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The role of recommendations in the Energy Performance Certificate

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1 Introduction

According to Article 7 of Directive 2002/91/EC, the Energy Performance Certificate (EPC) for buildings should include recommendations for a cost-effective improvement of the energy performance of the respective building. The recommendations demonstrate the improvement potential of the building from the energy efficiency point of view. This report discusses the role of the EPC recommendations in the Member States (MS) following these topics:

- Background and importance of EPC recommendations
- Type of information provided by EPC recommendations
- Advantages and disadvantages of standard and tailor-made recommendations
- Cost-efficient recommendations and the consideration of prebound or rebound effects in residential buildings
- Support mechanisms in implementing EPC recommendations
- Effective implementation of recommendations
- Conclusions

One of the goals of the EPC and its recommendations is to raise the renovation activities and, in doing so, to increase energy efficiency in the buildings. Having an overview on the renovation activities and renovation potentials of the buildings helps the MSs design their road maps towards energy efficiency. This report summarises the discussions and lessons learned at the Concerted Action EPBD between 2011 and 2015. It supports the MSs to see the importance of the EPC recommendations and to be prepared to push aside the obstacles hindering the building owners from taking up renovation activities.

2 Background: why EPC recommendations are so important

Article 11 of the Energy Performance of Buildings Directive (EPBD), requires the establishment of an Energy Performance Certificate (EPC) system in the MSs. The EPC of a building provides the main information about the quality of a building, related to its energy demand and performance. Availability of EPCs for buildings will create awareness and thus contributes to increase the demand for energy efficient buildings, both in the residential and non-residential building sector.

The recommendations in the EPCs are especially important for improving the energy efficiency of existing buildings. Not only do they provide an overview on the improvement potential of the thermal envelope (e.g., windows and external walls) of the building; they also consider how the energy performance of the heating, cooling and domestic hot water systems can be taken into account, and be optimised or replaced. Such information can be given in the form of a tailor-made list of actions. The recommendations provide a particularly important support for the building owner in order to make it easier for him to decide on renovation measures. For example, if the heating system is going to be replaced, it is essential for the owner to know that, through improving the thermal envelope, the heating system could be configured for a lower energy demand. Concerning the cost-efficiency of the measures, the holistic view of the renovation activities is an important task of the EPC recommendations.

According to a BPIE survey[1] (Figure 1), there is more than 25 billion m^2 useful floor area in the EU (including Switzerland and Norway). Seventy-five % (75%) of this corresponds to residential buildings. A large share of these buildings was built before 1980. The energy use in buildings shows a rising trend over the last 20 years. Space heating is the most energy-intensive end-use in EU homes, accounting for around 70% of the total final energy use.

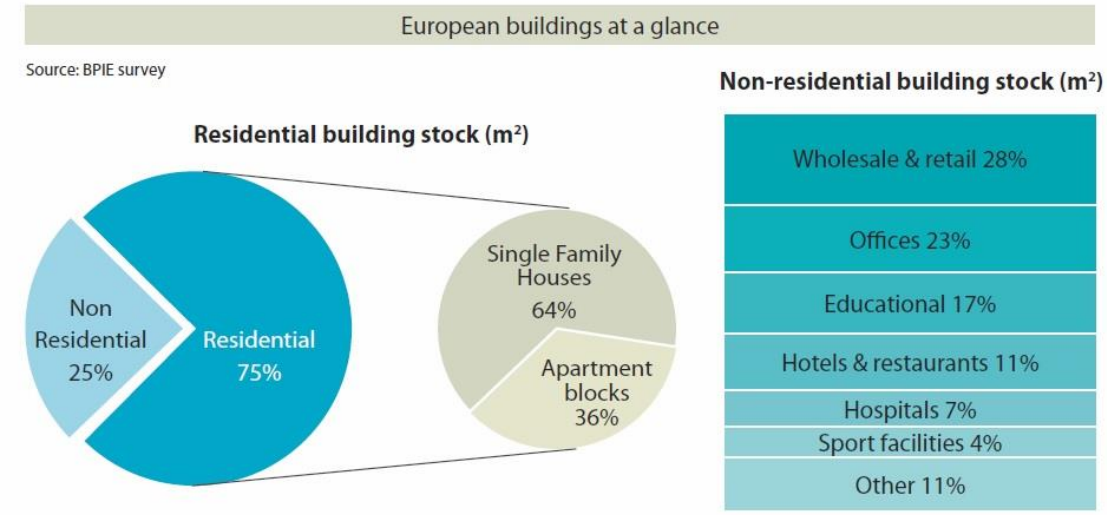

Figure 1. European buildings: division into residential and non-residential buildings[2].

In the non-residential sector, the average specific energy consumption was estimated at 280 kWh/m^2.year, which is 40% greater than the equivalent value for the residential sector[3]. Since buildings account for 40% of the energy consumption in Europe, it is important to improve the energy performance of buildings and implement the recommendations of the EPC. Providing improvement recommendations in the EPC has been mandatory since the transposition of the recast EPBD, Directive 2010/31/EU.

Thus, EPCs should contribute to stimulating the investments in renovation and to transforming the real estate market towards more energy efficient buildings.

[1] Source: BPIE M. Economidou; „EUROPE'S BUILDINGS UNDER THE MICROSCOPE" -A country-by-country review of the energy performance of buildings-2011
http://www.bpie.eu/uploads/lib/document/attachment/21/LR_EU_B_under_microscope_study.pdf; 12.09.2014

[2] Source: BPIE M. Economidou; „EUROPE'S BUILDINGS UNDER THE MICROSCOPE" -A country-by-country review of the energy performance of buildings-2011
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http://www.bpie.eu/uploads/lib/document/attachment/21/LR_EU_B_under_microscope_study.pdf; 12.09.2014

3 Type of information provided by EPC recommendations

The EPC and its recommendations demonstrate the buildings improvement potentials.

The mandatory recommendations of Directive 2010/31/EU on an EPC should indicate:

- Cost-optimal or cost-effective improvement measures: the cost-optimality level specified in Article 2.14 of the EPBD is addressed as "*the energy performance level which leads to the lowest cost during the estimated economic lifecycle*".
- Measures carried out within major renovations: upgrading the thermal envelope of the building (e.g., external walls, roof, and windows) and changing the heating and/or air-conditioning (AC) systems and energy carrier.
- Measures for individual building elements: installing new windows, wall and roof insulation, or replacing the heating and/or AC system.
- Provision of technically feasible measures for the specific building renovation activities and an estimation for the range of payback periods or cost-benefits and relevant savings during the life cycle of the building: calculation of the costs of measures relevant to energy efficiency, e.g., feasibility analysis of alternative systems, during the expected economic life cycle of the building, taking into account investment costs, maintenance and operating costs.
- Additional information on the technical details and steps to implement them: these could be on avoiding thermal bridges, building tightness and the requirements of installing new alternative heating or AC systems.

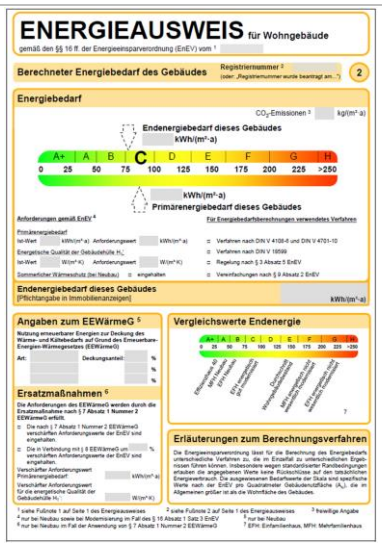
The recommendations in the EPC may be either "standard" or "tailor-made". The renovation measures could be listed giving the new U-value and quality of the building elements, the kind of heating/AC system including their capacity and considering the adaptation of the building according to the specific requirements of the systems (e.g., space needed for necessary storage of pellets in heating systems), and, if using a ventilation system, defining the ratio of the heat recovery. The recommendation could include an estimate of the savings regarding the energy costs and/or the CO_2 emissions per year and potential of the efficiency for higher standards. Depending on the type of recommendations ("standard" or "tailor-made") and the complexity of the building (e.g., simple apartment building or complex non-residential building), the recommendations in the EPC could be used for a rough estimate on the costs of the renovation measures and provide an indication where an energy audit would be necessary. Apart from very simple cases, they do not replace a more detailed energy audit as a basis for proceeding towards their implementation.

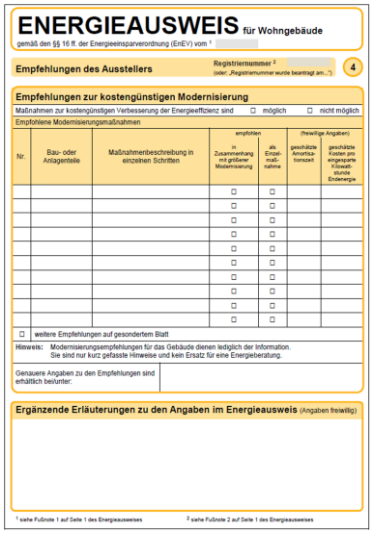
Figures 2 and 3 show two pages of the German and the UK EPCs (front and recommendations page) as examples that illustrate how the energy performance and recommendations are displayed.

4 Standard and tailor-made recommendations: advantages and disadvantages

Providing renovation recommendations in the EPC is being dealt with in different ways in the MSs. These differences could be summed up to two recommendation categories: standard and tailor-made.

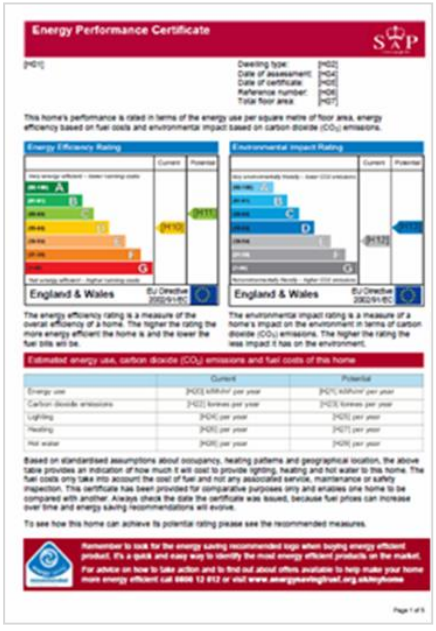
The standard recommendations show the improvement potential of the renovation measures providing the minimum U-value of the external walls, roof, floor and the windows, and the upgrading or the possible change of heating, AC and domestic hot water systems into more energy efficient alternatives according to the building type and age. These EPCs can usually be provided with less effort and thus cost less than the tailor-made ones, not defining, however, for example, the exact thickness of the insulation for that building, or the optimal detailed heating system.

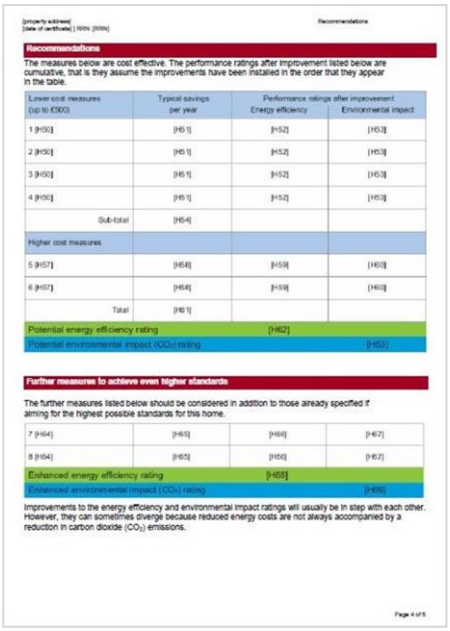




Legend (translating the headings of the 2 pages of the German EPC):
Energieausweis: EPC
Wohngebäude: Residential building
Berechneter Energiebedarf des Gebäudes: Calculated energy demand of the building
Energiebedarf: Energy demand
Endenergiebedarf dieses Gebäudes: Final energy demand of this building
Angaben zum EEWärmeG: Information on renewable energy law
Ersatzmaßnahmen: Alternative measures
Vergleichswerte Endenergie: Comparison values final energy
Erläuterungen zum Berechnungsverfahren: Explanation of calculation methodology
Empfehlungen des Ausstellers: Recommendation of the issuer (EPC issuer)
Empfehlungen zur kostengünstigen Modernisierung: Recommendations for cost optimal renovation
Ergänzende Erläuterungen zu den Angaben im Energieausweis: Additional explanations for the information provided in the EPC

Figure 2. Example of EPC recommendations in the German EPC.





Indication of energy-relevant specifications and environmental impact	Recommendation for cost-optimal renovation for the thermal envelope and heating system (top) and variations for higher efficiency standards (bottom)

Figure 3. Example of EPC recommendations in the UK EPC.

The tailor-made EPC recommendations not only demonstrate the energy efficiency potential of the building, but also propose detailed renovation measures, such as the thickness and quality of the insulation according to the calculated needed U-value, the quality of the windows, the appropriate heating and domestic hot water system or variations according to the condition and situation of the building. In order to obtain a reliable EPC and tailor-made recommendations, it is essential that an energy expert visits the site or the building and gets access to the documents concerning the construction and heating system (e.g., architectural plans). In effect, this can be equivalent to a specific energy audit of the building or building unit. The detailed set of measures and the amount of input connected with this kind of EPC recommendations has a significant impact on the price of the EPC. The information of these recommendations could be seen as the basis for the required subsidies and/or construction biddings. However, no country requires this level of precision in their EPCs. In most cases, even so called "tailor-made" recommendations are simple estimations that the banking sector does not accept for granting a loan[4].

There are advantages and disadvantages in both EPC categories (standard and tailor-made). The standard recommendations are cheaper and may keep the effort required low. The standard recommendations are kept general and basically provide the general potentials of the building components (e.g., U-values which a building of this size and age could reach, or the change or upgrade of the type of heating system). In this case, the building owner might not be motivated enough to carry out improvements.

The tailor-made recommendations would significantly increase the price of the EPC, but provide more specific information. The detailed or tailor-made EPC recommendations give the building owner a proper support in what needs to be done in relation to the energy efficiency of the building. Besides, it engages the stakeholders (e.g., building owners, tenants, and facility managers) to deal more intensively with energy issues. The effects of the measures carried out individually and collectively are better documented (e.g., what are the effects of only changing the windows without insulation of the walls or roof, or of changing the heating system without improving the thermal envelope, or of improving the indoor air quality through installing a ventilation system to prevent mould formation). However, the term "tailor-made" (meaning "specific") is not exactly defined, and therefore it is not fully clear where the basic investigations needed for the development of specific EPC recommendations end, and where the investigations necessary for carrying an energy audit start.

Nevertheless, in many countries where the renovation of residential buildings is supported by the government through subsidies or similar instruments, an EPC including recommendations is one of the main documents which applicants must submit. In some countries, energy audits are supported by the government, and many building owners use the opportunity to have an auditor or energy expert visit their building in order to obtain a tailor-made recommendation list that can then optionally also be used for the EPC.

Since the residential buildings, especially single family homes, are less complex with regard to their heating and AC systems, tailor-made EPC-recommendations might be more easily prepared and provide an important support for the home owner, as discussed before.

Due to the more complex situation in non-residential buildings especially with regard to building services systems (e.g., large office buildings, hospitals, universities, …), the optimisation of energy use in the non-residential buildings sector is usually not only based on EPC recommendations alone, but on detailed energy audits.

5 Cost-efficient recommendations and the prebound or rebound effect in residential buildings

Depending on the difference between the occupancy pattern (e.g., a given room temperature included in calculation standards) used in EPC calculation methods and the actual user behaviour in a certain building, the projected energy demand before and after having carried out EPC recommendations and the real energy consumption might deviate substantially and finally also contradict the results of cost-effectiveness calculations.

[4] See the final report from CT7 (2015) – http://www.epbd-ca.eu/ca-outcomes/2011-2015

When calculating EPC recommendations and communicating them to residential building users, experts must be aware of the so-called prebound and rebound effect, both describing the impact of residents' behaviour on energy consumption and having a significant effect on the cost effectiveness of the refurbishment measures included in the recommendations of the EPC. The prebound effect describes that many homes with poor energy efficiency actually use less energy than predicted by the EPC calculation method, because the tenants cannot afford the energy cost. In many of these buildings, the sick building syndrome (SBS) could be an issue. SBS describes situations in which building occupants experience acute health problems caused by the indoor environment in their buildings. One of the causes could be the humidity and poor air quality in the building. The lack of correct heating and ventilation in the building with poor energy efficiency supports the growth of bacteria and fungi (i.e., mould), causing diseases among the residents of these buildings. This might be counteracted by raising the energy quality of the building and therefore, should not be neglected. Studies carried out in the UK, The Netherlands, Belgium and France show that many tenants suffering from energy poverty heat fewer rooms or keep their homes generally cooler in winter, and therefore have lower energy consumption than that predicted in the EPC. As a consequence, the energy savings potential is also lower than predicted through the EPC recommendations. Nevertheless, especially these homes will benefit from energy efficiency measures due to their contribution to better indoor air quality. This phenomenon is called the "prebound effect" as opposed to the "rebound effect", which could happen when the decreasing energy demand (due to energy efficiency) leads to higher than predicted energy consumption due to increasing comfort requirements (e.g., heating or cooling more rooms, using more electric devices, etc.). In both cases, the difference between real and nominal savings may be quite significant.

Both effects can be taken into account by adapting the calculation method accordingly, in order to get a more accurate result in terms of cost-effectiveness of EPC recommendations, for example by introducing a so-called energy utilisation factor as practiced by the region of Vienna in Austria. By combining EPCs with income data, energy poverty households as presented above can be identified and targeted by specific measures as demonstrated by the Irish EPISCOPE project[5].

However, it has to be emphasised that displaying the exact investment costs in order to define material and equipment needed for the renovation is a challenging task and does not occur in the EPC recommendations at all. In all countries, the cost estimation is based on average or typical costs and generic price tables, not including the indirect costs such as construction permits and recycling. The range of possible deviation is also made explicit by presenting only typical cost savings in the EPC, or a range of possible cost savings instead of precise monetary figures, such as displayed in the Portuguese EPC.

6 Implementing EPC recommendations: support mechanisms

In many MSs, the EPC presents only general information about the recommendations. Specific refurbishment measures plus financial incentives and payback periods are missing. The reason might be difficulties in calculating reliable and exact data on construction-related measures.

Some countries (e.g., Austria) are developing tools (Figure 4) and procedures (Figure 5) to produce on-site subsidised tailor-made recommendation packages for the building owners, offered as a service to the public. Figure 4 presents one of the pages of "*Energieberatung*" (energy consulting), showing the expected labelling category and the amount of CO_2 emissions after the renovation.

[5] http://episcope.eu

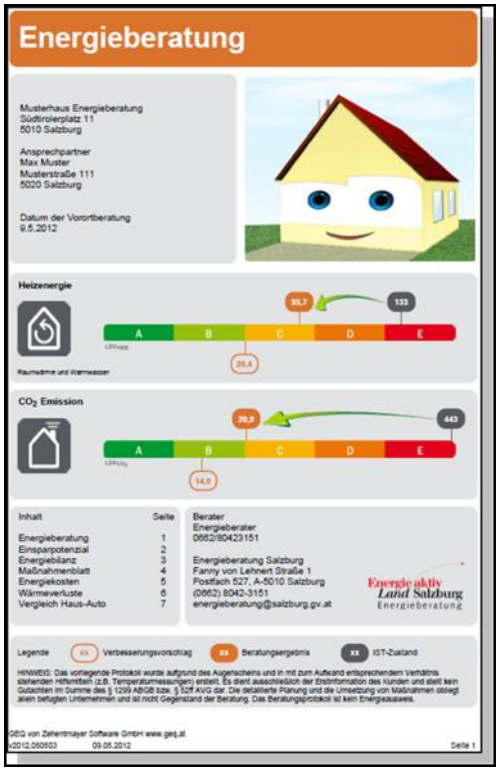


Figure 4. Example of the Austrian tool Energieberatung to produce a recommendations package on site, consisting of specific refurbishment measures[6].

The process of granting a subsidy is demonstrated in Figure 5.

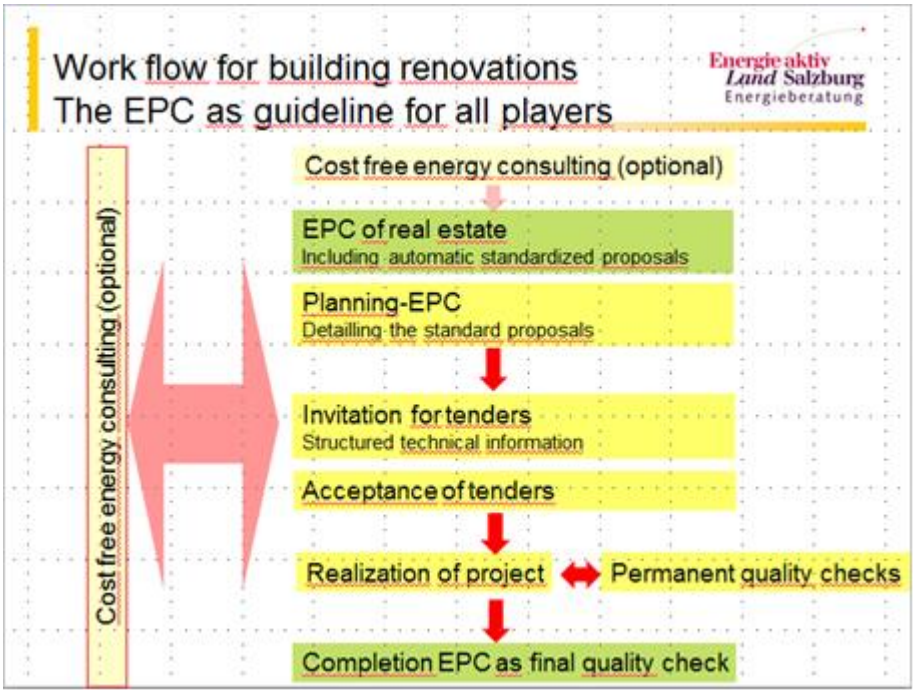


Figure 5. Example of the Austrian tool's workflow (under developement). The chart shows the process of cost-free consulting (subsidised by the regional government) and renovation[7].

[6] Energieberatung Salzburg, 2014 (under development)

[7] Energieberatung Salzburg, 2014

7 Effective implementation of recommendations

EPC recommendations need to be implemented to achieve an actual increase in energy efficiency.

Some countries, like The Netherlands, Italy, Denmark, Slovenia, Portugal and Germany, apply interesting measures for increasing the rate of implementation of recommendations, which can serve as good practise examples, namely:

- development of online simplified tools in order to get quick-scan ideas of the current situation and potential for improvement;
- free of charge tailored advice on technologies, subsidies, protocols, practical and comprehensive information that support technical information in the EPC;
- set-up a shared knowledge basis on cost-effectiveness of measures;
- reduce the EPC issuing fee for buildings that have implemented the recommendations.

In Denmark, the age of the building determines the level of detail for the certification. This ensures that buildings with the highest potential for energy savings will get the most attention. The validity of the certificates varies between 7 and 10 years, for buildings with a high or a low energy saving potential, respectively.

The development of dedicated software to assist the expert would also improve and standardise the quality of information provided to home owners.

One of the important issues related to the EPC recommendations is the quality of the EPC and its reliability. This makes regular random checks necessary. Therefore the implementation of a monitoring system for EPCs will be essential. There have been efforts to identify errors and mistakes and how they could be avoided or solved. Apart from technical measures for identifying the possible errors, implementation and evaluation of EPC recommendations has been recognised to be a very good support. In this way, a supporting mechanism for training the EPC assessors or energy experts could be developed to minimise the errors and raise the quality of EPCs. More information can be obtained from reports on compliance and control[8].

8 Conclusions

Even though including recommendations in the EPC has not been mandatory for a long time, its effects in the consideration of energy efficiency seem to have succeeded in many ways. Unfortunately, the statistical information on the number and type of EPC recommendations implemented in the MSs is scarce. This situation needs improvement to be able to evaluate achievements and adjust strategies accordingly.

For example, the information on the implemented recommendations could be collected in monitoring databases in order to analyse the trends of the measures applied in construction, as well as in heating, air-conditioning and domestic hot water systems. This would support developing and establishing improved constructions and building services systems, as well as appropriate and effective financing methods.

In addition, there are still other challenges to overcome, such as how to handle the term “cost effectiveness of recommendations”. Currently, it is difficult to present a consistent summary about the situation in MSs, as there are different views among them what cost-effectiveness of refurbishment measures actually means in the respective country. In some countries the definition calculates a simple payback time of the estimated investment cost and does not consider the entire building lifecycle nor other selected aspects such as maintenance costs. Apart from methodological differences which could be aligned by imposing clear definitions, the cost-effectiveness of similar improvement measures is different among the MSs, due to the different economic and climatic conditions of the countries, as well as local building practices.

Above all, the concept of cost-effectiveness and the aspects influencing the decision to invest in energy efficiency should be explored to find a link to facilitate the transition of the existing building stock to Nearly Zero-Energy Buildings.

[8] http://www.epbd-ca.eu/ca-outcomes/2011-2015

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