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World Sustainable Energy Days 2016

24 – 26 February 2016
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6 conferences | 6 Konferenzen:

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Europäische Pelletskonferenz

European Nearly Zero Energy Buildings Conference
Europäische Niedrigstenergie-Gebäude Konferenz

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Konferenz "Energieeffizienz-Dienstleistungen"

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OÖ ENERGIESPARVERBAND

BUILDINGS TRANSITION AND ENERGY SAVINGS BY 2050 WHILE IMPLEMENTING NZEB STANDARD

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ABSTRACT

The Energy Performance of Buildings Directive (2010/31/EU (EPBD)) requires the EU-Member States to define nZEB (nearly zero energy buildings) standards for new buildings and energy efficiency requirements for building renovation. Standard definition in terms of the primary energy demand and building codes for building elements differ from country to country. The main research question of this paper is as follows: How do the current building standards reflect the building stock transition and corresponding energy demand targets of the building sector until 2050?
The current national building codes and national definition of the nZEB are analysed and compared in France, Italy and Poland. Moreover, an ex-post analysis of the building energy demand by different standards is carried out. Based on the national definitions the energy demand scenarios are calculated. The scenarios are modelled by using a bottom-up, techno-socio-economic approach in Invert/EE-Lab model. Scenario results show the energy demand reduction of 25% from 2012 to 2050 in France in the current policy scenario. There is a high potential for the building renovation which is partly lost due to the lack of a strong building standard in the Business-as-usual scenario. A strong attention to the renovated building standards is needed in order to avoid log-in effects. The final version of the paper will include results for Italy and Poland and cross-country comparison analysis.

Keywords: Energy efficiency, building sector, nZEB, energy modelling, energy demand scenarios

1. INTRODUCTION

The main legislation on European level setting the instruments to reduce energy consumption of buildings is the Energy Performance of Buildings Directive 2010/31/EU (EPBD). The directive requires inter alia constructing new buildings to be built as nZEB (nearly zero energy buildings) from 31 December 2020 onwards (public buildings by 31 December 2018). Moreover, the EU-Member States must set minimum energy performance requirements for the major renovation of buildings [1].
The directive has to be implemented on the national level taking into account the country specific parameters such as building condition, climate, already existing building standards etc. Thus, the implementation of the directive differs from one country to another in terms of the ambitiousness of the energy efficiency requirements for new construction and building renovation.
In this paper, we want to test the effectiveness of the existing national building requirements to reduce energy demand of the building sector by 2050. In order to do so, we firstly analyse the national legislation on the building energy performance requirements and assess building construction statistics. In the second step, by using a bottom-up approach, we calculate energy demand scenarios by 2050.
We build this assessment on a harmonised methodology for the calculation of energy needs and primary energy demand according to EN13790. However, we are aware that the national definitions, calculation methodologies and standards might differ to some extent. This is a limitation of the cross-country comparison of this analysis.

2. METHOD

2.1. Ex-post analysis of the nZEB construction and renovation

The ex-post analysis of the building construction is based on statistical data assessment. The sources are mainly national statistics which were surveyed in the IEE project ZEBRA2020 (http://zebra2020.eu/) [2]. In order to do a comparison between the EU member states in terms of the building energy demand requirements, three different building standard definitions were carried out. The new building constructions are categorised as follows:

- buildings built according to the national building code
- buildings built better than building code and
- buildings built according to the national nZEB definition or better than nZEB definition.

The first category "Buildings build according to the national building code" reflects the building standards which were used inter alia in 2012 and until the time when the nZEB standard is in force. The definition "buildings built better than building code" describes these buildings which have better energy performance but don´t achieve the requirements of nZEB. "National nZEB definition or better than nZEB" definition describes the requirements set in the European Directive 2010/31/EU on energy performance of buildings which is defined as follows "*nearly zero energy building (…) a building that has a very high energy performance (…). The nearly zero or very low amount of energy required should be covered to a very significant extend by energy from renewable sources, including energy from renewable sources produces on-site or nearby*" [1]. The EPBD definition has to be implemented on the national level. The national definition of the nZEB is taken in this assessment.

To collect the building construction data according to the mentioned definitions, the national legislations and existing data bases were analysed. A cross-country analysis is carried out meaning that the countries are compared based on the abovementioned definition. However, in spite of the same definitions, the national standards of the building codes and nZEB definition differs from one country to another.

To compare the EU member state buildings which were renovated recently, the following definitions were chosen:

- minor renovation,
- major renovation and
- deep renovation.

"Minor renovation" is defined as renovation which reduces building transmittance values by 15% compared to not renovated building transmittance values. "Major renovation" means a reduction of the building transmittance values by 35% compared to not renovated building transmittance values and "deep renovation" corresponds to a renovation while implementing retrofit solutions which reduce the U-values by 60%. All these retrofit solutions lead to different energy savings and corresponding different cash flows of the investments. An additional renovation level was also taken into the calculation namely maintenance renovation. Maintenance renovation measure is a renovation undertaken for aesthetic reasons and is not related to thermal energy savings.

2.2. Modelling of the nZEB building penetration and energy savings by 2050

To calculate the nZEB penetration until 2050 and related energy savings, a bottom-up techno-economic approach is used. For this purpose, the building stock simulation tool Invert-EE/Lab is applied. Invert/EE-Lab is a dynamic bottom-up techno-socio-economic simulation tool that evaluates the effects of different policies on the total energy demand, energy carrier mix and CO_2-emission reduction [3], [4], [5].

Fig. 1 shows the simplified flow chart of the model. The package "Database" describes input data used in the model. The building stock data (I) can be clustered to the following data categories:

building types, building periods, building geometry, building envelope quality, heating supply systems, user profiles etc. These data were collected in an IEE project ENTRANZE for the three investigated countries [6], [7], [8]. Data on the new building standards (II) and renovation standards (III) is based on the national definition (see section “Ex-post analysis of the nZEB construction and renovation”). The package “Method” describes the methodology which covers three following steps. The first step is the energy demand calculation which is based on the monthly energy balance approach. In the second step, number of the new building construction, demolished buildings and renovated buildings are calculated. For this step, the Weibull-distribution approach is being used. Further, the type of renovation measure and type of heating system are chosen based on the investment-decision module and the nested logit approach. The model assigns the highest market share to the most cost effective measures. Thus, not only the most cost-effective option of the measures is taken into account but also the market share of less attractive options which is modelled with the nested logit approach.

The selection of a standard of new building construction is made as follows:

- If there is an obligation to build building according to a building standard (current national building code or nZEB), buildings are built according to the requirements which restrict the technological options that decision makers have.
- If there is no obligation to construct the building as nZEB, the selection of the building standard depends on the cost-effectiveness of the investments.

All these methodical steps are carried out for each single year starting with 2012 and finishing with 2050.

The model also uses the exogenous parameters which influence the decision process in the investment-decision module based on the abovementioned nested logit approach. These are inter allia the policy measures and energy fuel prices. Data on national policy measures were collected in IEE projects ENTRANZE and ZERBA2020 [9], [10], [2]. Energy fuel prices, renovation measures and their associated investment costs were collected in the frame of the abovementioned project ENTRANZE [11].

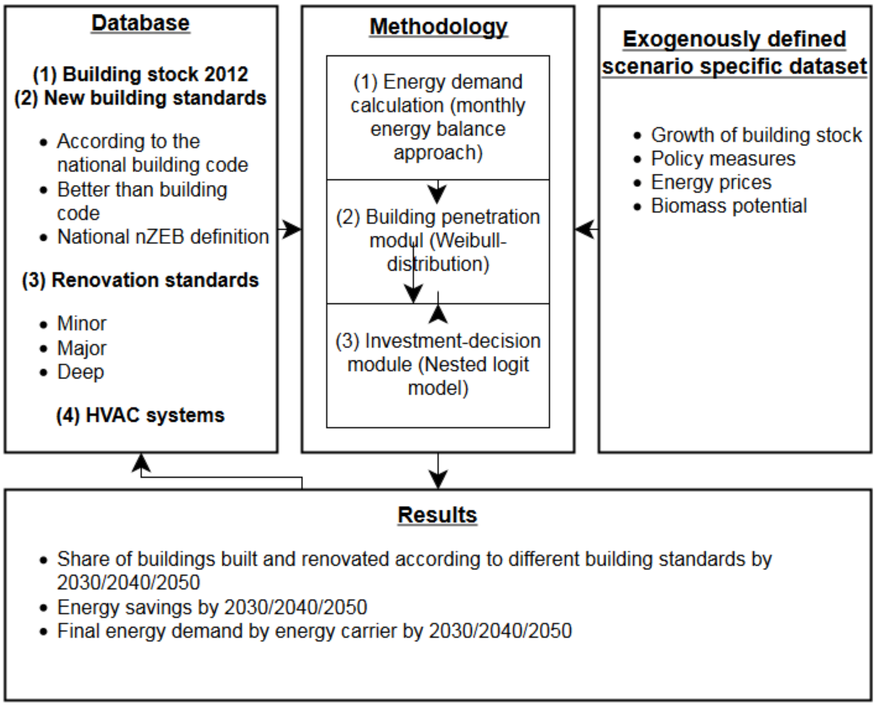

Fig. 1 Simplified flow chart of the model Invert-EE/Lab (own illustration based on [12])

3. RESULTS

3.1. Ex-post analysis of the building construction and building renovation: building codes and nZEB definition

To analyse and compare the investigated countries according to their building standards, three following building definitions were used: buildings build according to current national building standards, buildings built better than national building standards and buildings built according to national nZEB definition or better than nZEB definition. These definitions differ from one country to another in terms of the building energy performance requirements and building minimum transmittance value requirements as well as the time the requirements come into effect.

In France, the regulation RT2005 (French thermal regulation) was used from 2005 to 2012 which required building energy consumption in primary terms less than 150 kWh/m²/year. RT2012, the update of the regulation enforced from 2013 for new dwellings and from 2012 for new service buildings. This regulation sets a requirement for building consumption in primary terms of max. 50 kWh/m²/year. This latest requirement corresponds to the national French nZEB definition. That means that from 2013 all new buildings have to be built as nZEB [13].

In Italy, new buildings have to be built as nZEB starting in October 2015. The nZEB definition is formulated in Law 90/2013 "nearly zero energy buildings" which is a building characterized by a very high energy performance in which the very low energy demand is significantly covered by renewable sources, produces within the building system boundaries. The minimum transmittance values required for building elements have to be 15% lower from 2016 compared to the building codes used recently and given in Legislative Decree 311/2006 and by another 15% from 2021 [2].

In Poland, the nZEB requirements, "a building with low energy consumption" will be effective from 2019 for buildings occupied by government and from 2021 for all buildings. For the intermediate targets for 2015, the energy requirements for buildings are published in the Ordinance of the minister of Transport, Construction and Maritime Economy. The Ordinance provides requirements for the building transmittance values (see Fig. 3) and requirements for the non-renewable primary energy demand [2].

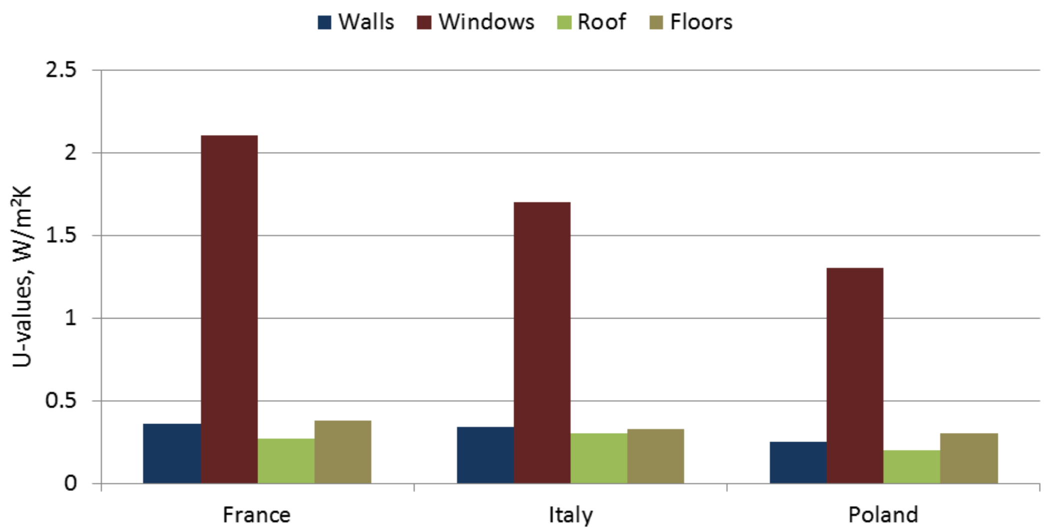

Fig. 2 The minimum building transmittance value requirements for building elements according to national building standards in France, Italy and Poland. U-values in France are defined in regulation RT 2012 coming into force from 2013 onwards as the national nZEB requirements. In Italy, the requirements are set in Legislative Decree 311/2006. These values are in force until 2016 and will be replaced with the requirements for nZEBs. In Poland, the requirements are defined in the Act of 29 August 2014, Dz.U. 2014 poz. 1200. The requirements for nZEB will be in force from 2018 respectively and 2021 onwards.

Fig. 3 shows the share of the new buildings build according to different building standards. In 2012, app. 30% of the new buildings were constructed as nZEB buildings (RT 2012) and app. 70% according to the national building codes RT 2005 in France. In 2013 and 2014, 100% of the new building construction was built as nZEB buildings required in RT 2012. In Italy, 10% of the new buildings were constructed as nZEB buildings and app. 50% of the buildings were built according to the national building code requirements (defined in Legislative Decree 311/2006) and app. 40% were built better that national building codes. In Poland, 35% of the new buildings were built according to the national building code (defined in the Act of 29 August 2014, Dz.U. 2014 poz. 1200), 53% of the new buildings were constructed better than national building codes and 12% of the buildings were built as nZEBs.

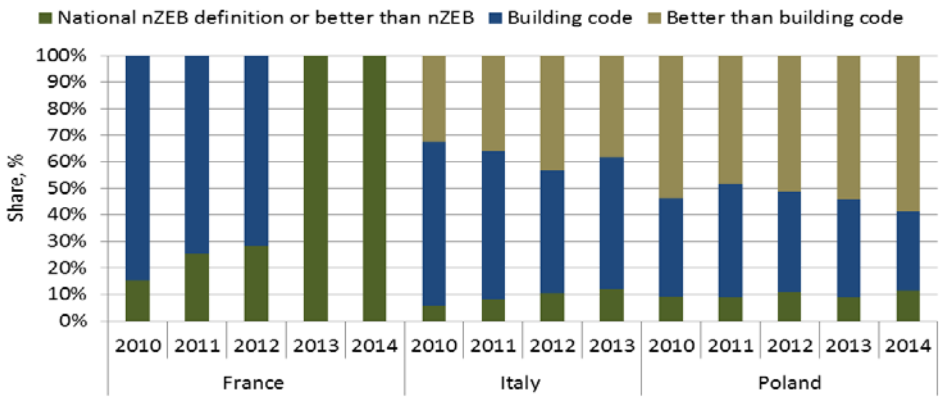

Fig. 3 Share of new dwellings built according to three different building standards: national nZEB definition, building code and better than building code [13]

3.2. Energy demand scenarios

Fig. 4 shows total cumulated floor area by different construction and renovation standards which are the main drivers for the total energy demand and energy savings in the building sector in the current policy scenario. Total floor area of the total French building stock was 2762 Mm² in 2012. Due to the French implementation of nZEB in 2013, a high penetration of new nZEB buildings can be expected by 2050. In 2020, the share of the new nZEB buildings is 2%, in 2030 – 8% and in 2050 18% on the total building floor area. The share of the renovated buildings floor area is 7% in 2020, 22% in 2030 and 63% in 2050. Starting from 2012, 63% of the total current building stock might be renovated until 2050. The split of the renovation levels in 2050 is as follows: 6% of the buildings are renovated according to the deep renovation level, 10% of the buildings use major renovation, following by the minor renovation with the share of 12% on the total building floor area. The maintenance renovation which is defined as a renovation without any energy performance improvement (e.g. paint of the façade) has a share of 35% on the total building floor area in 2050.

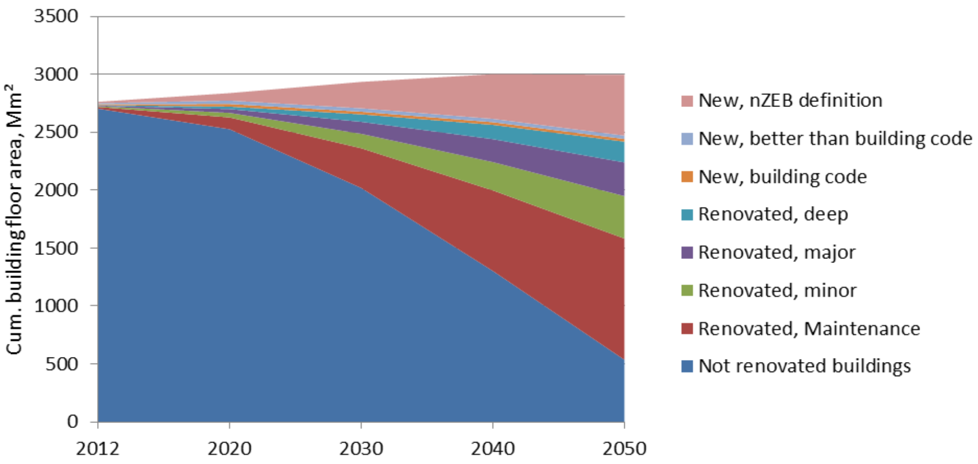

Fig. 4 Scenario results on the cumulated building floor area by different new building standards, renovation levels and not renovated buildings for France, 2012 to 2050, current policy scenario

Fig. 5 shows scenario results of the final energy demand for space heating and hot water from 2012 to 2050 in the French building stock. Final energy demand for space heating and hot water of the total French building stock is 509 TWh in 2012. The scenario shows a slow-down of the energy demand by 25% from 2012 to 2050. New building standards and ambitious renovation standards contribute to the energy demand reduction. Not renovated buildings energy demand is 493TWh in 2012 and is reduced by approximately 80% in 2050. The share of the new buildings energy consumption is 10% on the total building stocks energy demand in 2050. The renovated building stock energy demand makes up the share of 15% in 2050. Buildings undertaken a maintenance renovation has a high penetration from 2012 until 2050 which lead to a very high energy demand. This building stock might have the total final energy demand of approximately 192 TWh in 2050.

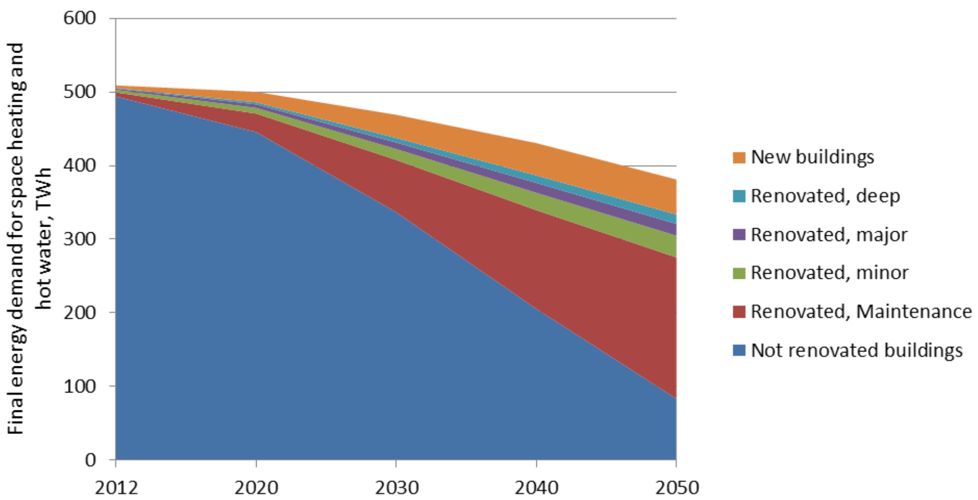

Fig. 5 Scenario results on final energy demand for space heating and hot water by different renovation standards and not renovated buildings as well as new buildings, France, 2012 to 2050, current policy scenario

4. DISCUSSION AND CONCLUSIONS

In this paper, an ex-post analysis of the nZEB definition in terms of building transmittance requirement was carried out for France, Italy and Poland. The comparison of the building codes and recent building construction activities according to different building codes were shown. The national definition of the current building codes and nZEB building standards as well as three

different level of renovation were implemented into the model Invert-EE/Lab to calculate the cumulated floor area as well as energy demand up to 2050.
The ex-post analysis showed the differences of the stage of implementation of nZEB between the countries. While in France, the nZEB definition is already in force, other investigated countries still use the current building codes. However, the comparison of the building transmittance values showed that the ambitious levels are very similar of the current nZEB definition in France and current building codes in Italy and Poland. This lets us say, that the thermal transmittance in the nZEB definitions in Italy and Poland aside from the late stage of the implementation could be expected to be more ambitious than in France. However, this does not allow any conclusion on the overall nZEB level in these countries, which is also influenced by energy requirements and calculation methodologies. This aspect will be tackled in a forthcoming report of the ZEBRA2020 project.
Preliminary scenario results show a slow-down of the final energy demand by 25% from 2012 to 2050 in France in the current policy scenario. The share of cumulated floor area of the new nZEB buildings is 18% on the total building floor area in 2050. The share of the final energy demand of these buildings is 10% on the total final energy demand in 2050. The calculation results showed a high share of the floor area of the buildings undertaken a maintenance renovation. These buildings have a high energy demand in 2050 accordingly. These buildings provide potential to be renovated by using a deep renovation and thus achieve very high energy savings by 2050. This potential, however, is lost in the BAU scenario due to the lack of the strong building standard. The results show a need of strong attention to the renovated building standards in order to avoid log-in effects.
However, the most recent developments in France regarding the implementation of a renovation obligation for low poerforming builidngs are not yet taken into account in this analysis.
In the full paper, scenario results for other countries namely Italy and Poland will be also shown and discussed.

5. ACKNOWLEDGEMENTS

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