliverables D5.1 and D5.2 of WP5 from Entranze Project.

BPIE, 2013. Boosting building renovation. An overview of good practices Renovation requirements, long-term plans and support programmes in the EU and other selected regions.

Economidou, M., Atanasiu, B., Despret, C., Maio, J., Nolte, I., Rapf, O., 2011. Europe's buildings under the microscope. A country-by-country review of the energy performance of buildings. Buildings Performance Institute Europe (BPIE).

GBPN, 2013. What is a deep renovation definition? Technical report.

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.

Jochem, E., Bürger, V., Dengler, J., Fette, M., Henning, H.-M., Herbst, A., Kockat, J., Kost, C., Reitze, F., Schicktanz, M., Schnabel, L., Schulz, W., Steinbach, J., Toro, F., 2012. Erarbeitung einer Integrierten Wärme- und Kältestrategie. Handlungsempfehlungen. Im Auftrag des deutschen Umweltministeriums.

Kranzl, L., Fette, M., Herbst, A., Hummel, M., Jochem, E., Kockat, J., Lifschiz, I., Müller, A., Reitze, F., Schulz, W., Steinbach, J., Toro, F., 2012. Erarbeitung einer Integrierten Wärme- und Kältestrategie. Integrale Modellierung auf Basis vorhandener sektoraler Modelle und Erstellen eines integrierten Rechenmodells des Wärme- und Kältebereichs. Wien, Karlsruhe, Bremen.

Kranzl, L., Hummel, M., Müller, A., Steinbach, J., 2013. Renewable heating: Perspectives and the impact of policy instruments. Energy Policy.

Kranzl, L., Müller, A., Formayer, H., 2011. Kühlen und Heizen 2050: Klimawandel und andere Einflussfaktoren, in: Märkte Um Des Marktes Willen? Presented at the 7. Internationale Energiewirtschaftstagung an der TU-Wien, Wien.

Mlecnik, E., 2013. Innovation development for highly energy-efficient housing. Opportunities and challenges related to the adoption of passive houses. Sustainable Urban Areas. TU Delft, Delft.

Müller, A., 2012. Stochastic Building Simulation, working paper. Available at http://www.marshallplan.at/images/papers_scholarship/2012/Mueller.pdf., Berkely.

Müller, A., Biermayr, P., Kranzl, L., Haas, R., Altenburger, F., Weiss, W., Bergmann, I., Friedl, G., Haslinger, W., Heimrath, R., Ohnmacht, R., 2010. Heizen 2050: Systeme zur Wärmebereitstellung und Raumklimatisierung im österreichischen Gebäudebestand: Technologische Anforderungen bis zum Jahr 2050. Gefördert vom Klima- und Energiefonds.