



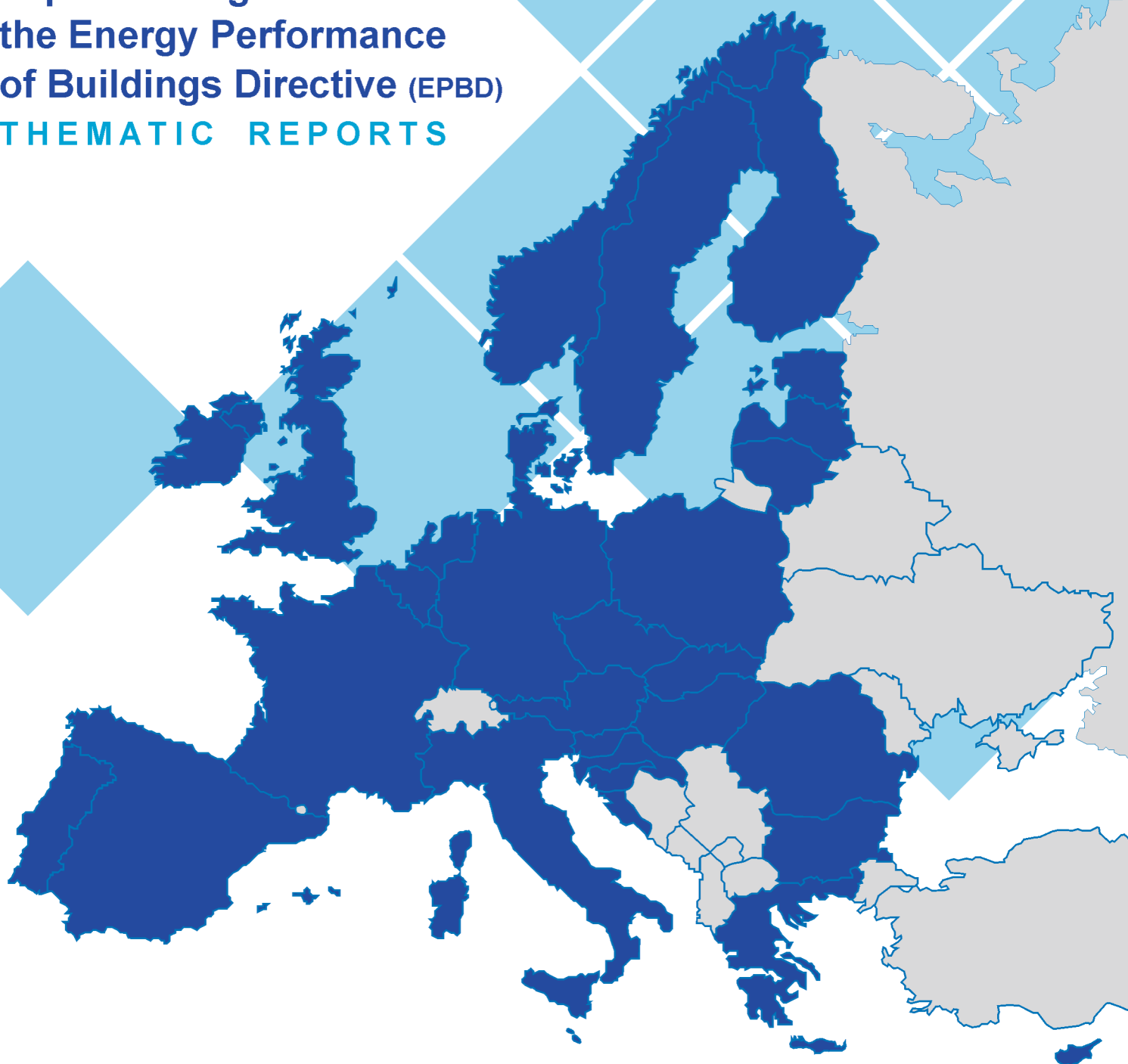
CONCERTED ACTION
ENERGY PERFORMANCE
OF BUILDINGS



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Editor's message

The Concerted Action EPBD (CA EPBD) is a unique forum that brings together national experts involved in the transposition and implementation of the Energy Performance of Buildings Directive (EPBD) as well as in the practical day-to-day management of initiatives related to the energy performance of buildings in general. A central focus is on sharing good and bad experiences, best practices, common challenges and efficient implementation mechanisms.

A key element in the CA EPBD is the plenary meetings, which take place approximately every 8-9 months, bringing together 150 experts from all 28 EU Member States plus Norway for discussion in sessions organised around the topics considered most relevant at the time. In the latest phase of the CA EPBD, the CA EPBD 2015-2018, the main focus was on topics related to the construction of new Nearly Zero-Energy Buildings (NZEB), on policies to improve the Existing Building Stock, on the Certification of Buildings (EPCs), and on Inspections of Building Supply Systems. Many discussions also concerned cross-cutting topics, such as Technical Elements, Complementary Policies for finance and information, as well as Compliance and Enforcement Issues.

Although the main objective of the CA EPBD is to connect national policy experts of all EU Member States and Norway, and to foster the exchange of knowledge and solutions among them, it has also collected a wealth of information which could be useful to a wider audience. In order to ensure broader and easier access to this information, also for experts outside the CA EPBD community, two major collections of the public material derived from the work performed in the context of the CA EPBD in 2015-2018 have been developed, one for Country Reports and one for Thematic Reports, as a way of further harvesting knowledge and information.

The present publication is the compilation of 7 Thematic Reports in their most recent update, organised around the topics selected for discussion and exchange among CA EPBD experts during the plenary sessions. The relevant discussions were often supported by additional research and material collected through national experts in the form of questionnaires or posters. The Thematic Reports, therefore, give an EU-wide overview and allow for the comparison of regulations and supportive schemes on the implementation at EU level, giving the opportunity for the systematic collection of lessons learned and recommendations for future processes or new implementation.

The Thematic Reports have undergone a systematic review process in the Concerted Action. As Coordinator of the action, I had the pleasure to read each report multiple times, and to comment and discuss on various topics; but, in the end, the main content of the reports is the responsibility of the individual authors / Thematic Team Leaders and contributors/ country teams. The European Commission, DG ENER and EASME have supported the work and provided their feedback but hold no responsibility for the content.

The Country Reports (compiled into a similar separate publication) present the status of implementation of the EPBD in 2016 / 2017 in the individual countries or regions. They are authored under the responsibility of the individual country teams who were given the freedom to emphasise more on topics which were considered more advanced, of highest national priority, or a success story of implementation in the country.

The Thematic Reports have been developed in two steps, starting in 2016/17 and updated in 2018 in order to include the last part of the CA EPBD 2015-2018 work. While the Country Reports have been created as snapshots at a certain point in time until 2017.

The developed material is envisioned to provide both an insight on the developments at the individual country/region level, as well as an EU overview, lessons learned and analytics on the development of policies related to the energy performance of buildings across Europe.

In the past, this type of information has been presented in the form of a printed book which was published every 2-3 years, containing the developments since the previous version. In CA EPBD 2015-2018, there was an intentional and gradual shift towards a more interactive and modern way of presenting this information, which is based on a database. The aim is that, on the longer term, this database will allow for a more systematic selection and combination of material from these reports. The online database will also allow for a simpler and more frequent update of material.

The Thematic Reports and the Country Reports are available in the online database, in the mentioned electronic compilations and individually on the website. Please note that further updates might become available online as further developments are being realised, so that, hopefully, the database will keep growing to become more interactive in the coming years.

The Thematic Reports and the Country Reports are further complemented by other publications. These include the Key Implementation Decision (KIDs) Reports, which present relevant performance indicators or implementation decisions for certain regions or countries, as well as the factsheets, which highlight one particular topic in a short and concise way. Both the KIDs and the factsheets are only available as individual reports directly on the CA EPBD website.

Finally, the website has also been used to directly share other information, including news and presentations from open events organised by the CA EPBD. Material has also been shared through collaboration with the other two Concerted Actions, on the Renewable Energy Sources Directive (DIRECTIVE 2009/28/EC), and on the Energy Efficiency Directive (DIRECTIVE 2012/27/EU).

In the period 2015-2018, key issues have been linked to the Directive 2010/31/EU such as NZEB public buildings, building codes and the implementation of new rules for certificates. Towards the end of the action, however, and in particular during the in-depth workshop in Frankfurt in May 2018, discussions and actions started to focus on the changes expected to derive from the upcoming amendment of the EPBD, now Directive (EU) 2018/844.

In the field of NZEB policies for new buildings, great progress has taken place during 2015-2018, but it is clear that there is still a very large potential in the existing building stock and that there is an increasing importance for collaboration in the field. These two issues will therefore be of increasing focus for the CA EPBD in the coming years.

Additionally, with the amendment of the EPBD in 2018, new challenges come into focus for the Concerted Action communities, and new elements are being integrated in the next phase of the CA EPBD; hopefully, the new structure will facilitate the development of fresh material on these interesting new topics while keeping the existing material relevant and up to date. The Concerted Action EPBD will continue to support countries and regions in the development of policies for the energy performance of buildings.

I hope that you will find the CA EPBD work and publications interesting, informative and inspiring, and that the collected material will contribute towards achieving buildings energy efficiency as well as the EU climate targets.

Jens Laustsen
Coordinator of the CA EPBD
20 August 2019

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CONCERTED ACTION ENERGY PERFORMANCE OF BUILDINGS

(CT1) New buildings & NZEBs - 2018 Status in February 2018

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KEYWORDS

Nearly Zero-Energy Buildings (NZEBs); Renewable Energy Systems (RES); best practice examples (case studies); NZEB definition

1. Introduction

In 2010, the adoption of the Energy Performance of Buildings Directive - [EPBD \(Directive 2010/31/EU\)](#) presented both the building industry and Member States (MSs) with new challenges. One of the most prominent among them, as far as new buildings are concerned, is the progress towards Nearly Zero-Energy Buildings (NZEBs) by 2021 (or, in the case of public buildings by 2019). Thus, since 2010 and also during the current working phase, the Concerted Action EPBD (CA EPBD) has been discussing the issues related to NZEB, promoting dialogue and the exchange of best practices among MSs, and thereby contributing to a more effective implementation of the EPBD.

The work of the CA EPBD under the Central Team New Buildings & NZEBs focuses on practical challenges and experiences with the early implementation of NZEBs in the MSs by collecting case studies and discussing how to integrate renewable energy systems (RES) and other innovative technologies, as well as the indoor climate issue, into the energy performance assessment methods.

This report summarises the main outcomes of the work of the CA EPBD under the Central Team New Buildings & NZEBs on these topics from October 2015 to February 2018. The work is based on the active participation of the national delegates (representing national authorities in charge of implementing the EPBD), and includes information gained from questionnaires, national studies and poster presentations.

2. Objectives

The aim of this Central Team's work is to support the implementation of policies on new buildings, particularly including requirements for new buildings, NZEB and the inclusion of RES as part of the energy performance of new buildings, as laid out in the EPBD Articles 6, 9, 2(2) and Annex I.

Article 6 of the EPBD requires MSs to “ensure that new buildings meet the minimum energy performance requirements” set in accordance with the calculated cost-optimal level and that “the technical, environmental and economic feasibility of high efficiency alternative systems” are “considered and taken into account”.

In 2019/2021, the minimum energy performance requirements for new buildings will be defined by the national application of the NZEB definition^{1,2}. MSs shall furthermore “draw up national plans for increasing the number of nearly zero-energy buildings” and “following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings”.

A NZEB is defined in Article 2(2) of the EPBD as “a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby”.

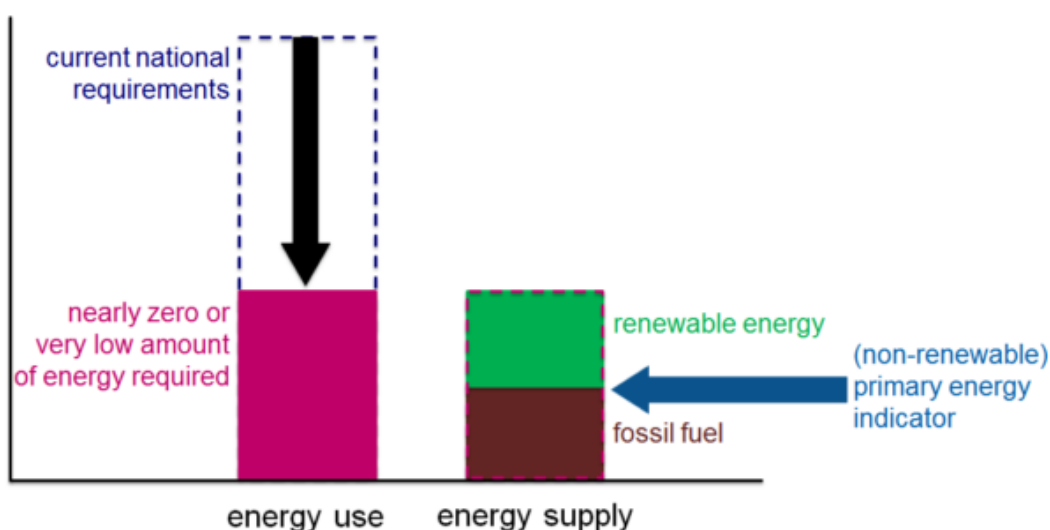


Figure 1: Graphical interpretation of the NZEB definition according to EPBD Articles 2 and 9.

The discussion topics of the Central Team New Buildings & NZEBs included the following:

- different national applications of the NZEB definition;
- suitable and innovative building and service system solutions;
- their impact on indoor comfort;
- national and European calculation methods; and
- demonstration buildings for raising awareness among the general public.

A particularly important objective has been the integration of RES into the NZEB national implementation strategies. This is part of the EPBD requirements, but it also links to the requirements of the [Renewable Energy Sources Directive \(Directive 2009/28/EC – RESD\)](#). In accordance with the RESD (Article 13(4)), by 31 December 2014, MSs must require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation. This requirement must be implemented in MSs' building regulations and codes, or by other means with equivalent effect.

The CA EPBD Central Team New buildings & NZEBs collaborates closely with the Cross-Cutting Team Technical Elements concerning innovative service systems and calculation methods, especially concerning the CEN EPB standards (Mandate 480). The discussions organised by both teams include the possible adoption and implementation of the CEN standards by the MSs. The outcome of this work is summarised in the Report of the Cross-Cutting Team Technical Elements.

3. Analysis of Insights and Main Outcomes

3.A. Analysis and insights

3.A.1 National applications of the NZEB definition

Although the target dates in Article 9(1) of the EPBD are in the future, the deadline for transposition of Article 9 was 9 January 2013. By that date, all the NZEB provisions of Article 9 had to be reflected in national transposition measures. Such a lengthy run-up was considered necessary given how long it takes to plan, acquire permission for and construct a building. While the date of NZEB implementation is approaching, the development of national applications of the NZEB definition is continuously being followed by the CA EPBD. The latest complete overview of the national NZEB definitions is presented in the report "[Nearly Zero-Energy Buildings: Overview and outcomes](#)" as part of the Concerted Action EPBD report "[Implementing the Energy Performance of Buildings Directive \(EPBD\)](#)" of August 2016. This overview and the definitions summarised therein, contributed also to the "[Commission Recommendation on NZEB](#)"³.

Updates of the national NZEB definitions have been the focus of work at the end of CA EPBD IV. For the overview at hand the following five main points have been analysed per country:

1. Is there a detailed NZEB definition available?
2. How is the "very high energy performance" expressed?
3. Where are the limits defined for "a very low amount of energy required"?
4. Is there a requirement for "covered to a very significant extent by energy from renewable sources"?
5. Is a "primary energy indicator in kWh/m².year" in use?

Table 1 was developed based on the detailed information provided by MSs' delegates in February 2018.

With the deadlines end of 2018 (new public buildings) and end of 2020 (all new buildings) approaching more and more MSs have their national application of the NZEB definition in place. By February 2018 a total of 76% of the countries have defined detailed NZEB requirements in legal documents. The remaining countries have mostly drafts available that are based on studies. They foresee to conclude the work on the NZEB definition within 2018.

Main points of the national NZEB definition (as reported by the CA EPBD delegates)			Country																														
			Belgium																														
Detailed definition	Included in a legal document	Government decree/law Technical regulation National NZEB plan																															
	Not yet included in a legal document	Draft available																															
Very high energy performance	Tighter requirements compared to current values for	General Mean U-value of building envelope Reference technologies Heating energy demand Final energy Primary energy (Primary) energy performance coefficient																															
	Top building class																																
	Specific new building class																																
	Passive house (building envelope) level																																
	KfW efficiency house 55/70																																
	Component U-values																																
	Thermal bridges																																
Nearly zero or very low amount of energy required. Limits on:	Mean U-value of building envelope																																
	Heat transfer coefficient/heat loss of building envelope																																
	Air permeability																																
	(Net) heat demand																																
	Installed lighting power																																
	System efficiencies																																
	Heating energy demand																																
	Cooling energy demand																																
	Total energy efficiency																																
	Electrical input																																
	Final energy (total or divided into energy uses)																																
	Primary energy																																
	CO ₂ emissions																																
	Summer overheating																																
Very significant extent of renewable energy	Direct	Minimum share in % Minimum contribution in kWh/m ² .yr (Choice of) exemplary RES measures																															
	Indirect **																																
Primary energy indicator in kWh/m ² .yr	Included																																
	Other main indicator, but PE as additional/interim result. Main indicator:	CO ₂ Primary EP coefficient																															

* At the time of the overview Luxembourg had a national NZEB definition for residential buildings in place, but not yet a NZEB definition for non-residential buildings

** Indirect: RES contribution required in order to achieve the minimum energy performance requirement

X Details based on drafts are marked with "X"

Table 1: Status of the detailed national application of the NZEB definition in practice in the CA countries as of February 2018.

CA EPBD has analysed not only the status of work of the NZEB definition in the countries, but also the political, economical, technical and procedural barriers that prevent or delay MSs from fixing their NZEB definition. The CA also supported MSs in their work through detailed discussions and exchange between delegates. More detailed information can be found in a CA EPBD factsheet⁴.

National NZEB definitions differ significantly from each other. This is documented in the tabular overview that deals with the four main points of the general NZEB definition in the EPBD. Limits for the energy performance are, for example, set in addition to primary energy on many different characteristics. Further deviations that prevent from comparing the national NZEB definitions among MSs are: different calculation methods, building culture, climate, investment and energy costs, etc.

During the CA work on the national NZEB definitions, it also became apparent that some of the definitions underwent changes since the first publication. Further revisions are planned. Reasons for this include the use of new calculation methods (including the change towards the new CEN EPB calculation standards), the new cost-optimal reports submitted by MSs taking into account the situation in 2020, and reduced required RES contributions, as studies showed that the earlier ones are difficult to achieve in the urban context.

Highlights of 3.A.1	CA EPBD has continuously followed up on the national applications of the NZEB definition. As of February 2018, a great deal of progress in this work has been recognised, since more than 70% of the MSs currently have a detailed NZEB definition in place.
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3.A.2 Use of renewable energy systems in urban NZEBs

The overview of national applications of the NZEB definition in CA EPBD III showed that countries use different approaches to RES requirements. Some MSs request a direct RES contribution (share in percentage, or minimum amount of kWh/m² per year); others have only included an “indirect” RES requirement by setting very low primary energy requirements that can only be met with RES contributions. Earlier CA EPBD work on national applications of the NZEB definition has shown that MSs see a specific challenge in how to include RES contributions to the energy supply of multi-family houses in city centres, where roof areas and other areas suitable for the installation of RES technologies (e.g., the ground around the buildings) are limited in comparison with the buildings’ floor area and are often shaded by other buildings.

In order to investigate these barriers and to present possible solutions, CA EPBD analysed which RES technology contributions can generally be assessed with the national energy performance calculation method, and which ones can fulfil possible direct RES requirements as part of national NZEB definitions. The result is an overview with information on the applicability of RES technologies across 24 countries. Large differences exist across countries regarding those RES solutions which can be included in their energy performance calculations, and those which can be used to fulfil direct NZEB RES requirements. Some technologies (e.g., solar thermal panels for domestic hot water generation and for heating, PV for self-use⁵ as well as biomass boilers and heat pumps coupled to external air/exhaust air/ground or ground water) can in general be accounted for in the energy performance calculation in all 24 countries that took part in the evaluation. Other RES technologies (e.g., PV for feed-in, RES as part of district cooling, micro-wind turbines (self-use or feed-in) and local hydro power for self-use) can be accounted for in the energy performance calculation in about half of the countries that took part. The RES technologies that can most rarely be accounted for in energy performance calculations are RES electricity via the grid (with a specific contract) and local hydro power for feed-in (see Table 2).

The evaluation whether the RES technologies can fulfil direct RES requirements as part of NZEB requirements (currently required in 11 of the 24 countries) resulted in a similar order as above. Solar thermal panels for domestic hot water and PV for self-use are accepted in all 11 MSs, and solar thermal panels for heating support, biomass boilers, micro wind-turbines for self-use, and PV for heating input are accepted in 10 MSs. RES electricity via the grid with a specific contract, RES as part of district cooling and local hydro for feed-in are accepted in only a few countries. A follow-up session is planned in order to investigate reasons for differences in the national approaches.

A discussion of specific RES solutions for multi-family houses showed that most countries allow systems to be installed on associated buildings such as garages, as long as they are under the same ownership and/or on the same building plot. Most also allow the use of community systems as long as there is a direct connection to the building. Some countries allow the use of waste heat from industry or from heat pumps based on sewage water, but others do not have calculation methods to account for these. The use of higher insulation levels as an alternative to RES is only applicable in a few countries. Additional RES solutions for urban multi-family-housing identified during the discussions were heat recovery from showers, purchase of green certificates and participation in RES projects.

Solution \ Country	BE-BR	BE-FL	BE-WA	BG	CY	DE	DK	EE	GR	ES	FI	FR	HR	HU	IT	LT	LV	MT	NL	NO	PL	PT	SE	SK	SL	UK
RES as part of district heating	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y		Y	N	Y	Y	Y
RES as part of district cooling	N	N	N	Y	Y	Y	N	Y	Y	N	Y	Y		N	Y	N	N	N	Y	Y	N	Y	N	N	Y	N
Solar thermal panels for DHW	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Solar thermal panels for heating support	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PV for self-use	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PV for feed-in	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	Y	Y	N
PV for heating (input to heat storage)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y		N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PV/T hybrid solar collectors for self-use	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
PV/T: PV for feed-in, T for self-use	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N
Micro wind-turbine for self-use	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Micro wind-turbine for feed-in	N	N		N	Y	Y	N	Y	Y	N	N		N	N	N	Y	Y	Y	Y	Y	N	N	N	Y	N	N
Local hydro for self-use	N	N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
Local hydro for feed-in	N	N	N	N	N	N	N	Y		N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	N	Y	Y	N
Biomass boiler	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Biomass CHP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y/N	Y/N	Y	Y	Y	Y/N	N	Y	Y	Y	Y		Y	N	Y	Y	Y
HP coupled to external or exhaust air	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
HP coupled to ground / ground-water	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Direct geothermal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Direct ground water cooling	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
RES electricity via grid (specific contract)	N	N	N	Y	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	Y	N	N	N	N	N	N
Alternative: higher insulation level	Y	Y	N	Y	N	Y	N	Y	Y/N	Y/N	N	N	N	N	Y	N	N	N	Y	Y	Y	N	Y/N	N	Y	N

Table 2: Accountable RES solutions in the MSs' energy performance calculations.



Figure 2: The Solar Active House in the city centre of Frankfurt features a heat pump coupled to the sewage water and PV modules on the roof and the façade (source: HHS Architekten).

Differences in calculations for RES in the MSs were investigated. The discussions resulted in a greater understanding of the countries' reasons for following specific approaches. Calculations in some MSs do not account for certain RES technologies (e.g. PV/T⁶, local hydro power). Some of the technologies (both PV/T and local hydro power) are not covered by CEN standards. Additionally, there is no or very little local use of some of the technologies and therefore no need to develop procedures. In some MSs there are additional procedures to deal with technologies for which there is no standard calculation defined. Some MSs impose limits on the amount of locally-generated energy that can be accounted for and some do not allow any exported electricity to be accounted for in order to avoid double-counting in the EPC and grid primary energy factor.

Some MSs have (different) ways of limiting the accountable amount of generated electricity, and have already partly implemented changes based on their experiences. Other MSs do not have limits, and some of these MSs have separate energy performance requirements for the building envelope instead.

The main advantages of having limits for the accountable amount of generated electricity were identified as:

- reducing probability of grid problems (e.g., too much PV in one region causing the grid to become unstable);
- making designers think harder about reducing energy demand;
- avoiding double counting of RES.

The main advantages of not having limits were identified as:

- encouraging RES and positive energy buildings;
- making renewable electricity available for more uses (e.g., e-mobility).

In most countries, RES are found mainly in single-family houses or public buildings. For buildings containing multiple dwellings, specific arrangements are needed so as to distribute or assign locally-generated energy to different users. Examples of such arrangements from Germany were given:

- A simple solution is for a collective of users (e.g., owners of the dwellings in the building) to own the renewable energy systems. The electricity generated might then be divided between the users according to a specific private contract, with any surplus fed into the grid and remuneration divided between the owners.
- In a building owned by a housing company, electricity generated is given as a gift to tenants (i.e., costs are included in the rent), who can decide to refuse the gift and use electricity from another supplier.
- In a building owned by a housing cooperative, a PV system is financed by a fund of the city's energy supply company only available to the tenants. Tenants pay into the fund and receive electricity at an attractive price.

In Denmark, a pilot building has been constructed to demonstrate how electricity can be distributed within a building which has multiple tenants, a PV installation, a storage battery and a grid connection. There are local sub-meters for the PV production, battery output, apartment usage, and a main meter for the grid connection. Smart meters allow the definition of an order of priority for energy use so that locally-produced electricity is used before locally-stored energy and that both of these are used before grid energy. The building is energy-neutral on an annual basis.

Highlights of 3.A.2

Countries differ greatly with regard to RES solutions that have been included in their energy performance calculations and in which solutions can be used to fulfil foreseen direct NZEB RES requirements. The collection of practical solutions for the use of RES at inner-city buildings presented approaches that can be applied in other MSs as well.

3.A.3 Best practice examples of NZEBs

EPBD (Directive 2010/31/EU) Article 9 states “MSs shall ensure that after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.” With this date approaching, MSs and/or municipalities in the MSs have started to design and construct pilot projects for public NZEBs. Some MSs have set up research or financial support programmes for (types of) high-performance public buildings. These form the basis of the collection of NZEB-like educational buildings that has been compiled within CA EPBD.

In total, 17 examples of educational buildings have been collected and compared, of which three are kindergartens, eight are schools (mostly primary schools), two are combined kindergartens and schools, and four are university buildings. The main results of the comparison are:

- Concrete/masonry construction was the most commonly used, although several of the buildings are of lightweight construction. The windows are triple-glazed in ten of the buildings and double-glazed in four of the buildings. U-values were found within the following ranges:

• Walls: 0.09 – 0.40 W/m ² K (average: 0.16 W/m ² K)
• Windows: 0.60 – 1.76 W/m ² K (average: 0.97 W/m ² K)
• Roof: 0.06 – 0.30 W/m ² K (average: 0.13 W/m ² K)
• Ground/cellar ceiling: 0.06 – 0.56 W/m ² K (average: 0.19 W/m ² K)
- For space heating, heat pumps are used in nine of 17 examples, gas boilers in two examples, biomass in one example, district heating in six examples and a combined heat and power unit based on wood pellets in one example. Hot water is mostly generated in combination with the space heating but some buildings have additional water heating features like electrical top-up and solar thermal panels. One example uses decentralised electric water heating.

- Twelve of the buildings include cooling systems with five of them using a reversible heat pump, one using a district cooling system, three using free cooling, one using adiabatic cooling, two using night ventilation and one having cooling built into the ventilation system.
- All buildings include elements of demand controlled mechanical ventilation, 14 with heat recovery and three without heat recovery. Controls are based on CO₂ emissions, occupancy, humidity or temperature.
- Lighting controls are based on manual control (four examples) or occupancy control (six examples). Daylighting control is included in five schools. One building uses DALI (Digital Addressable Lighting Interface) controls.
- Four buildings have no RES system included. PV systems are installed in ten of the buildings. Three buildings have solar thermal panels on the roof. RES (waste heat and/or biomass) are also included in the district heating systems used in three of the buildings, one of which also uses water from a nearby lake for cooling.
- The average final energy use for the buildings is 50.5 kWh/m².year but includes partly differing energy demands. The average primary energy use is 55.3 kWh/m².year.
- The improvement compared to current requirements is on average 68%. The average renewable energy contribution rate is 49%.
- The documented additional costs compared to conventional new educational buildings are on average 603 €/m² floor area (17% of total costs). The average is reduced down to 204 €/m² (11% of total costs) if an outlier (by far the most expensive example building) is not accounted for.

The variety in the thermal quality of the building envelope and the used service system technologies shows the impact of the different climatic conditions, regional building culture, user expectancies and specific aims of the pilot projects.

Highlights of 3.A.3

The collection of NZEB-like educational buildings showed that many countries are using public pilot projects in order to gain experiences with the building standard and to motivate builders and planners of private and commercial buildings to develop and realise NZEBs in advance of the 2019/2021 deadline. The analysis of the case studies showed however that the additional investment costs, with an average of 11% (or about 200 € per m² floor area), are still substantial.

3.A.4 Cost-efficient technologies, strategies or processes for NZEBs

The additional costs for NZEBs compared to conventional buildings are assumed to be a barrier for increasing the number of NZEBs for the time being. An earlier collection of NZEB-like case study buildings in CA EPBD III has shown that the additional costs were on average about 10% of the total costs, or roughly 200 €/m². The European Commission has financed and is financing several projects⁷ dealing with cost-effective technologies and strategies for NZEBs which were introduced to the CA members.

A CA EPBD survey identified the following technologies that are considered to offer the best potential for being cost-efficient in NZEBs: heat pumps, PV, insulation, heat recovery and renewable energy sources in general. Eight countries have guidelines for cost-efficient buildings and some countries use the cost-optimal EPBD analysis as guidance for cost-efficient buildings.

Lessons learned in the MSs concerning the building envelope, the technical building systems, and the design and construction processes are:

- Improving U-values of the building envelope with insulation and/or double or triple glazing is often cost-effective, but there is a need to balance decreases in heating demand and increases in cooling demand. Shading devices can be either outside the building or integrated into the building, and measures outside the building might also include the use of trees to provide shading. Taking into account factors such as positioning and orientation is often cost-efficient.
- Differences in cost-efficiency of technical building systems between countries tend to depend on climate, energy supply mix, existing infrastructure, subsidy policies and consumer perceptions. PV and heat pumps are popular and electric heat pumps are often combined with PV. Solar thermal systems may be cost-effective, but they are losing market share to PV. Mechanical ventilation systems with heat recovery are cost-effective in colder climates, and direct electric infrared heating is becoming popular in countries with low prices and low primary energy factors for electricity. Control and automation systems can be cost-effective, but are often not optimally operated, although LED lighting with presence and daylight control is generally cost-effective.
- Concerning the design process, architects and engineers are now working more closely together than they did 10 years ago, and it was suggested that BIM can help to further avoid unnecessary iterations. It is important to focus on the wider benefits of NZEBs and on achieving the best quality for the budget available instead of focusing only on the additional costs.
- It is important to include the energy specialist at each stage of the construction process. The use of Building Information Modelling (BIM) can help with quality control and effective communication between different teams. Cost, time available and quality are closely interlinked, but a problem arises when improved quality does not increase financial value. Copying solutions from other countries is difficult.

Highlights of 3.A.4

The additional costs of NZEBs compared to current new buildings are regarded as a barrier for an increased number of early NZEB buildings. The CA EPBD has exchanged experiences regarding technologies and strategies that can contribute to more cost-efficient NZEB buildings. The technologies considered most cost-efficient are heat pumps, PV, insulation, heat recovery and renewable energy sources in general.

3.A.5 Innovative technologies

The developments towards NZEBs in the MSs lead to more and more innovative technologies being introduced into the MSs' building market over the last few years. The CA EPBD collected and exchanged first experiences with new technologies in the MSs. Information was also gathered on how MSs handle these technologies in their calculation methods or other assessment procedures. The work concentrated on the following technologies:

1. demand controlled ventilation;
2. building automation systems;
3. reversible heat pumps (for cooling in summer);
4. advanced solar shading systems.

The discussion around innovative technologies shows that there are large differences among MSs in the used system variations and how commonly they are used in different types of buildings. According to the assessment of the CA participants, demand controlled ventilation (based on either humidity control, CO₂-control or temperature control) is used in the majority of new buildings in France and Belgium, is often used for non-residential buildings in Denmark, and is more rarely used in the Eastern EU MSs.

Building automation systems can be classified as defined in EN 15232. The more advanced building automation systems are currently mainly used in new non-residential buildings in Sweden, Italy, Portugal, France and Norway. However, the cost and time necessary for maintenance and repair was in general considered to be high, and it was thought that few people have a good understanding of the systems. These issues make it difficult to estimate the benefits of building automation systems. Reversible heat pumps can be based on different energy sources and are only rarely used in a few countries, and mainly in the context of residential buildings. In Norway, the use of reversible air-to-air heat pumps in residential buildings is more common, while reversible ground-to-water heat pumps are most commonly used in non-residential buildings. Use of advanced solar shading systems such as inter-pane shading devices, semi-transparent PV, switchable solar-protection glass and bio-shading remains rare in the EU MSs.

The methods of calculating the systems' impacts on the building energy use also vary across the different countries and technologies. Further information on the calculation approaches for these innovative systems can be found in the Report of the Cross-Cutting Team Technical Elements. An exchange between the countries and CEN might help to encourage broader use of the innovative technologies.

Highlights of 3.A.5	Innovative technologies are entering the building market in most MSs, but the handling of these technologies in assessment procedures differs between the countries.
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3.A.6 Indoor climate in high performance buildings

Inadequate design or execution of building energy efficiency improvement measures on the construction site can have negative consequences on the quality of the indoor climate in high performance buildings. Problems may include overheating due to increased thermal insulation (such as highly efficient windows) and increased airtightness, which can also result in lower indoor air quality if this is not complemented by a suitable ventilation solution. Other problems include emissions coming from the use of inappropriate materials, noise problems caused by ventilation systems, insufficient heating and poorly functioning installations. Work in the CA EPBD on the topic included the presentation of experiences from real buildings and the identification of key success factors to ensure a good indoor climate.

The main success factors identified were:

- correct installation and commissioning of ventilation and air-conditioning systems;
- in-use monitoring of the performance of building service systems;
- regulatory requirements setting targets (e.g., for minimum ventilation rate) or specifying measures to be used (e.g., solar shading, openable windows for night ventilation);
- quantitative indicator(s) of discomfort based on duration/intensity and the inclusion of comfort/discomfort indicator(s) in EPCs;
- education of users regarding behaviour, expectations of systems and possible lifestyle adaptations.

Indoor climate influence factors, such as the heat capacity of the building, outdoor CO₂ levels, ventilation rates etc., need to be further investigated. In general, calculation methods and energy performance requirements need to include indoor comfort issues. Different usage patterns can influence indoor comfort and therefore assessment methods need to take them into account.

Highlights of 3.A.5

High performance buildings, including NZEBs, benefit from reduced energy use but some of the commonly applied measures can also have a negative influence on indoor climate. In consequence, indoor climate requirements are increasingly being integrated into energy performance assessment and control procedures. Technical, regulatory and user dependent influence factors for good indoor comfort have been identified and discussed within CA EPBD.

3.B. Main Outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
National applications of the NZEB definition	The development of national applications of the NZEB definition is continuously followed by the CA EPBD.	The CA EPBD factsheet " National Applications of the NZEB Definition – The complete Overview " gives a detailed overview of the status of the national applications of the NZEB definition by February 2018.	CA EPBD will continue to follow up on the NZEB transposition process in the MSs.
Use of RES systems in urban NZEBs	Countries differ greatly in the RES solutions that can be assessed by their energy performance calculations and in which solutions can be used to fulfil foreseen direct NZEB RES requirements.	The collection of practical solutions for the use of RES in inner-city buildings showed potential for MSs to further learn from each other.	MSs have to solve legal and financial barriers such as how to distribute PV electricity generated on multi-family houses to the tenants.
Best practice examples of NZEBs	Seventeen examples of NZEB-like educational buildings have been collected and compared.	Many countries use public pilot projects to gain experience and to motivate private and commercial builders to develop and realise NZEBs in advance of the 2019/2021 deadlines.	Further work should include a focus on the renovation of existing buildings to NZEBs.
Cost-efficient technologies, strategies or processes for NZEBs	The CA EPBD has exchanged experiences with technologies and strategies that can contribute to more cost-efficient NZEBs.	The technologies considered most cost-efficient are heat pumps, PV, insulation, heat recovery and renewable energy sources in general.	Several EU Horizon 2020 projects are investigating this issue and will publish outcomes in 2019/2020.
Innovative technologies	Innovative technologies are entering the building market in most MSs.	The handling of these technologies in assessment procedures differs among the countries.	Exchange between the countries and CEN might be helpful for a broader use of innovative technologies.
Indoor climate in high performance buildings	Indoor climate requirements are becoming part of the national energy performance assessment procedures.	Technical, regulatory and user dependent influence factors for good indoor comfort have been identified and discussed within CA EPBD.	Further influencing factors such as the heat capacity of the building, outside CO ₂ level, ventilation rates etc., need to be further investigated.

4. Lessons Learned and Recommendations

While most EU MSs have set out their national application of the NZEB definition in legal transposition measures or in national plans on NZEB, some are still in the last phase of this development; in practice, this usually means a consultation process with stakeholders. The exchange of information in the CA EPBD has proven to be very helpful for experts responsible for the implementation of the EPBD in MSs.

According to the national CA EPBD delegates, the major challenges for tightening minimum energy performance requirements centre around the cost-optimality of the energy performance requirements, especially when one takes into consideration the following points:

- the unknown future direction of energy prices;
- the performance of new technologies;
- the investment costs of these technologies; and
- primary energy factors (mainly for electricity, district heating and cooling).

A specific difficulty lies in the integration of RES in buildings within a dense urban context. The work of the CA EPBD has shown that countries differ greatly in the RES solutions that can be included in their energy performance calculations, and in which solutions can be used to fulfil foreseen direct NZEB RES requirements. For buildings containing multiple dwellings, specific arrangements are needed to distribute or assign locally-generated energy to different users.

The majority of countries have built pilot NZEB projects, often using public buildings as pioneering examples, in order to gain experience with suitable technologies, costs, reliability and user-acceptance that might prevent rebound effects. However, in order to kick-start the roll-out of NZEBs throughout the EU, a significant reduction is needed in the additional costs compared to standard building regulations, from a current level of about 11% to about 5%. This development would be supported by national and EU programmes for the development of cost-efficient NZEBs. Several Horizon 2020 projects are currently developing relevant solution sets. Future approaches should also include NZEB solutions for new and existing buildings on a district level.

Experts from various countries strongly suggest combining energy performance requirements with indoor comfort requirements, not only for NZEBs but also in general in the building legislation (for both new buildings and renovations). Several countries have integrated indoor comfort indicators into their energy performance assessment procedures and requirements. The work on similar approaches in other countries will be accelerated by the information exchange within the CA EPBD. This corresponds to the “[Commission Recommendation on NZEB](#)” which highlights that to avoid deterioration of indoor air quality, comfort and health conditions in the European building stock, the stepwise tightening of minimum energy performance requirements resulting from the implementation of NZEB across Europe should be done together with appropriate strategies dealing with indoor environment.

For the next decade, new ambitious building energy performance targets need to be set which go beyond minimising the energy use and aim, as is the case with plus-energy houses, at (over)compensating the remaining low energy needs with renewable energy (produced on-site or off-site). Together with the implementation of the national long-term renovation strategies, this will be necessary for a highly energy efficient and decarbonised building stock by 2050 and for achieving the EU energy and climate goals.

Endnotes

1. See Article 9 of the EPBD that requires MSs to ensure that (a) by 31 December 2020 all new buildings are nearly zero-energy buildings; and (b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.
2. See also [Commission Recommendation \(EU\) 2016/1318 of July 2016](#) on guidelines for the promotion of nearly zero-energy buildings and best practices to ensure that, by 2020, all new buildings are nearly zero-energy buildings.
3. See endnote 2.
4. Erhorn-Kluttig, H.; Erhorn, H.: National Applications of the NZEB Definition – The complete Overview. Status February 2018. Factsheet of the Concerted Action EPBD, 2018.
5. I.e. without using the national grid as buffer; this may include a battery.
6. Hybrid solar photovoltaic thermal panels
7. Within the Horizon 2020 programme the EU is financing the following projects dealing with cost-efficient technologies and strategies for NZEBs:
 - ZERO-PLUS (GA no. 678407): Achieving near Zero and Positive Energy Settlements in Europe using Advanced Energy Technology;
 - InDeWaG (GA no. 680441): Industrial Development of Water flow Glazing;
 - CHESS-SETUP (GA no. 680556): Combined HEat SyStem by using Solar Energy and heaT pUmPs;
 - CoNZEBs (GA no. 754046): Solution Sets for the Cost reduction of new Nearly Zero-Energy Buildings;
 - CRAVEzero (GA no. 741223): Cost Reduction and market Acceleration for Viable nearly zero-Energy buildings;
 - A-ZEB (GA no. 754174): Affordable Zero Energy Buildings;
 - NERO (GA no. 754177): Cost reduction of new Nearly Zero-Energy Wooden buildings in the Northern Climate Conditions.



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(CT2) Existing Buildings & Systems - 2018

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1. Introduction

Existing buildings and the technical systems within them are covered by the main themes:

1. minimum requirements for the energy performance of existing buildings, especially those undergoing major renovation;
2. energy performance of technical building systems in existing buildings, including their monitoring and control;
3. regular inspection of heating and air-conditioning systems; and
4. alternatives to regular inspection.

The scope of the EPBD in respect of these themes is set out under Article 7 (*Existing buildings*), Article 8 (*Technical building systems*), Articles 14 and 15 (*Inspection of heating and air-conditioning systems*), and Article 16 (*Reports on the inspection of heating and air-conditioning systems*). Other relevant parts are Article 4 (*Setting of minimum energy performance requirements*) in relation to existing buildings, and Article 6 (*New buildings*) for consideration of high-efficiency alternative systems on major renovation.

With a few exceptions, the provisions of the EPBD (Directive 2010/31/EU) were to be applied by MSs by July 2013. Since then, implementation activities by the MSs have mainly focused on refinement and consolidation, rather than on major changes. Further revisions of the EPBD (by way of Directive (EU) 2018/844) entered into force in July 2018, and MSs will have to transpose the revised provisions by March

2020. However, other legislation also aims to improve the energy performance of buildings, which suggests that an integrated approach to implementation may be beneficial. This includes the development of a long-term strategy for building renovation, formerly part of the EED (Directive 2012/27/EU) but now transferred to the EPBD, as well as other provisions of the EED, such as energy efficiency obligation schemes (for energy suppliers), energy auditing (of consumers and enterprises) and installation of smart meters. The RESD (Directive 2009/28/EU) also contains relevant requirements, which are considered in the Central Team report on New Buildings. Furthermore, a new set of standards to support the EPBD has been prepared. These standards were adopted after a formal vote in late 2016, and MSs will decide how they are to be used when reviewing their regulations.

By way of the most recent amendments to the EPBD, an important additional theme has emerged. This is *'smartness of buildings'* and the concept of *'smart readiness'* – meaning the provision of smart features that it might not be possible to use immediately, but will become valuable as a consequence of other developments. Examples of smart features that might be unusable or insignificant at present but may play a more important role in future include:

- the ability of a building to manage itself efficiently;
- interaction with its occupants in a user-friendly manner;
- responding to external conditions, by postponing or advancing some of the electrical or heating load;
- contribution to the smooth, safe and optimal operation of connected energy assets;
- vehicle charging facilities.

Smart buildings will require much better control of their integrated technical building systems, including effective monitoring and feedback, and to that extent they have a strong connection with the second of the main smart features listed above.

2. Objectives

The objectives are:

- To develop a wider understanding of the detailed requirements and options in the EPBD concerning the performance of existing buildings, technical building systems, intelligent monitoring and control, and the inspection of heating and air-conditioning systems.
- Within these themes, to identify and explore the topics currently of greatest interest to MSs, to observe the progress made and share the experience of successful implementation and difficulties encountered.
- To consider the overlap with other directives, notably the EED and RESD, and investigate the potential for better integrated regulation and activities.

3. Analysis of Insights and Main Outcomes

3.A. Analysis and insights

3.A.1 Topics of concern for CA EPBD IV

MSs have already set the minimum performance requirements for existing buildings, including technical building systems, and have created regular inspection schemes or equivalent alternative measures. More recently, efforts have been made to improve them, and to fill any gaps. At the beginning of the CA EPBD IV, CA members were asked which topics were at that time of greatest interest or concern to them, and this has helped to direct the subsequent work. The areas identified were:

- the overall ambitions and long-term objectives for the existing building stock, step-by-step renovation and the effectiveness of each step, goals for packages of renovation measures and energy efficiency measures in suburban and low-income areas where there is no investment capacity;
- ensuring that overall requirements for the building (as opposed to requirements for components) do not become obstacles to refurbishment, raising the rate of refurbishment through incentives, motivating building owners, and making the EPBD more simple and transparent for building owners and tenants;
- dealing with the diversity of the building stock (types of construction, age, occupancy, etc.), allowing for the preservation of historic buildings, recognising occupants with special needs (e.g., the elderly);
- consideration of “*high-efficiency alternative systems*” for major renovations, renewable energy source technologies in existing buildings;
- what is “*technically, functionally, and economically*” feasible, realistic prediction of energy savings and calculation versus measurement;
- long-term retention and re-use of EPC data, achieving coherent results from EPC when a “new” building has become an “existing” building;
- other sources of data for existing buildings, the identification of qualifying buildings to ensure that regular inspection takes place, analysis of the data from EPC and regular inspections, and wider usage of EPC databases;
- essential features of “*intelligent metering*” and “*active control systems*” for technical building systems and how they should work, the role and capabilities of building energy management systems (BEMS);
- continuous monitoring of heating, ventilation and air-conditioning systems to assess the energy performance and reduce the need for regular inspection;
- alternative measures to replace regular inspection of air-conditioning, and evaluation to determine the equivalent impact.

The CA EPBD IV work on existing buildings has concentrated on these ten main areas of current interest, together with other topics that emerged later when it became clear what amendments to the EPBD were being agreed.

**Highlights
of 3.A.1**

During the lifespan of the CA EPBD IV, the general aim is to refine and improve existing policies, regulations, and schemes. The amendments to the EPBD (May 2018) bring significant changes and additions to be implemented later.

The topics of interest for existing buildings are becoming more specific and, in many cases, more technically detailed.

Overall, they comprise: renovation, feasibility and cost-effectiveness, monitoring and control, data management and analysis, inspection and alternatives to inspection. Monitoring and control are expected to acquire much greater importance in the context of smart buildings and smart-readiness.

3.A.2 Strategic objectives for renovation

The obligation to provide a long-term strategy for the renovation of the building stock has been transferred from the EED to the EPBD; the EPBD also sets the minimum energy performance requirements that apply to renovation works. Consequently, the impact of the EPBD on the depth of renovation is now accompanied by the wider role of raising renovation rates. Performance is expected to rise over time, with the prospect of reducing energy consumption by existing buildings, as well as by new buildings, until it falls to NZEB levels. The long-term strategic outlook can anticipate this development.

The long-term renovation strategies have to include measures to stimulate deep renovations of buildings, including staged deep renovations, where “*deep renovation*” means work leading to a very high energy performance and the reduction of energy consumption by a significant percentage. However, the EPBD legislates for “*major renovations*”, defined by reference to the total cost (relative to building value), or by the affected proportion of the surface area of the building envelope. Neither deep nor major renovations are required to go beyond what is cost-effective.

In the working document accompanying the COM (2013) 225¹, deep renovation means at least 60% primary energy savings compared to the status of the existing building before the renovation; this can be considered as an official interpretation. In addition, other documents² indicate that “... *the multi-objective nature of cohesion policy, contributing to economic, social and territorial cohesion, requires an integrated approach and should be used in support of the deep renovation of buildings in order to meet the energy efficiency targets for 2020 and beyond. As such, the sole focus on a simple payback period is not appropriate in the context of long-term energy efficiency investments. Rather, the aim should be to encourage deep renovations leading to significant (typically more than 60%) efficiency improvements*”.

DG Energy, with the support of the JRC, assessed the first national renovation strategies³ due in 2014 and found that only a few MSs reported “*planned*” measures for energy efficiency in buildings, while the vast majority reported only existing policies. The section related to forward-looking perspective to guide investment received the lowest average rating in the assessment exercise. This seemed to indicate that most renovation strategies lack a clear long-term vision. Few included research and development, though that could be the key to cost-optimality and lower costs, generally.

More recently, the CA EPBD has discussed the assessment of the second national renovation strategies⁴, which were due in 2017. Twenty-one (21) of the strategy documents from MSs had been fully revised and the others partly revised. Considerable improvements were found in the assessment scores, some by a large margin, and nearly all fulfilled the requirements of EED Article 4. More data had been collected and

analysed by the MSs, with a better range of scenarios. Fifteen (15) MSs put forward their long-term vision with targets for 2050.

Discussion at the CA EPBD shows that the over-riding problem for many MSs is the legacy of a large amount of housing, especially multi-apartment blocks, that is in poor condition and suffering from neglect and weak management. The immediate need is for stricter regulation and building codes to raise standards significantly, though not to such an extent that it becomes too expensive to comply with them. Experience has shown that it is possible to reduce energy demand in older housing from about 200 kWh/m² per year to less than 70 kWh/m² per year, but there are many technical and financial barriers to overcome.

Some of the barriers are:

- the difficulty for building owners in carrying out renovation projects, particularly because of the large amount of time and organisation needed;
- lack of confidence in predicted savings;
- payback times are too long to form an effective incentive for private finance;
- funding schemes are not available, or are too limited;
- reluctance to take out loans;
- distrust of administrative procedures and officials;
- different interests of stakeholders in buildings under shared ownership or with multiple tenants.

Solutions include making procedures simpler and more transparent, and using IT platforms to hold data, record progress, and link stakeholders. Financial models need good guidelines, standardised contracts and other documents. More needs to be done to reduce the burden on building owners. MSs feel that more research and development is necessary, especially to establish what is cost-effective under different circumstances.

The European Commission has launched the “*Smart Finance for Smart Buildings*” initiative, which, in close cooperation with the European Investment Bank (EIB) and the MSs, supports the development of flexible energy efficiency and renewable financing platforms at national level to make more attractive financing options available on the market. This initiative will:

- encourage the more effective use of public funds, in particular through financial instruments and investment platforms;
- help aggregation and assistance with project development;
- make energy efficiency investments more trusted and attractive for project promoters, financiers and investors, by providing them with access to market evidence and performance track records available from the De-risking Energy Efficiency Platform (DEEP) and by developing a commonly accepted framework for underwriting investments in this area.

Where there has been a long history of energy efficiency policies, supported by tax incentives and subsidies, it has been possible to set more ambitious targets. In Germany, a CA EPBD study tour was able to examine 60-year old apartment blocks in Frankfurt, which previously had little or no insulation and were now undergoing deep renovation to achieve 80-90% energy savings. CO₂ emissions were expected to be

reduced from 52 kg/m² per year to 5 kg/m² per year, in line with the city's policy objective of decarbonisation by 2050. In Denmark, strong regulations aim for a 35% reduction in energy consumption by 2050 (Figure 1), with building codes setting limits of 30 kWh/m² per year in existing buildings and 20 kWh/m² per year for new buildings. One novel idea has been to build a “library” of typical buildings for which standardised solutions can be adopted during renovation.



Figure 1. Activities in long-term renovation plans.

The costs of widespread renovation programmes may be too high for governments to bear, and more needs to be done to encourage building owners to pay for this themselves. In housing, the cost may well exceed 20,000 € for deep renovation of a typical home. Key components of programmes designed to motivate building owners are:

- information: more about the wider benefits of energy renovations (e.g., greater comfort, increased asset value, healthier indoor conditions), as well as savings in energy costs;
- investment: convincing homeowners that renovation will add value to the property and produce a positive return;
- trust: raising confidence in the ability of contractors to carry out improvement works competently and at competitive prices, assisted by codes of practice for the building trade and standardised improvement packages where possible.

Questions for further investigation include:

- ensuring that targets for overall performance (as opposed to component/elemental performance) of individual buildings do not become a deterrent to action;
- how longer-term goals should be expressed, and their level of ambition;
- building renovation passports;
- whole policy packages for renovation.

As noted earlier, amendments to the EPBD adopted in May 2018 move the obligation to produce a long-term strategy for building renovation from the EED (Article 4) to the revised EPBD (new Article 2a). The final meeting of the CA EPBD IV anticipated and debated this. It is expected that future CA EPBD activity will concentrate on how the transfer is brought into effect, and on further work on the new provisions in Article 2a, including:

- progress monitoring and roadmaps that include measures, measurable progress indicators and indicative milestones at 10-year intervals;
- the role of smart financing, including techniques such as aggregation of projects to make the funding process easier, de-risking to make projects more attractive to investors, and leverage of public funds to obtain greater benefits from the private sector;
- greater emphasis on the conscious assessment of feasibility and cost-effectiveness;
- facilitation, such as one-stop shops and building renovation passports;
- improvements to data availability and modelling;
- the relevance of building renovation to other policies, such as the alleviation of energy poverty and the needs of the elderly;
- wider benefits that are not limited to energy saving, such as those related to health, safety and air quality.

Highlights of 3.A.2

Difficulties that have been found when implementing renovation strategies are:

- the legacy of many buildings in poor condition, suffering from neglect and poor management;
- balancing available funding against the longer term horizon of deep renovation and NZEB;
- persuading building owners to invest in energy efficiency measures themselves;
- simplifying procedures, and providing help for building owners to follow them;
- raising confidence in the quality and competence of renovation contractors;
- developing standard solutions to reduce the costs in typical cases.

Future work is likely to focus on:

- progress monitoring and roadmaps;
- smart financing and facilitation for renovation projects;
- acknowledgement, identification and measurement of the wider benefits.

3.A.3 Expanding the use of databases

The majority of MSs have been using databases to keep EPCs and reports from regular inspection of heating and air-conditioning systems since these schemes were introduced for the EPBD about 10 years ago. A large amount of data has now been collected, which can be used to show the condition of the building stock, engage the general public, and encourage further investment in energy efficiency. It can also be used to examine the rate of change, assess the impact of existing policies, inform future policy development, and support research.

Earlier CA EPBD work indicated that there is value in having strong linkages between databases for the EPBD and others that hold building data for different reasons. Linkage gives an opportunity to fill gaps and check consistency wherever there is duplication. Questions then arise about definitions, compatibility, and accuracy. There are also data protection, privacy and disclosure concerns when links are made between databases holding data that has been gathered for different purposes.

Databases are in use across the MSs, but in many cases they are not being used beyond the minimum requirements of the EPBD. However, there are some known examples of:

- ***EPC/inspection databases being used to provide input data for other databases:***
property valuation and taxation databases, building stock statistics, monitoring and quality controls, planning procedures, and reporting of progress in National Energy Efficiency Action Plans;
- ***existing databases (other than EPC) used to provide input data to the EPC database:***
property identification details, including address, building type, names of owners and former owners, maps, local climate correction factors, and the credentials of the energy expert who produced the EPC;
- ***databases used to help achieve national policy targets, or implement EU directives other than the EPBD:***
development of building codes, the renovation strategy for the EED, setting energy-saving goals for different stakeholders, energy-saving targets and planning, and other actions to evaluate and improve the quality of buildings;
- ***databases used to support research:***
databases of EPCs and inspection reports have already become a valuable source of national building data; an example (in the UK) is a research project on the national stock of air-conditioning systems, in which it was possible to analyse 500 inspection reports and EPCs for the same buildings.

MSs vary in their approach to disclosure of this type of data, some having open source databases and others limiting access under restrictive data protection rules.

The advantages of combining databases are: providing answers to questions about buildings (in the absence of other sources of knowledge); informing policy development; improving quality controls;

avoiding unnecessary duplication; increasing the motivation for building improvements; engaging the market; and supporting social research. The drawback is that the development of complex databases is seen as expensive, and gathering more data is expected to lead to more complicated inspection procedures and calculations.

A single database containing all building information would be ideal, but the reality of trying to achieve this poses many problems. Data is usually acquired at different times by different agencies and for different purposes, meaning that underlying assumptions may be incompatible, and content and data formats different. Preventing further divergence through future development requires strong overall control. The barriers and risks are illustrated in Figure 2.

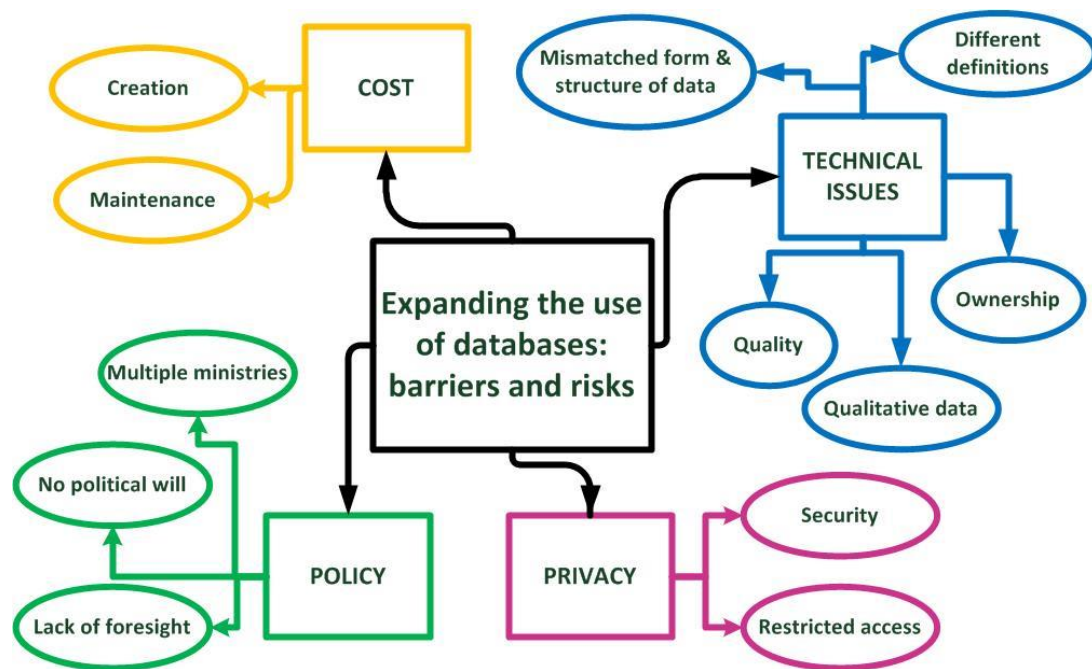


Figure 2. Expanding the use of databases: barriers and risks.

The main difficulties experienced by MSs in setting up, maintaining, and combining databases for buildings include:

- changing or conflicting rules (e.g., EPC rating scale, different definitions of treated floor area);
- privacy barriers to free circulation of information;
- not being able to locate all buildings, or all heating and air-conditioning systems;
- building ownership data not sufficiently up to date;
- low level of assessors' technical skills;
- industry resistance to supplying new information demands;
- independent control systems (and quality control more generally) for databases, and successfully applying sanctions.

Although they see the opportunities for wider systems, MSs generally have a cautious approach to expanding the use of databases.

The following ideas are among those being considered:

- use of data for strategic thinking and planning of long-term energy savings;
- more accurate and useful information for building occupants; recommendations could be made for a building at the point of sale based on data from case studies of similar properties; larger mortgages would be made available for a buyer wanting to carry out the improvements;
- innovation, gap analysis and data mining would provide opportunities for the development of new energy efficiency solutions;
- open data: information could be opened up to anyone who wants access via a simple, government-provided gateway; the market would be expected to find novel uses for this data.

It is usually necessary to refine and combine raw EPC information with other data before use in a wider context. Understanding and compensating for errors and incompatibility at a technical level (e.g., definitions and measurement conventions) is necessary to produce coherent data sets. Statistical data can be used to fill in gaps and provide a complete data set for individual buildings. Aggregated data is of little commercial value, as it does not identify the buildings in need of particular energy efficiency measures.

To exploit buildings data successfully there is a need for vision and careful planning, and to fully understand the requirements when mining data. Many common barriers exist across MSs. The potential advantages of combining databases must be weighed against the cost. Although many ideas have been put forward for developing and using coherent datasets, most have not yet been put into practice.

The amending EPBD makes explicit reference to the collection of data for buildings. Article 10, (6a) and (6b), requires EPC databases to allow data to be gathered on measured or calculated energy consumption, and that at least aggregated anonymised data shall be made available for statistical and research purposes. CA experience indicates that most MSs already have well established EPC databases and they should be able to comply with these requirements without difficulty.

Highlights of

3.A.3

Databases of EPC and inspection reports are currently in widespread use across MSs but they are generally being used only to support the minimum requirements of the EPBD.

There are many interesting possibilities to expand their use, including strategic thinking, information for building occupants, data mining, support for research projects, and open data.

There are significant barriers when doing this, in terms of multiple ownership, disparate purposes, technical issues, privacy, cost of development, and the ongoing costs of reconciling data from different sources.

3.A.4 Heritage buildings

Heritage buildings present a particular set of challenges, as upgrading to improved levels of energy performance may be intrusive, visible, and unacceptable. Alterations to the building fabric can lead to a change of character; examples of the insensitive use of exterior wall insulation on old buildings in France have been observed and illustrated in a journal article⁵. Although MSs apply minimum performance standards to major renovation work, the EPBD allows exemption to be given to buildings of special architectural or historical merit. The obligation to renovate public buildings under Article 5 of the EED contains a similar exemption, insofar as compliance with minimum energy performance requirements would unacceptably alter their character or appearance.

MSs are aware that meeting the same minimum levels of energy performance after renovation entails far higher costs for heritage buildings than for other buildings. They also have to satisfy numerous organisations and authorities with a strong interest in building preservation. There is a considerable amount of available guidance on the renovation of special buildings, as well as a range of technical solutions, such as concealment of sensors, wireless links, automatic window control, underfloor heating. Some MSs (notably Germany) have taken a numeric approach to the relaxation of requirements, in which targets for heat loss through components in W/m^2 per K, or overall energy intensity in kWh/m^2 per year, are modified according to the type of building and the difficulty of renovation. Targets can be set as a reduced proportion of those applicable to a reference building (Figure 3).

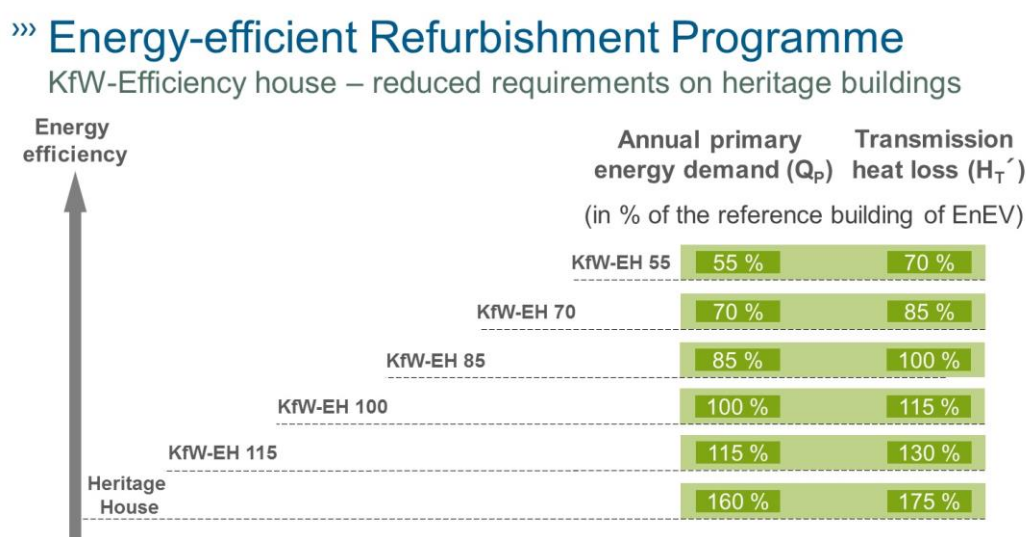


Figure 3. Reduction of targets by proportion.

Enquiries have shown that about two-thirds of the MSs have a recognised definition of heritage buildings and have established principles to be followed concerning preservation of their external appearance. A similar number allow exemption, to some degree, from the minimum performance requirements that would normally apply during major renovation. Fewer than half have published guidance or rules concerning energy efficiency improvements to heritage buildings. For some MSs, heritage buildings are not a priority, while in others a mild climate means that improvement of the thermal envelope is not always necessary.

One concern is funding schemes linked to increases in energy performance, under which heritage buildings do badly in comparison with others. Seen as an investment, the benefit/cost ratio is relatively poor. Most countries do not allow for special rules (a “*heritage factor*”) when energy efficiency projects are competing for funds, and if they have to compete then it is on equal terms. There is no such competition where national funding for heritage buildings is treated separately.

An integrated approach to take account of the EPBD, EED, and RESD is seen as advisable, though the aim of renovation projects is usually not limited to saving energy and reducing environmental impact. Renovation extends the life of the building, and raises the quality of living and working spaces as well as improving occupant satisfaction. However, efficiency and cultural heritage are often the responsibility of different ministries. This requires a holistic approach and planning (Figure 4) with co-operation between technical and cultural experts in different teams. In monumental buildings, energy performance may be considered a minor aspect, while factors such as tourism play a much bigger role. This is acknowledged in the Namur Declaration on the objectives and priorities for a common European Heritage Strategy⁶, which places a high value on the contribution of heritage to quality of life, the living environment, and Europe’s attractiveness and prosperity.

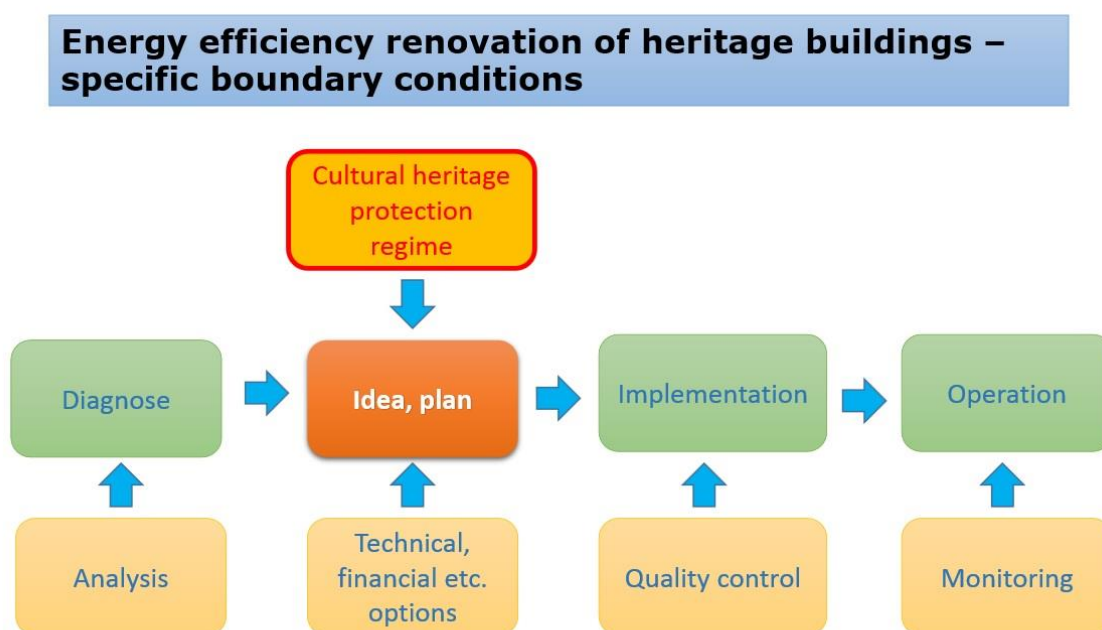


Figure 4. Planning for renovation of heritage buildings.

A thorough assessment of an historic building and its energy consumption is necessary before a renovation project is planned. One successful approach is to categorise the different types of historic construction: this helps to identify suitable and cost-effective solutions that have worked in the past and to generate guidance for the future. This has allowed historic renovation to become somewhat simpler and less expensive.

Some future prospects are:

- wider categorisation of historic building types, with corresponding guidance and best practice;
- further development of renovation guidelines by reference to previous experience based on building categories;
- attention to the greater importance of technical building systems and energy management systems where it is not feasible to improve insulation and airtightness of the building fabric;
- specific guidance for installation of renewable energy source technologies in sensitive buildings;
- climate-specific solutions, applicable across a number of countries;
- better co-ordination of government departments responsible for energy, culture, and heritage.

Highlights of 3.A.4	Renovation of heritage buildings is restricted in scope and it is relatively expensive to achieve a high level of energy performance. Funding for renovation is difficult to obtain if competing on the basis of the benefit/cost ratio. Some relaxation of the minimum performance requirements is necessary. Energy efficiency and heritage are the responsibilities of different government departments and good working relationships are needed. Categorisation of building types helps to identify suitable and cost-effective solutions, leading to better guidance for future projects.
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3.A.5 Technical Building Systems

Technical building systems (TBS) comprise installations that provide heating, hot water, air-conditioning, ventilation, and lighting. In the revised EPBD, the definition has been expanded to include building automation and control, as well as on-site electricity generation, including systems using energy from renewable sources. They are addressed in EPBD Article 8 (*Technical building systems*), now replaced in the amending EPBD by Article 8 (*Technical building systems, electromobility and smart readiness indicator*). Furthermore, heating and air-conditioning systems are subject to requirements for regular inspection, set out in EPBD Articles 14 and 15 (*Inspection of heating and air-conditioning systems*) and Article 16 (*Reports on the inspection of heating and air-conditioning systems*).

The scope and implementation of the EPBD in regard to TBS and regular inspections have been explored extensively by the CA EPBD in earlier meetings. Before the amending EPBD, Article 8 mentioned that (with the exception of lighting) requirements must be set for the overall energy performance, installation, dimensioning, adjustment and control of systems in existing buildings. During the CA EPBD IV, these topics were revisited to consider the impact of air-conditioning inspection schemes and the report “*Unleashing the power of the EPBD’s Article 8*”.

In the discussions held during the CA EPBD IV, it was shown that the status of air-conditioning installations is becoming more widely known as a result of regular inspection, from which experience has been accumulated with common findings and the improvements that are most frequently recommended.

However, some MSs have chosen to introduce 'alternative measures' instead of regular inspection, in which case they must produce a report every three years to demonstrate that these measures have equivalent impact.

The principal questions for both heating and air-conditioning inspection schemes concern maintenance, monitoring, and the differentiation of actions by reference to the type and age of the installed plant. It has been found that most recommendations arising from inspection are 'quick fixes' concerning operational hours, controls and routine maintenance. Other factors were the need for accessible energy meters, regular analysis of readings, presentation of understandable and useful information without data overload, and the motivation of building managers. Points for debate are whether defects are more likely to be noticed during maintenance or inspection, the prospect for commercial online monitoring services, the feasibility of linking the frequency of inspection to the age of the plant, and the system's size above which regular inspection is clearly a better policy than 'alternative measures'.

Little is known about the energy savings achieved as a consequence of regular inspection. They depend on the extent to which recommended improvements are taken up. Nevertheless, this has to be estimated for the purpose of comparison with 'alternative measures' when MSs have to report on equivalent impact; in 2014, a CA EPBD working group produced a framework for writing such reports. An analysis has been carried out concerning the reports already published on the EC website. This analysis found that these MSs had faced difficulties in acquiring sufficiently detailed data and creating energy models on plausible assumptions. In at least one case, these difficulties were successfully overcome with a comprehensive stock model of system types, power ratings, age, and replacement rates, combined with reasonable expectations of utilisation, coefficients of performance (COP), annual energy consumption, quality of maintenance, and degradation profiles.

The report "*Unleashing the power of the EPBD's Article 8*" ⁷ (March 2017) draws attention to the generally poor and unambitious regulatory treatment of TBS. It claims that there is huge potential for energy savings in TBS, but most MSs have not taken the opportunity (encouraged by the EPBD) to introduce stronger regulations to achieve that. The contribution of prospective energy savings to the national targets could be equal to that of the whole of the rest of the EPBD. To do so would require a wider understanding of the effective measures that can be implemented on *systems*, rather than on individual components, and of how to optimise their energy performance. The greatest scope for savings is from the TBS *replacement* in *existing* buildings, which occurs naturally at the time of the building's refurbishment or the expiry of TBS life. Effective regulation would need to refer to the minimum energy performance levels that are reasonably achievable for each of the different systems and technology types, and to include technically specific requirements for installation, adjustment and control. While this would be difficult initially, and there were practical objections to confront, the cost would not be unduly high compared with the achievable energy saving benefits.

In the amending EPBD, the threshold for inspection has been raised to 70 kW for both heating and air-conditioning systems. The idea is to focus more strongly on medium to large buildings (e.g., offices, shops, and apartment blocks with communal services to more than 10 units), where inspections are most effective. Ventilation systems will be inspected in the case where they are integrated with heating or air-conditioning systems above the specified threshold. In addition, the amending EPBD allows the inspection to be replaced by monitoring in buildings equipped with electronic monitoring and building automation and control systems. Electronic monitoring of TBS informs building owners/managers when the system efficiency has significantly decreased and when system maintenance is necessary. It has been shown that this was a cost-effective substitute for regular inspection. Furthermore, building automation and control

systems will be required by 2025 in very large non-residential buildings (system capacity above 290 kW for heating or air-conditioning), provided they are technically and economically feasible. Finally, the amending EPBD requires the installation of self-regulating devices for room temperature in new buildings, as well as in existing buildings when heat generators are replaced, on the condition that the installation is economically and technically feasible.

Highlights of 3.A.5	Improvements to TBS, including the regular inspection of heating and air-conditioning, have the potential to save very large amounts of energy in existing buildings. In the case of air-conditioning inspection, valuable experience has been acquired concerning common faults and most frequently recommended improvements. Where 'alternative measures' have been adopted in place of regular inspection, sophisticated models now exist to predict and compare their impact: these are needed for the 'equivalence reports' that must be prepared at three-year intervals. A report in March 2017 claims that regulations for TBS are not sufficiently ambitious, and far more could be achieved at a moderate cost, mainly by focusing on the energy performance of whole systems as opposed to the individual products and components.
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3.A.6 Smart Buildings and Smart Readiness

Smart Buildings and Smart Readiness are relatively new concepts. In the context of the amending EPBD, smartness refers to three key functionalities of a building and its technical building systems:

- (a) maintaining good energy performance and operation of a building in a more automated and controlled manner, including (for example) the adaptation of energy consumption to maximise the use of RES when available;
- (b) responding to the needs of the occupant and reporting on energy use, while maintaining healthy indoor climate conditions and paying attention to user-friendliness;
- (c) offering flexibility of the building's overall electricity demand in relation to the supply grid, with active and passive as well as implicit and explicit demand response (for example, by load shifting).

Annex 1a of the amending EPBD sets out the purpose of the smart readiness indicator. It is to assess the capabilities of an individual building as above, covering features for energy saving, benchmarking and flexibility, and enhanced functionalities and capabilities resulting from more interconnected and intelligent devices. Assessment for smart readiness must take into account features such as smart meters, building automation and control systems, self-regulating devices for indoor air temperature, built-in home appliances, recharging points for electric vehicles, energy storage, interoperability of features, as well as the benefits for indoor climate conditions, energy efficiency, performance levels and enabled flexibility.

Smart buildings and smart readiness depend strongly on automation, monitoring and advanced controls for TBS, all of which have been referenced previously in Articles 8, 14, and 15 of the recast EPBD (May 2010). Assessment of buildings for 'smart readiness' will revive interest in these technical topics. Many of the energy saving features now described as 'smart' are techniques that are not new, though they may have received little attention while they were simply an optional part of the advanced control or of building energy management systems (BEMS). A few examples are:

- careful division of a building into zones, with set points for temperature, which are automatically allowed to vary slightly according to weather conditions;
- night cooling by mechanical ventilation, deployed to reduce the necessity for active cooling on the next day;
- measurement of CO₂ levels to identify more densely populated parts of a building and temporarily raise the ventilation rate;
- temporary restraint of the TBS for heating, hot water and cooling during times of peak demand on the supply grid, with a financial reward for doing so, offered through flexible time-of-day pricing tariffs.

The latter is an example of readiness to participate in schemes that are not yet widely available, though the capability to do so can still be recognised.

The CA EPBD has devoted some attention to smart buildings and smart readiness in anticipation of the amending EPBD. Concepts and terminology have been explored and debated, and discussions were held on the evolution of 'smart' features, in the expectation that MSs will need to review and strengthen their regulations for TBS.

The CA EPBD has also played an active role in the widespread consultations for the EU study to support setting up a Smart Readiness Indicator (SRI)⁸. In the initial study, ending in August 2018, the project team has identified eight (8) impact criteria for ten (10) domains (sets of building services). A comprehensive taxonomy of smart functions within each domain has been drawn up. The vision is the development of a SRI that can differentiate individual buildings and reflect something end-users understand and care about, and hence stimulate change that supports policy objectives. Development of the relevant metrics and a suitable scale for the results is a technical challenge, and it is acknowledged that there is a need for the careful definition of smart service functionality and functional levels, and that the impacts ascribed to different levels should be estimated with a reasonable degree of confidence. Depending on MSs' wishes, it is possible that smart readiness assessment could be connected to energy performance calculation and EPCs (e.g., become an additional module in the existing procedures), though the calculation methodology for the indicator will have to consider impacts wider than energy or primary energy.

At the end of December 2018, a second study started in order to consolidate the earlier results and support the preparation by the EC of the legal acts that will establish the SRI.

Highlights of 3.A.6

Smart Buildings and Smart Readiness are included within the amending EPBD. The key elements are using controls and automation to maintain good energy performance, responding to the occupants' needs and adding flexibility by introducing demand response.

This supplements the existing provisions for TBS, especially in regard to automation, monitoring and feedback to occupants.

A technical study launched by the EC to support the development of the SRI and the related calculation methodology concluded in August 2018. It has already tentatively identified impact criteria and technical domains (sets of building services) that could be considered in the calculation of the SRI.

3.B. Main Outcomes

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Objectives for renovation of the building stock	- building renovation strategy is required by EED (soon to be a requirement of the EPBD instead); “deep renovation” and “major renovation” have different definitions; “major renovation” need not be planned but is subject to minimum standards; - legacy of housing in poor condition; - NZEB standards for the longer term	- strategies not yet linked to the NZEB vision; - payback times too long to attract private investment; - difficult for building owners to initiate renovation projects, even with available funding	- simplification of procedures; - better information and help for building owners; - progress towards standardised solutions; - raising trust and confidence in contractors; - new requirements for a long-term strategy as defined in Article 2a of the amending EPBD; - progress monitoring and ‘roadmaps’; - smart financing and facilitation for renovation projects; - identification, acknowledgement, and measurement of the wider benefits
Expanding the use of databases	- databases not used except to support the basic requirements of the EPBD; - significant barriers: technical issues, privacy, and cost of development	- many possibilities to expand database use; - need for vision and good planning to ensure value is provided	- using data for strategic thinking and planning for long-term energy savings; - providing information for building occupants; - wider access to open data
Improvement of heritage buildings	- restricted opportunities; - higher costs to achieve good energy performance; - energy efficiency often a minor aspect	need for clear definitions and guidance, some relaxation of minimum requirements, different funding streams or rules, coordination between	- categorisation of construction types to facilitate reference to earlier solutions; - greater attention to technical building systems

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
	of renovation projects	different government departments	when fabric alterations are not feasible
Technical Building Systems	• very large potential for energy savings; • experience gained from the regular inspection of air-conditioning systems; • study of reports from MSs on the alternatives to the regular inspection of air-conditioning systems; • reported lack of ambition in MSs' regulations for improvements to systems in existing buildings	• common faults revealed by regular inspection are related to operational hours, controls, and routine maintenance; • comprehensive models now developed for the assessment of alternatives to regular inspections; • need to optimise performance at system level, rather than simply at product and component level	• the amending EPBD brings significant changes to the requirements for TBS and regular inspection; • in particular, continuous performance monitoring will become an alternative to regular inspection; • large installations for heating and air-conditioning to be equipped with building automation and control systems by 2025; • overall TBS energy performance to be assessed whenever a system is installed, replaced or upgraded
Smart Buildings and Smart Readiness	• unfamiliar terminology, with precise definitions yet to emerge; • main functions are automation, monitoring, feedback, advanced control, and demand response; • progress of the EU study to develop a SRI	• heightens the role of TBS with advanced controls, invoking new features; • prospect of SRI assessment procedure similar to, and allied with, that for EPCs; • SRI calculation methodology not confined to the fundamental units of energy or primary energy	• implementation of the amending EPBD, which introduces the SRI; • SRI calculation methodology yet to be developed and refined; • conclusions from the first technical study to devise methodology and assessment procedure (August 2018); • second technical study started at the end of December 2018

4. Lessons Learned and Recommendations

Minimum requirements on building renovation, and renovation strategies (required by the EED), should look forward to NZEB levels of performance as the long-term objective. While that may be relatively straightforward in the MSs with a long history of regulations to improve energy performance, it is more difficult in those that have a large legacy of buildings in poor condition and limited funding programmes. The more urgent short-term requirement is to renovate to reasonable standards, as widely and as quickly as possible, without the additional expense and technology risk that accompanies “*deep*” renovation. However, that may perpetuate sub-optimal performance over the longer term. For private investment in building renovation, more needs to be done to simplify the process, help and encourage building owners, develop “*standard*” solutions for typical buildings, and increase confidence in contractors. Transfer of the obligation to produce a long-term building renovation strategy from Article 4 of the EED to Article 2a of the amending EPBD will focus MSs’ attention on a number of new requirements (summarised under Main Outcomes above).

There is a need for vision and effective planning to expand the use of databases and exploit their full value, in particular to target building renovation programmes, improve compliance with building codes and support stronger and better quality schemes for energy performance certification. The potential advantages of combining databases must be weighed against the cost. Combined databases are already used in several MSs, for example to provide input data to EPC, and using EPC data for monitoring of property value, planning purposes, and building stock statistics. A number of barriers such as incompatible data conventions, conflicting rules, different updating cycles, and privacy restrictions are common across most MSs. A thorough understanding of the limitations, with compensation for errors and incompatibility at a technical level, is necessary to produce coherent and reliable data sets.

For heritage buildings, it is more expensive to renovate to the same standards, and sometimes impossible without unacceptable changes to appearance and building character. Exemption is permissible under the EPBD and EED, but relaxation, rather than total exemption, is preferable. Schemes that set proportionately reduced performance targets on a numerical basis, according to circumstances, can be used widely without having to consider too many special cases. Categorisation and “*standard*” solutions, when possible, help to reduce costs. Where changes to the building fabric are not acceptable, greater attention should be given to obtaining very high performance from technical building systems to compensate.

During the CA EPBD IV, it was shown that progress with inspection schemes for air-conditioning systems has built up experience on the most common faults and recommendations for improvements. Where alternative measures have been chosen, some comprehensive models have now been developed to assess and compare impact for the purposes of ‘equivalence reporting’. In regard to regulating for the better performance of TBS, a greater understanding and emphasis is needed of the behaviour of whole systems, rather than individual products or components.

Smart buildings and a SRI form part of the amended EPBD, and the work to develop the calculation methodology and assessment procedures is in progress. This is intended to run in parallel with the established calculation and assessment procedures for the energy performance of buildings that deliver EPCs. However, SRI metrics will not be limited to energy, and at this stage it is not yet clear if it will become feasible (and desirable) to combine SRI and EPC procedures.

Endnotes

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7. See www.ecofys.com/files/files/ecofys-2017-optimising-the-energy-use-of-tbs-final-report.pdf
8. The study “Support for setting up a Smart Readiness Indicator for buildings and related impact assessment”; see <http://smartreadinessindicator.eu/>



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(CT3) Certification, Control system and Quality - 2018 Status in February 2018

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1. Introduction

All MSs are required to set up certification and disclosure schemes for buildings. They must also set up inspection schemes for heating and air-conditioning systems, or implement alternative measures. Most of the requirements related to certification and inspection derive from the EPBD Directive 2002/91/EC, which was to be fully implemented by 2009, and were followed-up in Article 11 of the EPBD recast Directive 2010/31/EU. Therefore, countries have systems in place that address these requirements, though a few are still working on the transposition of specific parts of that directive. Most countries have developed systems for, and now have significant experience in, the certification of buildings, the inspection of heating systems and, to some extent, the inspection of air-conditioning systems. Furthermore, over the years, countries have developed and collected significant experience with independent control systems.

According to the Evaluation¹ of the EPBD, *"even if Energy Performance Certificates (EPCs) have positively influenced property valuation, EPC recommendations could have had a higher impact on informing and stimulating higher renovation rates. For certification to go beyond its main objective of giving a market signal for efficient buildings and equally stimulate more building renovation, EPCs should be better integrated within a framework of supporting measures including EPC databases, and stronger links to financing schemes and to compliance checking. For instance, EPCs can be a valuable tool for assessing the level of compliance with building codes and enable efficient compliance checks by providing information to central bodies. The public consultation indicated that, in their current form, inspection reports could be*

poorly suited to the needs of non-expert building owners, with a high risk for the recommendation therein of being ignored".

Currently, the major challenges lie in the quality and effective implementation of certification and inspection systems, to ensure that the **full impact** of these systems is achieved. The focus of the work in the CA EPBD is oriented towards possible improvements to existing schemes and the exchange of best practices, rather than on developing systems from scratch.

This report focuses on the quality of both certification and inspection systems, as well as on the full implementation of the certification system. For consistency, issues linked to the actual implementation of inspection systems are covered in the CT2 report on existing buildings.

2. Objectives

For the general public, the EPC provision of the EPBD is one of the most visible elements of the directive. EPC systems use significant national resources and can thus be expected to deliver significant savings. However, some elements in the systems that have been developed reduce their impact. This central team's objectives are, therefore, to identify the elements that limit the certificates' outcomes and to investigate how these could be improved upon, using the substantial experience gained from the MSs. The differences and challenges are often found in the system's details that require improvement: for example, the quality of the reports and certificates, the monitoring and development of databases and capacity building on multiple levels.

A major challenge is the quality and use of certification and inspection systems in order to maximise impact whilst maintaining reasonable costs. Many lessons have been learned on a national level, and a key objective of the CA EPBD is to foster the sharing of experience and the development of guidance documents to gradually improve certification, inspection reports and control systems, as well as to help understand why some systems work better than others.

The work focuses on learning from European experiences and developing lessons learned and recommendations. It focuses especially on the quality and usefulness of the certification system and on specific technical elements linked to certification, which countries have found to be of interest.

3. Analysis of Insights and Main Outcomes

3.1 Steps in the Energy Performance Certification process

The scheme that delivers EPCs or inspection reports can be divided into several steps (Figure 1). Based on this structure, those aspects that significantly influence the quality and the public's perception of the schemes have been identified and have been central for the discussions.

Figure 1 presents the elements for the implementation of functional EPC schemes and the regular inspection of heating and air-conditioning systems. This image presents six (6) steps necessary to develop a functional EPC or inspection scheme, to deliver the reports and to guarantee the overall quality of the system. The process begins with the legal framework (step 1), requires a methodology (step 2), training of experts (step 3), the delivery of an EPC (step 4) and its availability for third parties (step 5). It concludes

with feedback from the market (step 6) covering various aspects, such as the stakeholders' perception of the system or the feedback on the EPC layout and content resulting in the improvement of the attractiveness of EPCs. The independent control system and the communication strategy are two relevant overarching elements for the whole process. Depending on the country, some of the steps in Figure 1 can be arranged in a different order. Each step covers different elements that may not necessarily be fully developed in every country. For instance, a few countries have not begun working with a central EPC database and some do not have a single official EPC software.

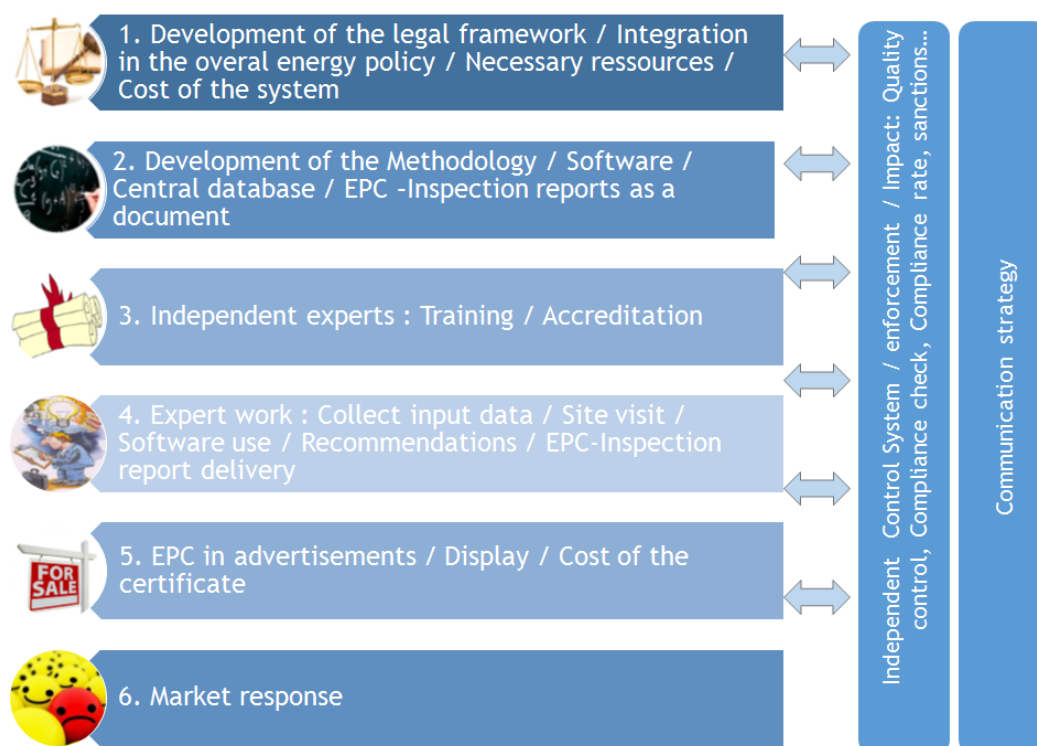


Figure 1. Steps in the Energy Performance Certification and regular inspection scheme process.

The different EPBD articles can be linked to these steps and overarching items. In practice however, there is a number of additional attention points beyond those explicitly specified in the EPBD articles that have to be taken into account. This structure has been used to organise the discussions between countries and is also used in the context of this report.

3.2 Understanding and improving the perception of the EPC system

Good quality data and information forms the backbone of confidence in an EPC system. Criticism has been expressed in the past regarding the efficiency of EPC systems as they are currently implemented². To achieve the goals of the EPC system, stakeholders' perceptions of and trust in the system is critical. Therefore, understanding stakeholders' opinions in order to make improvements in response to their feedback can be an important part of maintaining an EPC system. In practice, numerous individuals are involved in the EPC system and even more are in contact with the documents (certificates), including: experts in charge of the delivery of the EPC, real-estate agencies, the owners of the certified buildings, and future tenants or buyers.

3.2.1 Assessment of the perception of the EPC systems

The reputation of the EPC system varies significantly among countries. A self-evaluation of EPC systems by EPBD CA experts shows that no MSS' systems were rated either very-poor (0-value) or excellent (4-value). The evaluation scores are in the range of 1 to 3, with an average of 2.1. EPCs are delivered in very different situations (new buildings vs. existing buildings, residential vs. non-residential buildings, at building permit stage vs. at commissioning stage, etc.), with the consequence that there can be different perceptions of the various EPC systems among different stakeholders/types of certificates in one particular country. These multiple (positive or negative) perceptions are not the same in every country. For instance, in Croatia it is the scheme for existing residential buildings that is best perceived.

More than half of the countries participating in the EPBD CA consider it essential or very important to be able to objectively assess the perceptions of their EPC system. As of the end of 2016, 12 countries have realised programmes or studies to evaluate the quality of the EPC system. These programmes were conducted by the organisation in charge of the EPC or by third parties, such as consumer organisations (Figure 2). This feedback from the market has been used in several countries to enhance the EPCs by improving their content and layout and, hence, their attractiveness, as described in §3.4.



Figure 2. Examples of EPC quality assessment undertaken by consumer organisations in Europe.

Twenty countries intend to develop, begin or continue actions to evaluate and improve the perception of their EPC schemes. To date, no country has an exact set of criteria regarding the elements that should be taken into consideration to objectively evaluate the perception of their EPC system.

3.2.2 Elements identified as significantly impacting the perception of the EPC system

Based on countries' experience, the following main elements have been identified as most significantly impacting the credibility of EPC schemes:

1. communication relating to the EPC;
2. implementation and management of the independent control system;
3. effective and proportionate sanctions in case of poor quality or non-compliance with the EPC-related requirements;
4. resources necessary to operate the EPC system;
5. initial expert training and expert profile requirements.

The top five issues identified as problematic for the perception of the EPC system are:

1. differences between calculated/estimated (asset rating) and measured energy consumption;
2. means to monitor and improve the perception of the system;
3. resources required to operate the EPC system;
4. inputs and data required from the building owner;
5. communication and marketing campaigns related to the EPC.

Identification of these elements makes it possible for countries to initiate specific actions to improve EPC schemes by addressing these points.

Highlights of 3.2

Currently, no country has an exact set of criteria regarding the elements that should be taken into consideration to objectively evaluate the perception of their EPC system. This needs to be further investigated in the future.

More than half of the countries consider the ability to objectively assess perceptions of their EPC system important.

Main Outcomes of 3.2

Confidence in the EPC system shapes its credibility and the general public's perception. Twenty (20) countries intend to develop, begin or continue actions to evaluate and improve how their EPC schemes are perceived. Actions to objectively assess perceptions were effectively undertaken in 12 countries. This feedback from the market has been used in several countries, for instance, to improve the EPCs by modifying their content and layout and, hence, enhance their attractiveness. In practice, the EPC perception varies from country to country and multiple perceptions of the EPC, according to the type of building considered, may be found at the national level. A ranking of the elements that impact perceptions of the EPC allows for specific actions to be developed to improve these perceptions.

3.3 Costs for the development and operation of the EPC scheme

To be operational, an EPC scheme requires a set of tools and services (see Figure 1). It should cover, among others, the EPC software, the EPC registry (if applicable), a website for the qualified experts and the public, helpdesks and the operation of an independent control system. The EPC registry or database, for instance, can take several forms, ranging from very simple ones, containing only the EPC reference, to databases containing all the EPC data, intermediate calculation and final results. Associated software tools for data mining or quality control checks are also implemented in some countries. Among all costs, the business and IT investments for the development of the EPC registry and associated software may be considerable, depending on the range and scale of EPC registry functions. There are also recurring operational costs to maintain these registries and the associated software tools. In practice, the financing mechanisms and the costs for the development and operation of the EPC system can vary significantly, depending on the country considered. Several countries are interested in the existing options to limit these recurrent costs; the knowledge of the existing underlying business models in the countries, presented below, could provide an answer.

3.3.1 Different business models for the financing of the EPC system

The situation regarding the financing of the EPC scheme varies among countries, based on models where the initial development costs and the running costs are totally, partly or not at all financed by public funds. Table 1 presents a summary of the different approaches for each of the elements of an EPC.

Element of the EPC system	Situation
Costs	Only comparable if the national context is taken into account.
Financing and business model	• Totally, partially or not financed by public funds. • Fee required or not required from the qualified experts. • Fee paid can be annual and/or per EPC issued.
EPC software	• Single mandatory software or multiple software tools available. • Software development by public authorities or private companies. • Financed by public authorities or by third parties. • Mixed situation, e.g., both government and private company software can be available.
Registries / databases	• The content of these registries varies from country to country. Some store EPC rating only and others store all input data and evidence records as well.
Independent control system	• The three options described in Annex II of the EPBD are used and also equivalent measures.

Element of the EPC system	Situation
	• Administered by public authority or delegated to third party. • Number of conducted checks varies.
Other services	• Additional services not always present. • Additional services can be helpdesks, websites, advertising, statistics and legal services.

Table 1. Overview of different approaches for the EPC system across EPBD CA countries.

According to the option selected at the MS level, the amount of public funds used to finance the system can be very different, ranging from several million € on a yearly basis to almost no public funds. Performing a fair cost comparison between countries would require that the national context is systematically taken into account. In some MSs, qualified experts have to pay fees. Annual registration fees and fees to be paid for each EPC delivery also exist. Based on these fees, several MSs have (fully or partly) self-financing EPC schemes; for example, Denmark, Ireland and Portugal.

3.3.2 Example of the EPC software

The different options chosen by the countries regarding their EPC software, as presented in Table 1, illustrate very effectively the ways initial and running EPC costs are financed. The EPC calculation procedure is implemented in software tools in every case. In some countries, such as Belgium, Croatia and Lithuania, the development of mandatory EPC software is totally financed by public funds. The opposite situation is that no public funds are used to develop the software; for example, in Denmark and Portugal. Several software tools are available in the market, and the initial development and running costs of these tools are supported by third parties, such as private companies or universities. An official approval of these software tools can be required by the governments. This software approval can be free of charge for the software provider if the considered software fulfills the standard, as it is the case in Italy.

Main outcomes of 3.3

The financing of the EPC scheme varies among models where the initial development costs and the running costs are totally, partly or not at all financed by public funds, ranging from several million € on a yearly basis to almost no public funds.

The use of the system by the qualified expert can be free of charge or can be based on fees. In some MSs, qualified experts have to pay fees, either in the form of an annual registration fee, or as a fee to be paid for each EPC delivery. In several countries, these fees finance (fully or partly) the implemented EPC scheme.

Main outcomes of 3.3

The knowledge of these existing underlying business models shows possible solutions for the countries that intend to limit the recurrent costs financed with public funds associated with the running of the EPC schemes.

3.4 Modifying the EPC content and layout

EPBD CA countries identified communication relevant to the EPC as the most significant element impacting EPC perceptions (see §3.2). Improving the attractiveness of EPCs is therefore an important lever to maximising benefits. Since the introduction of the first version of national EPCs, many countries have in some way modified the EPC delivered to the final clients. Alterations to the EPC may include adding classes, changing limits (e.g., Figure 3), changing colours and modifying the layout (e.g., Figure 4).

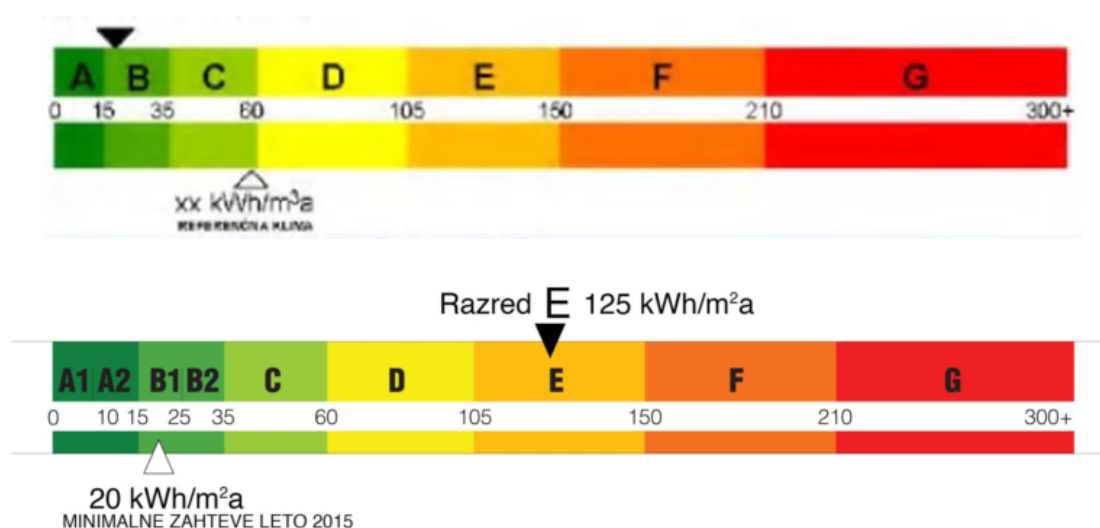


Figure 3. Example of rescaling the EPC – 2008 and 2014 EPC in Slovenia.

There can be different motivations for modifying the EPC content and layout. In 2010, the main driver for countries to modify the EPC was the introduction of new, stricter requirements: for example, alterations to the stepped certification scale (classes) to better reflect both ends of the scale, for both existing buildings and new buildings complying with new requirements. With increasing national experience, other motivations may lead to updates of the EPC content, such as taking consumer feedback into account, integrating better knowledge of the building stock or solving specific national problems³. The coexistence of old and new EPCs also needs to be taken into account.

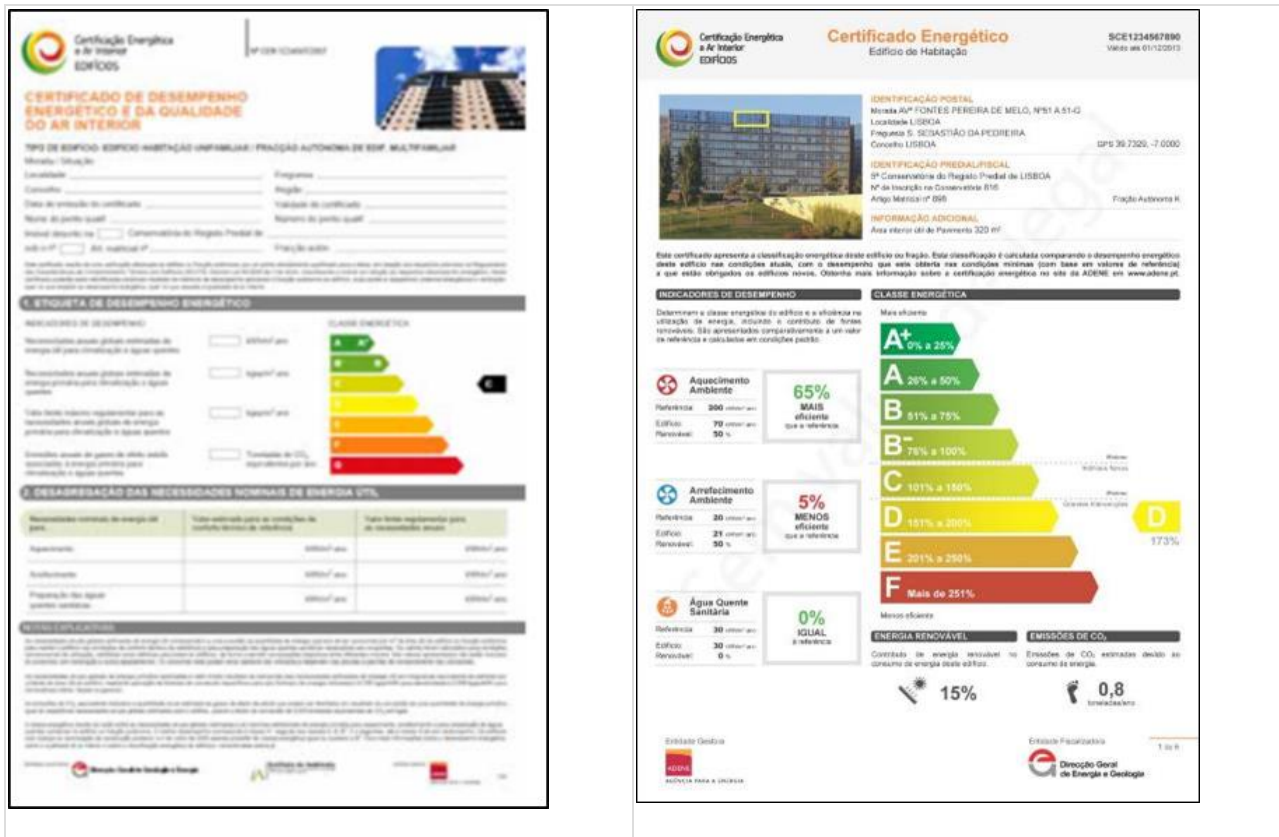


Figure 4. Example of modifications to the EPC layout – 2008 and 2014 EPC in Portugal.

3.4.1 A wealth of existing experience

Comparison between EPCs issued in 2008 and 2014 shows that half the countries have modified the layout of their EPCs. A second type of modification results from a change in the definition of the label, the consequence of which is a rescaling of the new EPC. Such a rescaling has taken place in 15 countries. This rescaling can take different forms: a full change of the EPC concept, dividing some of the A to G classes, changing or merging the classes' limits (Figure 5). After several years of experience, many countries have a better knowledge of their national building stock. This information from past EPCs and those included in the database, if any, may be used to define the new scale and band boundaries.

3.4.2 Managing the coexistence of several EPC versions at the same time

Most EPCs have a maximum validity of ten (10) years. Modifying the EPC content means that EPCs with different content could coexist for several years. When a new version of the EPC is launched, no new EPCs based on former versions will be issued but EPCs already issued under the previous version could still remain valid for several years. In 2010, this was deemed a risk that could create confusion for the public. This coexistence is, in general, taken into account when modifying EPC content, e.g., to make a comparison possible, and countries that have experience with overlapping versions of EPCs do not consider it to be a major issue any longer.

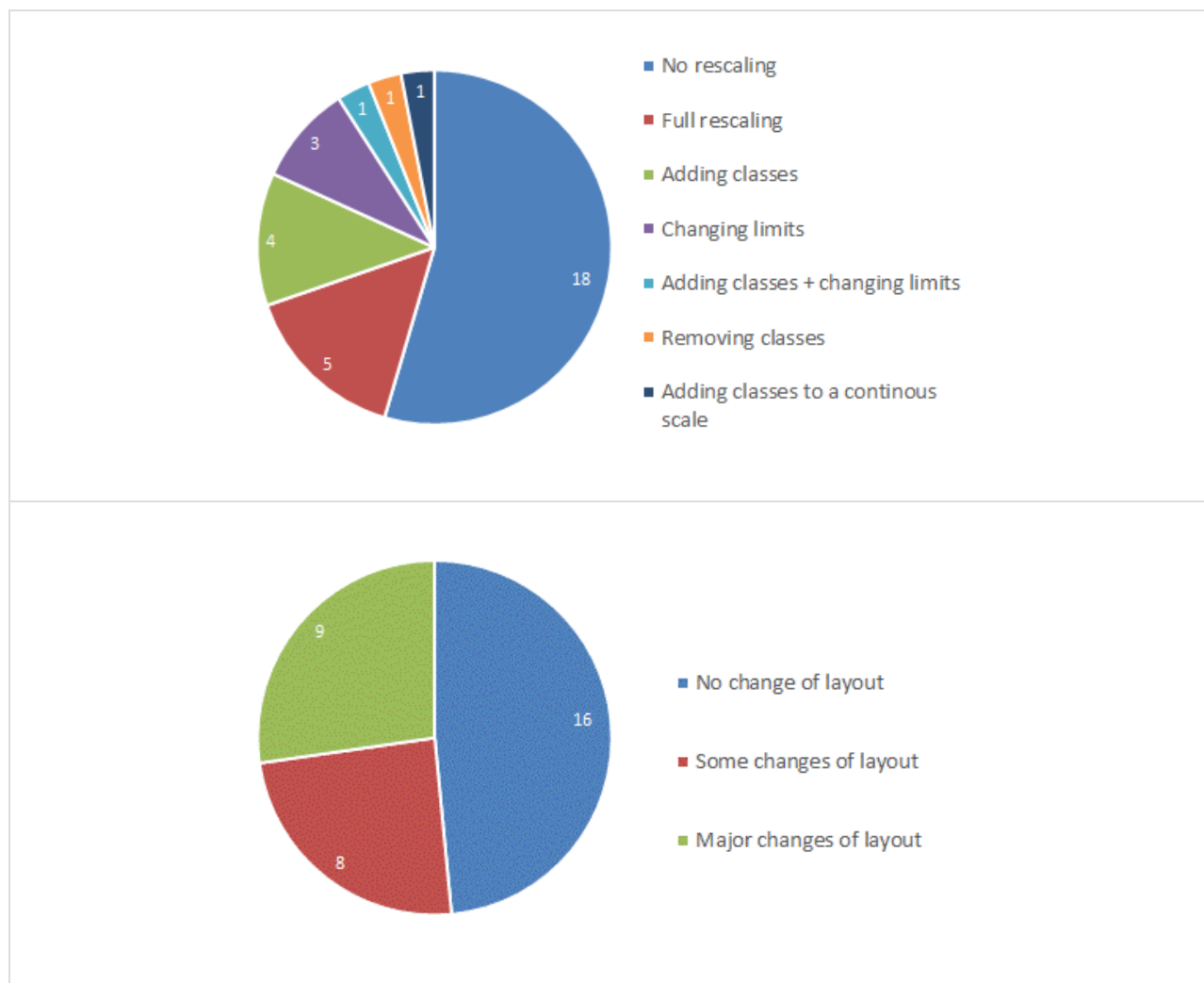


Figure 5. Types of rescaling (top) and layout changes (bottom) made to EPCs between the 2008 and 2014 versions⁴.

Highlights of 3.4

When comparing the 2008 and 2014 versions of the EPC, 17 countries had modified the layout over time. Major changes to the layout had been made in nine (9) countries. During the same period, fifteen (15) countries rescaled EPCs, ranging from light changes to a full rescaling.

Main Outcomes of 3.4

EPBD CA identified communication related to EPCs as the element with the greatest impact on the perception of the EPC. There is significant experience in Europe around modification of the EPC content in order to improve the certificates' attractiveness. Changes may be motivated by customers' feedback on previous versions of EPCs, by the integration of improved knowledge of the building stock and/or by the need to acknowledge the improved energy performance of new buildings complying with stricter energy performance requirements. Given the long validity of the EPC, it is a common situation in countries to have new EPCs based on the last version coexisting with still valid EPCs based on former versions. The country experience has shown that this situation is not experienced as a real issue for the end-users any longer.

3.5 Integrating step-by-step renovation in the EPC

The renovation of the existing building stock and the increase of deep renovations are essential to meet the EU 2020 targets and the commitment undertaken in Paris in 2015. The EPC is an important tool in this context. It provides information regarding the building's energy performance and contains recommendations to improve it. The renovation of buildings may occur in one step, where all energy efficiency measures are simultaneously applied. However, in practice, only part of the work might be done in one step. Staged (or "step-by-step") renovation works could then be the answer. Only a few national authorities have statistics regarding the number of step-by-step renovations in their country.

Although not formally required by the EPBD, taking these step-by-step renovation scenarios into account in the EPC could be, in some cases, an interesting way to promote deep renovations, and a way to increase energy renovation over time.

3.5.1 Integration of step-by-step renovation in the EPC or in complementary voluntary tools

The way EPCs were implemented at the national level influences the possibility or not to support step-by-step renovations. There are significant variations in the methods used to generate recommendations. EPC schemes containing tailor-made recommendations could integrate step-by-step renovation scenarios, while EPC schemes containing only standard recommendations appear to be less appropriate for this. A survey among 20 EPBD CA countries showed that only a few of them, 4 out of 20, are taking step-by-step renovations into account in their EPC. Portugal and Ireland, for instance, have made changes to the display and content provided for EPC recommendations that make them compatible with step-by-step renovations. Within the existing EPC schemes, the recommendations included in the EPC are required to be made in a specific order, based on criteria such as relevance or economy, in about half of the countries (10 out of 20) – see Figure 6.



Figure 6. Example of the Portuguese EPC defining priorities for the recommendations.

Several countries have decided not to use the EPC to address step-by-step renovations, but to develop other voluntary tools possibly linked with national incentive schemes for renovation works. This is the case

for some energy audits or tools such as the *“building renovation roadmap”* in Germany or the *“Energy Advice Procedure”* (EAP2.0) in Belgium (Walloon Region). This option was justified by particular considerations, such as the need for an extensive dialogue between the building owner and the expert, and the level of detail required to explain a deep renovation scenario or to limit the cost of an EPC.

Main Outcomes of 3.5

Taking step-by-step renovation scenarios into account in the EPC could be a way for countries to promote deep renovations. The integration of step-by-step renovation in the EPC exists in a few countries, while others have developed complementary tools, such as energy audits, to promote deep step-by-step renovation.

A single approach to addressing step-by-step renovation is not suitable for all countries, due to the different EPC systems currently in place and, in particular, the level of recommendations. Solutions taking the national context into account are needed.

3.6 Linking EPC and regular inspection schemes

Directive 2010/31/EU mandates energy performance certification of buildings (Articles 11-13) and regular inspection of heating and air-conditioning systems (Articles 14-15). Not all MSs have put in place operational inspection schemes, since the EPBD allows for the possibility to adopt alternative measures. EPCs and inspection systems in place in MSs are generally kept completely separate. However, several countries have experience in linking these two requirements, at, for example, the level of data storage or tools used to deliver the reports.

3.6.1 Interactions between the EPC and the inspection reports

In 2016, fifteen (15) countries implemented inspection schemes for both heating and air-conditioning systems, seven (7) implemented alternative measures for heating systems but inspection schemes for cooling systems, and six (6) implemented alternative measures for both heating and cooling systems⁵.

In most countries, the EPC and operational inspection systems are totally separate, with few to no links (in five (5) countries) made between them. Six (6) countries do make use of valuable interaction between these two tools, while four (4) have developed strong interaction. It should be mentioned that due to the exchange of best practices between countries, 15 now intend to create or further develop links between the EPC and the regular inspection scheme. The following connections are the most common between the two schemes:

1. EPCs and inspection reports are stored in the same database system;
2. data for both EPCs and inspections can be collected during a single building visit;
3. the applied control systems are similar for both instruments;
4. EPCs and inspection reports are both used to assist energy efficiency programmes;
5. EPCs and inspection reports are stored in different databases but a link can be made between the two.

In five (5) countries, data from EPCs can be useful and may be used to produce inspection reports. On the other hand, ten (10) countries allow information from inspection reports to be used to establish EPCs. In both cases, these links are optional and not mandatory.

There are several potential levels of interaction between the two systems. Simple levels of interaction were the most beneficial, e.g., building owners having access to all certificates and reports for an individual building through a single register.

3.6.2 Identifying sequence of EPCs or of inspection reports

In the lifecycle of a building, several EPCs or inspection reports may be issued. Most countries (11) do not identify sequences of EPCs or inspection reports applicable to a particular building. In cases where they do, the relevant EPCs are identified based on the address of the building -ten (10) cases- or based on a unique property reference number - five (5) cases)..

Main Outcomes of 3.6

While EPC schemes are implemented in all EPBD CA countries, not all have regular inspection schemes for heating and air-conditioning systems. Within the 22 operational inspection schemes, very few have interactions with the EPC system. Six (6) countries recognise the potential for valuable interactions between these two schemes, and only four (4) of these countries currently have strong links between the two. There are several potential levels of interaction between the systems, and simple levels were considered most beneficial, e.g., building owners having access to all certificates and reports for an individual building through a single register.

4. Lessons Learned and Recommendations

EPBD CA countries are investigating strategies for more effective EPC schemes. Creating synergies with the regular inspection of the heating and air-conditioning system is one of the methods used to improve national systems. Although not formally required as such by the EPBD, in some countries, the EPC can also be an appropriate tool to promote deep renovation works by taking step-by-step renovation into account. This option is adopted in a few countries, while others have developed alternative tools, such as energy audits.

Countries are also developing a vision based on the most important factors influencing EPC quality and how the market perceives this tool. Actions or studies to evaluate the quality of the EPC scheme were realised in 12 countries. It should be noted that no country has an exact set of criteria that should be taken into consideration to objectively evaluate the EPC perception by stakeholders. Such criteria will certainly have to be developed in the future to enable a common understanding at the EU level.

Communication related to EPCs is recognised as the factor with the greatest impact on how this tool is perceived. Communication has been and still is carefully taken into account in most countries. In 2014, half of the countries changed the layout of their EPCs in comparison to the 2008 versions. A modification of the definition of the label, causing a rescaling of EPC levels, was also made in almost half of the EPC schemes. In several cases, these modifications were designed based on possible improvements identified during

national studies, for instance from consumer organisations, or on the findings from the quality control systems.

Financing of the EPC scheme varies among models, where the initial development costs and the running costs are totally, partly or not at all financed by public funds. Some countries have reduced the public funding invested to develop and operate the EPC scheme. The qualified experts' use of the system can be free of charge, but can also be based on fees. In some countries, these fees may (fully or partially) finance the system.

Endnotes

1. The Evaluation of the EPBD was a direct follow-up to the Communication on an Energy Union, which asked for a review and possible revision of the Directive by the end of 2016.
2. 2016 – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports - ISBN 978-972-8646-32-5 – Editor's message - p7)
3. An example is the case of apartments, where inefficient buildings appeared “too good” in the former version of the EPC.
4. More information related to this topic is available in the factsheet "Heijmans, Loncour - Changes in EPCs scales and layouts - Experiences and best practices"
5. 2016 – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports - ISBN 978-972-8646-32-5



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(CCT1) Technical Elements -2018

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1. Introduction

Many of the aspects dealt within the CA EPBD are closely interlinked with each other and may refer to both new and existing buildings, as well as to inspection and certification. This is also true for technical aspects, such as the calculation methodologies and how to include technical systems' efficiency, or how to integrate renewable energy within them. The central team for Technical Elements deals with issues of a technical nature, which are common to new and existing buildings, and/or with minimum requirements, certification and inspection.

This report focuses on the implementation of Articles 3, 4 and 5 of the EPBD, as well as its Annex I on the calculation methodology and Annex III on cost-optimality.

An important element of work on the EPBD is the implementation of the package of the energy performance of buildings (EPB) Standards¹, and their adaptation and use in the energy performance calculation methodology in MSs. This builds further on previous CA EPBD experience and existing material on cost-optimality.

In the future, new technical elements of interest might be identified based on needs arising from the discussions in the CA EPBD around new buildings, existing buildings, certification and inspection. Significant interaction is expected between these areas, as well as with the CAs for the RESD and the EED.

2. Objectives

In the past, the CA EPBD has already undertaken considerable work on CEN's first and early second versions of EPB Standards for calculating the building energy performance. Furthermore, the CA EPBD has evaluated, commented on and used the methodologies for cost-optimality.

The CA EPBD's current feedback to CEN builds on this work and supports MSs with the implementation and national adaptation of the new set of EPB Standards, supporting solutions to new challenges arising from this process.

All MSs have developed and implemented national adaptations to their first version of energy performance methodologies and calculation procedures. A combination of experiences and solutions from MSs, as well as lessons learned and reflections on best practices, will facilitate the process of implementation of the new set of EPB Standards.

Some of the key topics covered by the Technical Elements team are:

- adaptation of existing calculation procedures based on the ongoing revision of EPB Standards;
- calculation of energy performance and cost-optimality;
- implementation of cost-optimality procedures in the national setup of minimum performance requirements.

In parallel, the team collected lessons learned from certification and inspection schemes in MSs, in order to improve the schemes, and discussed issues with accounting for onsite and offsite renewable energy in the energy performance calculations for new and existing buildings.

Similarities and/or differences between energy related products as described in the EcoDesign Directive (2009/125/EC) and as laid out in EPBD procedures will be discussed in the future. Discussions will explore the "holistic approach" applied in buildings versus the more prescriptive elements for component requirements. Additionally, the needs and possibilities for easy access to reliable input data from the energy labelling of products for the calculation of a building's energy performance will be evaluated.

3. Analysis of Insights and Main Outcomes

The Technical Elements analysis deals specifically with issues of technical implementation that are common to new and existing buildings, as well as with minimum requirements, certification or inspection.

Some of these topics were discussed in a wider context within the CA EPBD, and descriptions of these topics may also be found elsewhere in this book.

3.1 A new set of EPB standards

In 2010, the European Commission gave CEN the mandate (M/480 EN) to create a new set of standards for the calculation of the energy performance of buildings. The participants of the CA EPBD have reviewed the development of the new EPB Standards and their possible applicability in national legislation. MSs focused

especially on the practical implementation and on the transition from the current standards. In particular, it seems that the new EPB Standards are complex and can be difficult to understand, and there is a perceived gap in technical support and guidance². The main outcomes of the discussions were:

- Implementation will depend on the context within each MS.
- Calculation methods are in some MSs defined in legal documents, which can make the transition to new EPB Standards more difficult, particularly when the standards are inter-dependent.
- MSs use a mixture of monthly and hourly calculation methods, but a discussion of the relative merits of each is missing.
- Any transition to the new EPB standards must be smooth to ensure consistency.
- There is little incentive for MSs to implement the new EPB standards, unless they improve existing methods.

The overall procedure for calculating a building's primary energy performance using the new EPB Standards is illustrated in Figure 1 and was put to formal vote in late 2016. The voting resulted in the acceptance of all standards, except the standard concerning indoor air quality. The standards went through a final editing by CEN and ISO, based on the editorial comments. Most of them were published in the summer of 2017³.

In the Liaison Committee, a major focus of the dialogue with the standards developers was on the usability of the new set of EPB Standards in relation to their implementation in national regulations. The standards now include flexibility for MSs to implement them in their regulations in a stepwise approach, most likely beginning with the overarching Standard EN/ISO 52000-1⁴. They also include flexibility to set national calculation conditions in regulations or in a national annex⁵. It is expected that this flexibility will lead to wider uptake of the new set of EPB Standards in national regulations.

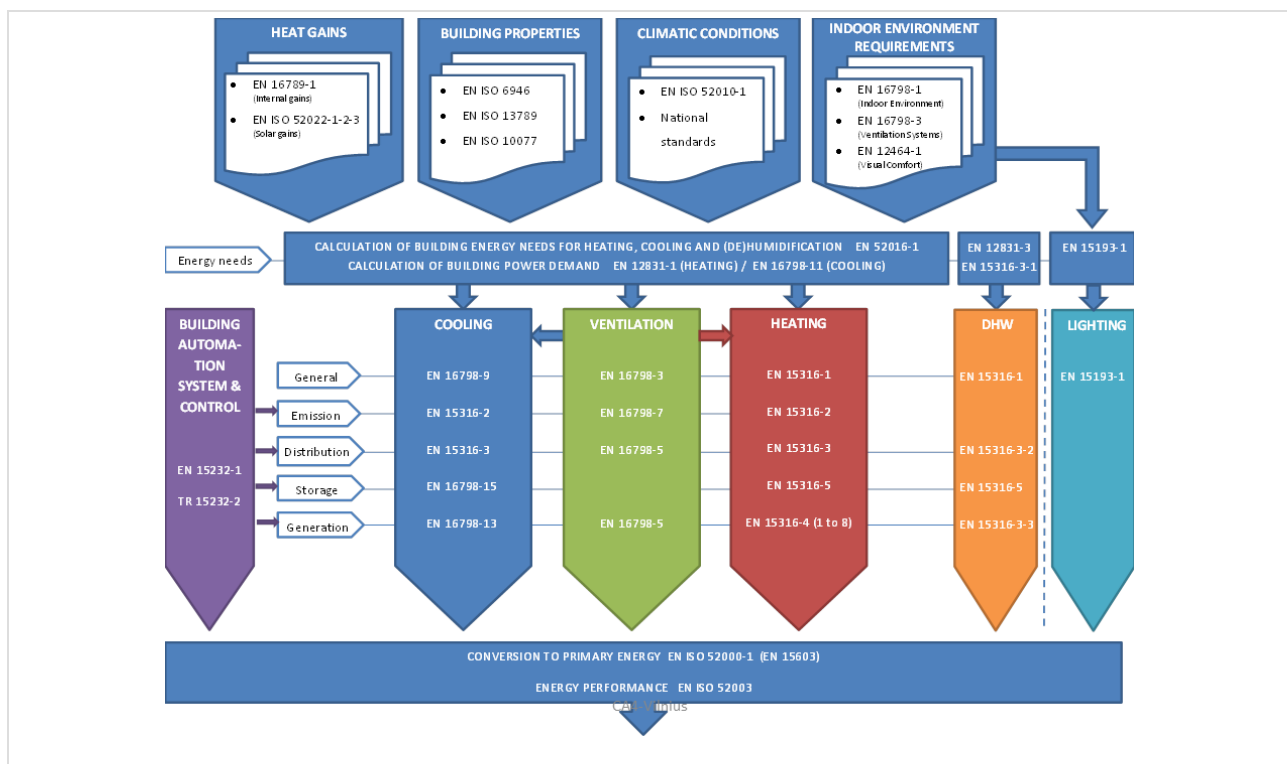


Figure 1. Schematic overview of the overall structure of the new EPB Standards for the calculation of a building's primary energy performance.

For each new standard, an Excel spreadsheet has been developed by CEN to demonstrate the functionality of the standard and support the further development and use of the EPB Standards by software developers. This demonstrates how the rules are to be interpreted. The structure of the new EPB Standards is modular, which offers the possibility of replacing single modules as long as the input/output structure is preserved.

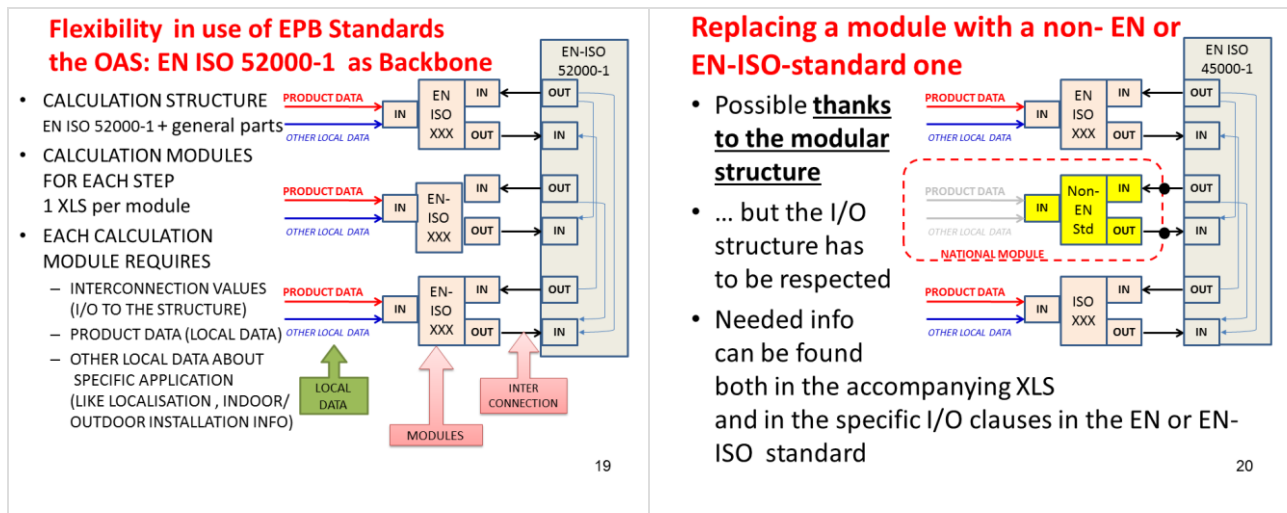


Figure 2. The new EPB Standards are created as individual modules.

In general, MSs delegates felt that the new EPB Standards will provide valuable support for the implementation of the EPBD. The CEN committees emphasised that the new standards have been developed to offer flexibility for their application throughout Europe and worldwide. Furthermore, it was discussed whether the EC should invest in a common software core; it was agreed that this issue should be analysed further and that an answer would be required before MSs begin implementation.

In parallel to the development of the new standards, a consortium was established by DG Energy to assess the usability of the draft EPB Standards, using example cases. The standards were examined as a package and tested for consistency between inputs and outputs. The data analysis further evaluated the degree of competence required to gather the input data as well as quality, accuracy and error rate. In addition, the usability analysis also considered the ease of use and the time and effort required. An example case calculation for a recently constructed office building with a total floor area of 6,000 m² (useful area 4,800 m²) and an envelope area of 7,961 m², heated by district heating and without mechanical cooling, produced the following statistical information:

- There are nearly 1,000 inputs for this specific building assessment.
- Of these inputs, around 500 come from “internal” sources, such as other standards or tables in (national) annexes.
- Around 500 inputs need to be provided by the assessor; these concern the building, the systems and some general climate or behavioural data.
- If inputs per zone are taken into account, the total number of input values to be provided can increase to around 700 (in building models with three zones).
- Systems-related inputs are by far the most numerous; these concern not only static properties (capacity or length of pipes and ducts) but also dynamic properties (functioning of the system over a certain period).

Some overall conclusions from this example case study were:

- The “one-size-fits-all” approach in the structure of the EPB Standards leads to detailed calculations, in order to also cover more complex cases.
- The drawbacks of such a detailed approach are:
 - many input data need to be specified (500-700 for a typical building);
 - many details are not relevant for simple assessment situations, but choices still need to be made for every input, which negatively impacts the usability of the standards without adding value to the assessment.
- The approach does not guarantee easy incorporation of new building/system configurations, and can even impede it, e.g., for uncommon systems that are excluded from the calculation methodology described in the standards.
- The modular set-up of the EPB calculation can minimise some drawbacks but assuring consistency in the set-up and proper exchange of data is more difficult.
- The use of default values could solve some of the problems, but it would be necessary to ensure that default values are realistic.
- The current energy performance calculation system could be converted into a user-friendly integrated energy performance calculation core that includes standard input data.
- A more systematic approach for the management of primary building input data is needed.
- The use of a reference building in the calculation can reduce the significance of systematic errors.

Highlights of 3.1

The new package of the final draft EPB Standards has been through formal voting in CEN and ISO in late 2016, and was finished in January 2017, with all, except one standard, concerning indoor climate, accepted. The standards come from the different CEN TC's involved in mandate M/480: TC89, TC156; TC169; TC228, TC247 and TC371. The standards come from the different CEN TC's involved in mandate M/480: TC89, TC156; TC169; TC228, TC247 and TC371. The voting showed that all except one standard, concerning indoor climate, were accepted.

DG Energy is encouraged to support the development of a common calculation core⁶ to ease implementation of the new set of standards in MSs. Example cases have highlighted some weaknesses in the draft set of the standards. It seems that the complexity of the standards is overwhelming in some cases, e.g., in existing buildings, due to the considerable input data required in combination with the lack of detailed information for these buildings. The use of default values can solve some of the problems, but it is necessary to ensure that the specific values are realistic.

The package of the EPB Standards was published by ISO and CEN in June 2017.

Main Outcomes of 3.1

The new EPB Standards developed by CEN were discussed in four sessions during the first two meetings of the CA EPBD IV. MSs gave valuable input to CEN, resulting in adaptations of the standards and development of example cases to document the standards' usability.

The EPB Standards were approved in January 2017 and published in June 2017. Implementation of the standards in MSs' legislation initiated in late 2017.

There are large differences among MSs regarding their plans for the implementation of the new EPB Standards. These range from those MSs that intend to implement the new EPB Standards as soon as possible, over those MSs that require the standards to be available free of charge in their national language before any decision can be made, to MSs who do not plan to implement the new set of EPB Standards at all. In the planning for the implementation of the new EPB Standards, few MSs seem to be moving from monthly calculations to hourly simulations. The intention among other MSs is to use hourly simulations only for more complex buildings (e.g., non-residential) and NZEBs, where more precision is required to accurately model the buildings. In some MSs, hourly simulations are used only for certain parts of the calculation (e.g., cooling).

3.2 Energy Performance Certificate (EPC) calculations

3.2.1 Previous changes in MSs EPC

A desk study on how MSs had rescaled or renewed their EPC between 2008 and 2014 found that many MSs had made changes. Alterations to the EPC included adding classes, changing limits, changing colours and layouts, many of them to accommodate the NZEB requirement in 2020. Many of these changes are directly connected to regulations for new buildings or to general improvements for existing buildings.

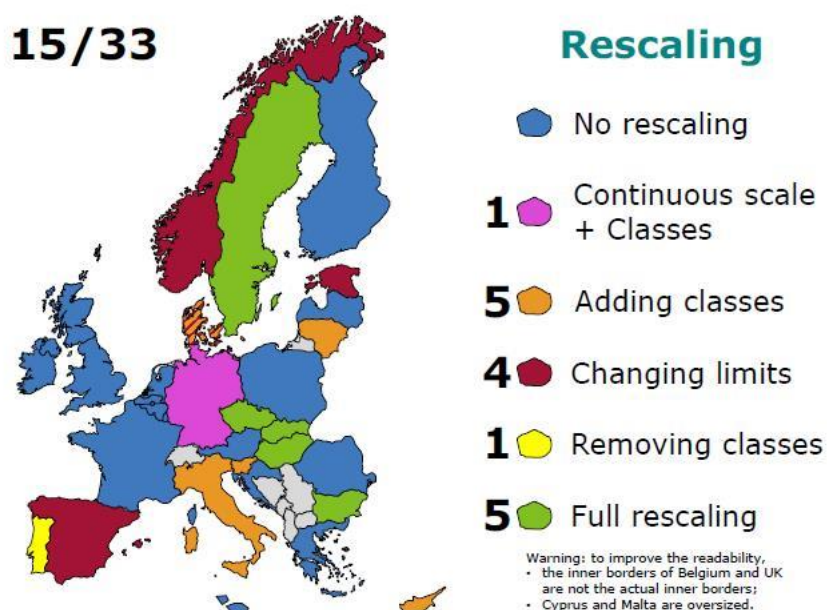


Figure 3. MSs' changes to their EPC were analysed from information collected for the Country Reports included in the 2010 and 2016 CA EPBD books.

Basically, there are 3 options for rescaling the label scale of the EPC:

1. No change is made to the existing labelling scale; buildings constructed according to new, tightened energy requirements are placed in the top category. This approach is simple but gives no further motivation for building owners to improve their building's energy performance. Better energy performance values are not reflected in the certificates at the top of the scale, as indicated in the left column of Figure 4.
2. Certificates that have been previously issued remain unchanged, and new, narrow top categories are implemented to reflect the new energy requirements. This option avoids problems with the "old" certificates. It could work, provided that accurate and motivating new top categories are implemented and that energy performance is expressed precisely according to variations in energy performance at the top of the scale. One of the drawbacks of this option is that the number of categories increases, and there are some other practicalities that need to be addressed, such as the question of colours, letters, or terms.
3. The number and the names of categories remain the same, while the thresholds are modified. The advantage to this approach is that the number of categories remains unchanged. On the other hand, the "old" certificates also need to be changed and the issuing data becomes very important, to be able to understand the full meaning of the label value on the certificate.

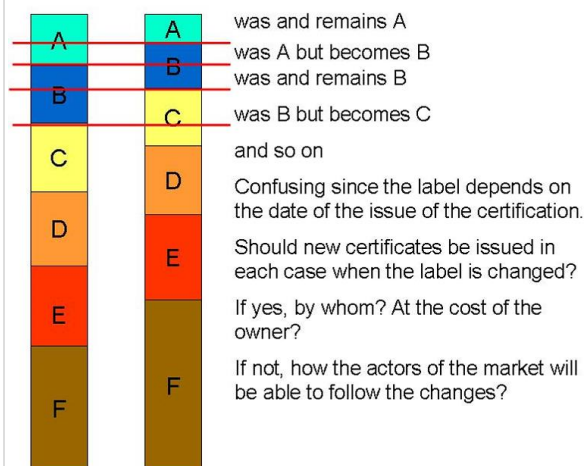
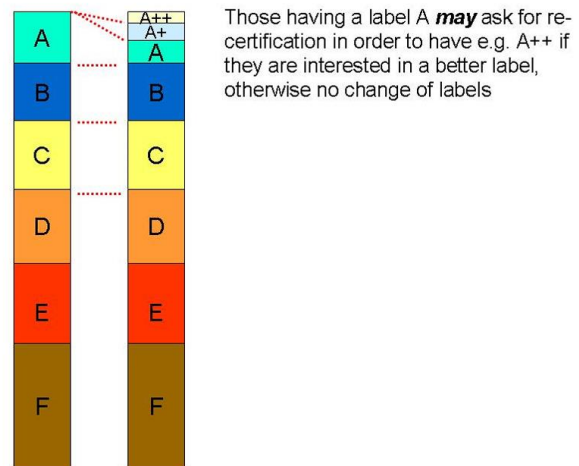


Figure 4. Different strategies for changing the EPC scale (options 2 and 3).

3.2.2 Calculating realistic energy savings

The energy performance shown in most MSs' EPC is based on a standardised calculation of the primary energy demand. This, however, may not be the same as the measured energy consumption in a building, and savings presented in the EPC might differ from the experienced energy savings. The EPBD does not envisage the calculation of non-standard energy consumption, and hence expected energy savings. Nevertheless, realistic estimations of energy savings are necessary in order to determine the time scale of returns on investments. In Sweden, the EPC for new buildings is based on metered energy after two years of use and energy performance calculations prior to construction must reflect the expected metered energy use.

CA EPBD investigated the possibilities and barriers associated with using the EPC building data model (i.e., the input parameters collected from the building, in order to carry out an energy performance calculation using an approved calculation tool) for the additional purpose of calculating energy savings caused by user behaviour. Information on the physical description of the building envelope and installations in the data models that are used to calculate the energy performance in the EPC is generally accurate. However, the calculated energy demand deviates from the measured consumption, primarily due to user behaviour that varies from the standard assumptions. Building data models can then be used – after modifications of the standard input parameters, i.e., internal gains and losses, usage patterns, indoor and outdoor climates – to calculate realistic energy demand and potential savings. Some MSs allow the alternative use of the EPC model for a more detailed analysis of the energy saving potential, e.g., the Slovak Republic, Lithuania, the UK, Denmark and Hungary.

The ownership (Figure 5) of the EPC building data model can in some cases hinder its use for alternative calculations. This can happen, for example, when the EPC data is owned by the expert who carried out the certification and created the EPC building data model, whereas additional calculations would be carried out by a third party.

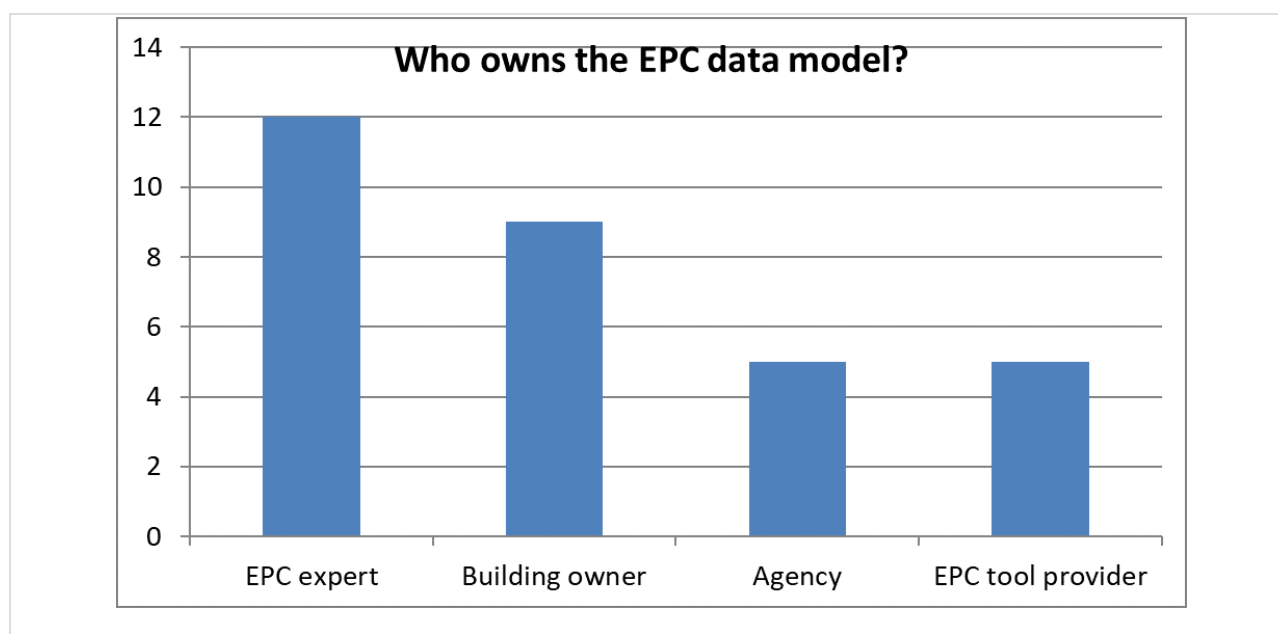


Figure 5. Ownership of EPC building data model in MSs participating in the survey. Multiple ownership occurs in some MSs.

From the selected MSs' examples, it appeared practical to modify critical input parameters to predict more realistic energy consumption calculations for energy savings. For example, the key variable parameters are occupancy behaviour (number of users, use of domestic hot water and use of appliances) and temperatures (both indoor and outdoor). From the example cases, these adapted models produced results that closely align with the measured energy consumption. MSs gave several different examples for adapting the building data model to the actual conditions:

- Denmark used the energy performance calculation model to compare the gap between actual measured data and the standardised EPC.
- The Walloon Region, Belgium used an adapted model for additional reports based on the EPC model data.

- Latvia used an adapted model (calibrated against measured consumption) instead of a standardised EPC model.
- France used an adapted model to study the coherence between asset and operational rating methods.

Discussions highlighted a conflict between the clear benefits of improving model accuracy with the frequent lack of interest among consumers. This lack of interest can be explained partly by other issues (i.e., economy) garnering more attention, and partly by the inconsistency between standard calculations and measured energy consumption. The most important contribution for any calculation is in the value added to decision-making, but no direct benefit will be realised in practice if the consumer is not sufficiently engaged. For instance, building-owners tend to not calculate the energy savings they might obtain when carrying out other modifications to their property; there seems to be a lack of interest in the potential for energy savings. Decisions taken by building-owners tend to be primarily driven by comfort conditions or issues of maintenance and improved functionality. However, it is important to show in the EPC how energy saving measures would also result in co-benefits, e.g., comfort improvement in order to incentivise building-owners.

Highlights of 3.2

It has been necessary in some MSs to change the scaling of the EPC labels in order to accommodate the approaching NZEB requirements. In most cases, this has been done by subdividing the top class into narrower classes, representing steps, e.g., intermediate building regulation requirements, towards the NZEB requirement in 2020. In most cases, the new and the old scale co-exist until all “old” certificates have been replaced by new ones or become outdated. In other cases, only an automatically updated on-line version of the certificates is valid.

EPC calculations are based on standard assumptions, hence calculated energy demands and potential energy savings may not match the measured consumption. However, energy performance building data models can be used for calculation of realistic energy demands and hence equally realistic energy savings if modified to reflect the actual conditions in buildings. In some MSs, it is possible to use the EPC model for more detailed analyses of the energy demand and the energy saving potential. However, ownership of the model sometimes creates obstacles.

Main Outcomes of 3.2

The motivations for rescaling the EPC vary and include, among others:

- ensuring the EPC's contribution to making it more attractive to build or renovate very efficient buildings;
- inefficient buildings rated too high in old EPCs;
- solving problems with old EPCs for apartments;
- stricter energy performance requirements for new buildings, and introduction of NZEB in national requirements;
- changing from energy use to primary energy use.

Main Outcomes of 3.2

Discussions focused around the co-existence of old and new EPCs on the market, and whether this might create confusion for the public in terms of understanding the energy performance of the building.

Displaying realistic energy savings in the EPCs is not the prime focus since buildings are to be compared excluding the influence of the occupants. Building owners undertake improvements for many reasons apart from saving energy, especially when purchasing or renting a property. Improved functionality and indoor climate are generally considered the two main drivers for carrying out upgrading works. Energy savings are in many cases seen as an additional benefit to planned renovation.

Only a few MSs seemed open to the possibility of using the energy performance building data model for purposes other than issuing an EPC. Among the prime reasons for this are the ownership of the building data model and the risk of incompatibility between tools that use the same building data model, but different energy performance calculation tools.

3.3 Calculating energy performance

There are specific issues related to energy performance calculations for new buildings applying for a new building permit and for the energy performance certification of an existing building.

3.3.1 Innovative systems

This topic mainly relates to new buildings, although many of the findings are equally valid for existing buildings.

The progress towards NZEB in MSs has led to more innovative technologies being introduced to the market over the last few years. The purpose of this topic was to collect and exchange initial experiences with such technologies in the MSs.

Four categories of technologies were discussed, with wide variations in the frequency and methods of their use, and in the types of buildings involved. Significant differences were also found in ways in which the systems' impacts on building energy demand were calculated. Exchange of knowledge between MSs and CEN might prove helpful for a broader use of innovative technologies in the future. The four categories of technologies are as follows:

- *Demand-controlled ventilation* is mainly divided into mechanical exhaust systems and balanced mechanical ventilation systems with heat recovery coupled to different control strategies. The calculation is often performed using a detailed dynamic simulation method as part of the simplified standard calculation method, although a few countries use fixed factors as rough estimates.
- *Building automation systems* can be grouped according to EN/ISO 15232 into classes A to D, with class A being the most advanced holistic building automation systems, and class D being simple manual controls. Classes A and B are mostly applied to new non-residential buildings. Some MSs are considering introducing requirements concerning levels of building automation. The calculation of the impact of building automation systems varies among use of fixed factors as rough estimates, detailed calculations within the assessment method, and use of external dynamic simulation tools. In several MSs, building automation systems cannot be assessed directly, using the national method and hence

provision must be calculated in alternative ways. Generally, energy savings seem to be overestimated, and only occur after a thorough commissioning of the system.

- Information on seven (7) different types of *reversible heat pumps* was collected and discussed, and categorised according to the supply source and the heat delivery system. The use of specific systems differs among MSs. In Sweden, reversible heat pumps can be calculated by using a dynamic external simulation tool. Other MSs assess the impact of heat pumps either by using a detailed method within their calculation procedure or by using a fixed factor as rough estimate. The obvious advantage of a reversible heat pump is that only one system is needed for heating and cooling.
- Several still-innovative *advanced solar shading systems* were discussed by the participants, for example inter-panel shading devices, semi-transparent PV, double façade systems with integrated shading systems, movable sun-protection glazing and bio-shading. Most systems can be modelled fully only by using an external dynamic simulation tool. As an example, bio-shading is calculated in one MS within the regular calculation method by using a rough factor, and in another MS by using an external dynamic simulation tool. However, most MSs do not take bio-shading into account in their national calculation standard.

3.3.2 Costs and energy performance

Cost-efficient technologies, strategies or processes for NZEBs

The costs for NZEBs compared to those for buildings complying with current requirements, ranging up to an additional 500 €/m² or 50%, are presently considered a barrier for increasing the number of NZEBs. A previous collection of case study buildings resembling NZEB in the CA EPBD has shown that the additional costs were, on average, about 10% of the total costs, or roughly about 200 €/m².

A short, more recent questionnaire on cost-effective technologies, strategies and processes was answered by 24 MSs plus Norway and one region of Belgium. The estimated additional costs are up to 500 €/m² or up to 50%. Eight countries have guidelines for cost-efficient buildings and some countries use the cost-optimal EPBD analysis as guidance for cost-efficient buildings. One MS claims that, for residential buildings, there will be no additional cost and therefore no cost barrier in this country.

In the construction process, it is important to include energy efficiency at each stage. Additionally, the use of building information modelling (BIM) can help with quality control and effective communication among different teams in the design and construction process. In the design process, architects and engineers are now working closer together than they did 10 years ago. This decreases the number of iterations and facilitates an increased focus on energy performance.

Cost-efficiency of technical systems depends on the climate, the energy supply mix, the existing energy infrastructure, subsidy policies and consumer perceptions. Replicating solutions from other countries is also difficult, due to differences in building tradition, cost levels, legislation, energy infrastructure, climate, etc.

Commonly, PV and heat pumps are popular and often combined. Solar thermal systems may be cost-effective, as domestic hot water is one of the last remaining large energy demands in NZEBs. Mechanical ventilation systems with heat recovery are cost-effective in colder climates. It seems that direct electric infrared heating is becoming popular in countries with low prices and low primary energy factors for electricity. In general, control and automation systems can be cost-effective, and LED lighting with presence detection and daylight control is generally cost-effective as well.

In the building envelope, improving U-values and/or use of double or triple glazing is often cost-effective, but there is a need to balance the resulting decrease in heating demand and the subsequent increase in cooling demand. Shading devices may well be a necessity in NZEBs to secure a comfortable indoor climate. Taking into account factors such as the location and orientation of the site for the optimal utilisation of solar gains or shadings is often cost-efficient in new buildings.

Cost, available time and quality are closely linked, but a specific problem arises when improved quality does not increase financial value.

Experience from the first round of calculating cost-optimal levels

Experience from EU MSs' first round of cost-optimal calculations provided valuable input ahead of the second round of calculations. A short survey on the first round of the calculation and reporting of cost-optimal levels for new and existing buildings helped to identify key areas for the revision of the guidance document and the procedure. This concerns energy prices, the calculation of energy demand, references to new standards, and simplifications of the procedure in general.

The European Commission has financed and is still financing several projects dealing with cost-effective technologies and strategies for NZEBs. One of these, conducted by Ecofys⁷, was thoroughly discussed in the CA EPBD. One of the conclusions from the Ecofys report was that, despite the guidance provided to MSs regarding the calculation of global costs and the reporting of the calculation of energy demand, further clarification may be necessary. Furthermore, the equation used in the guidance document for calculating the gap between the cost-optimal level and the current requirements should be applied.

The CA EPBD recommended that there should be increased focus and clarity in reporting, and that the Ecofys' suggestions¹ for standard reporting and the reporting template from Annex III of the regulation should be used.

Specific recommendations from MSs for further improving the procedure were that:

- More guidance is needed on establishing and using reference buildings.
- The number of measures and simulations required should be optimised to eliminate unnecessary calculations and ensure that calculations are as relevant as possible.
- A standard economic analysis procedure should be developed and performed.
- The methodology for calculating cost-effectiveness should be consistent with the methodologies used for calculating primary energy factors and the energy performance of buildings.
- Both the calculation and the reporting should be simplified.

Highlights of 3.3

New and/or innovative systems will be increasingly used in both new buildings and existing buildings undergoing major renovation. Furthermore, in order to support innovation, it is necessary to integrate the effect of these systems into national calculation procedures, either by including them in the standard calculation tools or by proving their effectiveness in external tools.

The additional costs of NZEBs compared to those of buildings just complying with current requirements are considered to be a barrier for increasing the number of NZEBs. In the construction process, it is important to include the energy efficiency at each stage. A fundamental difference among procedures is whether the primary energy factors apply to total or non-renewable primary energy (or both), since the alternatives imply different energy policy objectives. Several MSs also acknowledge that their primary energy factor values reflect national energy policy objectives.

Main Outcomes of 3.3

MSs have different ways of integrating new and innovative systems in buildings' energy performance calculations; this creates obstacles to innovation and prevents innovative systems' penetration into the free market. It is important to continue to facilitate the promotion of new and innovative systems for energy efficient buildings and automation.

The second round of calculating cost-optimal levels for new and existing buildings is due in March 2018. MSs would welcome more guidance on the definition and use of reference buildings for the calculation of the cost-optimal level, and suggest that the number of measures and simulations needed be optimised so as to eliminate unnecessary calculations and ensure that calculations are as relevant as possible.

The costs for NZEBs compared to those for buildings complying with current requirements, ranging up to an additional 500 €/m² or 50%, are presently considered a barrier for increasing the number of NZEBs. It is important to emphasise more on the benefits of NZEBs, among which, achieving best quality for the budget available.

Comparison between measured and calculated energy consumptions resulted in interesting findings. Calculated energy consumption seems to identify (physical) opportunities to reduce consumption, but it is likely that, on average, the levels of savings that are likely to be achieved – especially in dwellings with high initial energy use per m² floor area – are overestimated.

A transparent definition of primary energy factors in EU MSs is key for allowing comparison of energy performance requirements for existing new and NZEB buildings.

3.4 Renewable Energy Systems (RES)

Inclusion of RES in the calculated energy performance of buildings is a key issue for new buildings that comply with national NZEB requirements. Most RES solutions are equally important for existing buildings, especially those undergoing major renovations. The following section deals with technical issues related to calculation and implementation of RES.

3.4.1 RES in an urban context

The CA EPBD analysed which RES technologies can generally be assessed as part of the overall energy performance calculation and which ones can fulfil possible direct RES requirements as part of national NZEB definitions and energy performance calculations. The result is an overview by MSs of the applicability of RES technologies. Participating MSs vary considerably in the RES solutions they include in their energy performance calculations, and the solutions which can be used to fulfil NZEB RES requirements. Some

technologies can, in general, be accounted for in the energy performance calculation in all 24 MSs that took part in the evaluation: for example, solar thermal panels for domestic hot water generation and heating, electricity production from PV for use in the building (self-use), biomass boilers and heat pumps coupled to external air/exhaust air/ground or ground water (Figure 6). Other RES technologies can be accounted for in the energy performance calculation in about half of the MSs examined – examples include PV for feed-in, RES as part of district cooling, micro-wind turbines (self-use or feed-in) and local hydropower for self-use. Relatively few countries allow for RES electricity via the grid (with a specific contract) and local hydropower for self-use⁸ or feed-in.

Country	BE-BR	BE-FL	BE-WA	BG	CY	DE	DK	EE	GR	ES	FI	FR	HR	HU	IT	LT	LV	MT	NL	NO	PL	PT	SE	SK	SL	UK	Σ	Yes	Σ	No	Σ	Others
Solution	BE-BR	BE-FL	BE-WA	BG	CY	DE	DK	EE	GR	ES	FI	FR	HR	HU	IT	LT	LV	MT	NL	NO	PL	PT	SE	SK	SL	UK	Σ	Yes	Σ	No	Σ	Others
RES as part of district heating	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	Y	Y		Y	N	Y	Y	Y		21	4		1	
RES as part of district cooling	N	N	N		Y	Y	N	Y	Y	N	Y	Y		N	Y	N	N	N	N	Y	N	Y	N	N	Y	N		12	13		1	
Solar thermal panels for DHW	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		26	0		0	
Solar thermal panels for heating support	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		25	0		1	
PV for self-use	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		26	0		0	
PV for feed-in	Y	Y	Y	Y	Y	N	N	Y	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	Y	Y	N		17	9		0	
PV for heating (input to heat storage)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		24	2		0	
PV/T hybrid solar collectors for self-use	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		24	2		0	
PV/T: PV for feed-in, T for self-use	Y	Y	Y	N	Y	Y	Y	N	N	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N		19	7		0		
Micro wind-turbine for self-use	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y		18	8		0	
Micro wind-turbine for feed-in	N	N		N	Y	Y	N	Y	Y	N	N		N	N	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N		10	14		2	
Local hydro for self-use	N	N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y		15	11		0	
Local hydro for feed-in	N	N	N	N	N	N	N	Y		N	N	N	N	N	Y	Y	N	Y	Y	N	N	N	N	N	Y	N		6	19		1	
Biomass boiler	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y		25	1		0	
Biomass CHP	Y	Y	Y	Y	Y	Y	Y	Y					Y	N	N	Y	Y	Y	Y	Y		Y	N	Y	Y	Y		20	3		3	
HP coupled to external or exhaust air	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		26	0		0	
HP coupled to ground / ground-water	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		26	0		0	
Direct geothermal	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		24	2		0	
Direct ground water cooling	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	Y		22	4		0	
RES electricity via grid (specific contract)	N	N	N	Y	N	N	N	N	N	N	N	Y	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N		4	22		0	
Alternative: higher insulation level	Y	Y	N	Y	N	Y	N	Y			N	N	N	N	Y	N	N	N	Y	Y	Y	N		N	Y	N		10	13		0	

Figure 6. RES sources that MSs accept to be included in their calculations of building energy performance.
Legend: white – no answer, grey – answer given between yes and no.

For urban, multi-family houses, most MSs allow RES systems on garages and other associated buildings to be included in the energy performance calculation of the building, but the deciding factor is the ownership of the system and/or the boundary of the building plot. Most MSs also allow the use of community systems in the energy performance calculation as long as there is a direct connection to the building. The use of waste heat from industry or wastewater heat pumps is allowed in energy performance calculations by some MSs, but others do not have calculation methods to account for these.

Some MSs cannot account for certain types of RES technologies (e.g., a combination of PV and solar thermal; local hydro power), due to the lack of calculation procedures, either because the procedures are not covered in the EPB Standards or because there is very little or no local use of these technologies and, therefore, no need to develop such procedures. In some MSs, there are additional procedures to deal with technologies for which there is no standard calculation defined.

Some MSs impose limits on the amount of locally generated energy that can be accounted for in the energy performance calculation, and others do not allow any exported electricity to be accounted for, in order to avoid double-counting in the EPC and the grid primary energy factors. Some MSs impose additional requirements on the energy performance of buildings instead of requirements on RES. Imposing limits can

make designers think harder about reducing the energy demand, prevents double-counting and can make grid integration more manageable. Not imposing limits can encourage greater adoption and, therefore, maximise the potential of RES on buildings. The existence of limits creates a more level playing field among different building types and RES availability, while non-existence of limits creates a more level playing field among different heating systems.

The use of higher insulation levels as an alternative to RES is only applicable in a few MSs. Some additional RES solutions for urban, multi-family houses that were identified during the discussions included heat recovery from showers, purchase of green certificates and economical participation in RES projects not directly connected to the building or the building site.

Highlights of 3.4

There is significant variation in the RES supplied at the building or nearby that are accepted in MSs' energy performance calculations. Imposing limits on locally generated energy that can be accounted for in the energy performance calculations can make designers think harder about reducing energy demand, prevents double-counting and helps to make grid integration more manageable, while not imposing limits can encourage greater adoption and therefore maximise the potential of RES on buildings.

Main Outcomes of 3.4

Inclusion of energy supply from RES in MSs' building energy performance calculations is dealt with very differently. Some MSs only allow inclusion of energy from limited RES, while others are willing to accept input from a variety of sources, and some even accept additional insulation to compensate for a lack of RES supply. In an urban context with little space on the building and in its immediate surroundings, combined with limitations due to neighbouring buildings, overly rigid requirements for RES may hinder efforts to meet the requirements for a certain RES share in buildings that comply with national NZEB requirements.

Some MSs impose limits on the amount of locally generated energy that can be accounted for in the energy performance calculations and others do not allow any exported electricity to be accounted for, in order to avoid double-counting in the EPC and grid primary energy factors.

4. Lessons Learned and Recommendations

The modular structure of the new EPB Standards, valid for all building types, allows for a flexible system that can be easily adapted to national requirements while maintaining the overall structure of the calculation procedure. However, a methodology targeting all building types results in simple cases being overly complicated and necessitating an excessive amount of input information. The intention among a few MSs is to use hourly simulations only for complex buildings (e.g., non-residential) and for NZEBs, where more precision is required to accurately model the buildings, while using simplified calculations for existing buildings. In some MSs, hourly simulations are used only for parts of the calculation (e.g., cooling and summer comfort). It was recommended that the EU should establish a common, modular calculation core,

leaving the establishment of national user interfaces to MSs; the recommendation has been accepted, and the process has begun.

Some MSs have, over time, changed the thresholds of their EPC to accommodate room for new, stricter building energy classes that move towards NZEB. Naturally, EPCs should facilitate promotion of NZEB by distinguishing them from other buildings on the scale, and reluctance in adapting the scale should not hinder this process.

Energy savings displayed in the EPC are, in most cases, calculated based on a standardised use of the building and thus do not necessarily reflect actual energy savings. However, this does not seem to present a barrier to building owners' willingness to invest in energy savings, as this is primarily carried out in combination with planned renovation and in order to improve indoor climate and building functionality. Building energy performance calculation models should be made available for use in other calculation tools for more realistic energy saving calculations.

The EPBD allows the use of either measured consumption or calculated energy demand as a means of determining the energy performance rating of buildings. In practice, the use of calculated ratings is by far the most common choice, not least because the use of measured consumptions is impossible for buildings that are not yet constructed or in use. However, measured energy performance facilitates a more realistic estimation of energy savings compared to energy savings based on calculated energy performance. It seems that calculated energy savings overestimate the levels of savings that are likely to be achieved – especially in dwellings with high initial energy use per m² floor area.

The costs for NZEBs compared to those for buildings complying with current requirements, ranging up to an additional 500 €/m² or 50%, are presently considered a barrier for increasing the number of NZEBs. In the construction process, it is important to include the energy efficiency at each stage.

The main recommendation to the European Commission is that there should be increased focus and clarity in the reporting of calculating cost-optimal levels. Additionally, it was mentioned that the guidance provided to MSs regarding the calculation of global costs and the reporting of the calculation of energy demand could be improved.

There is a great variety of ways in which MSs include energy from RES in their energy performance calculations. In some MSs, only limited RES are considered in the calculations, while other MSs are willing to include a more complete spectrum of solutions. Imposing limits on locally generated energy that can be accounted for in the energy performance calculations can make designers think harder about reducing energy demand, prevents double-counting and can help to make grid integration more manageable. In contrast, not imposing limits can encourage greater adoption and, therefore, maximise the potential of RES on buildings. In order to meet the requirement for the RES share in NZEBs, some MSs are even willing to include additional insulation levels to compensate for a lack of RES, for example in urban contexts where there may be limited free space on or near the building.

A fundamental difference between procedures is whether the primary energy factors apply to total or non-renewable primary energy (or both), since the alternatives imply different energy policy objectives. Several MSs also acknowledge that their primary energy factor values reflect national energy policy objectives. A transparent definition of primary energy factors in EU MSs is key for allowing the comparison of energy performance requirements for existing, new and NZEB buildings. Also, setting primary energy factors has significant implications on the effect of the integration of renewable energy in the energy performance of buildings.

Endnotes

1. <https://epb.center/>
2. In 2018, the European Commission has launched a specific contract to close this gap.
3. In December 2018, the full set of EPB Standards was published.
4. The standard is preliminary until the final approval of the edited version.
5. By using Annex A/B solutions included in all the standards.
6. A specific contract to support this point has been launched.
7. Boermans, J. Grözing, B. von Manteuffel, N. Surmeli-Anac, A. John, K. Leutgöb, & D. Bachner. Assessment of cost optimal calculations in the context of the EPBD (ENER/C3/2013-414) - Final report. ECOFYS Germany GmbH. Cologne, Germany, 2015.
8. Without using the national grid as a buffer. This may include a battery.



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(CCT2) Policies and Implementation Status in November 2016

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1. Introduction

The implementation of core EPBD requirements has been supported by a range of national policies and measures, such as awareness raising and information programmes, energy advisory services, training and up-skilling programmes for various professional profiles, financial incentives, and advanced financial mechanisms. The MSs' long-standing experience in implementing such measures shows that many support policies work best when combined into policy packages. This is why the EPBD focusses on a holistic policy approach through its articles on finance and on information (Articles 10 and 20).

The policies supporting the EPBD's central articles address the implementation of minimum requirements in new and existing buildings, energy performance certification and recommended cost-effective measures, cross-linking of certification and inspections, as well as financial incentives for the major renovation of existing buildings and for the construction of NZEB.

This report covers the various policy packages that MSs have put in place over the period of 2015-2016 to support the EPBD implementation. These are often developed around financial incentives from EU and national funding, with the common target to increase the comprehensive renovation of existing buildings (at cost-optimal level or beyond) and to facilitate early construction of NZEB. Equally, information programmes are an important EPBD policy support measure, dedicated to owners and tenants of buildings in order to help them better understand and benefit from the EPCs and inspection reports, improve building energy performance in cost-effective ways, and have better access to financial instruments.

2. Objectives

2.1 Financial incentives as part of EPBD implementation

Article 10 of the EPBD states that MSs shall take appropriate steps to consider the most relevant financing and other instruments to catalyse the energy performance of buildings and the transition to NZEB. MSs shall take into account the effectiveness of use of structural funds, EIB and other public funding, as well as coordinated EU and national funding. Cost-optimal levels (or beyond) must be considered when incentives for construction and major renovation are provided. The objective of the Cross Cutting Team Policies and Implementation is to look into different experiences of MSs having successfully implemented such financing mechanisms; in particular the ones supported by a holistic set of policies addressing the main market barriers to the deployment of investments in buildings energy renovation and early compliance with NZEB standards.

2.2 Information Activities

Article 20 requires MSs to take the necessary measures to inform the owners or tenants of buildings and building units of different methods and practices leading to enhanced building energy performance. This includes the effective sharing of the information available in EPCs and inspection reports, as well as provision of the information on cost-effective ways to improve the energy performance and available financial instruments for energy renovation. The objective of the Cross Cutting Team Policies and Implementation is to identify best practices in MSs in holistic information policy packages for building owners and tenants, as well as to collect ideas for more effective measures in this field. Guidance and training of relevant stakeholders in MSs is also part of Article 20, in particular regarding the optimal combination of improvements in energy efficiency, the use of energy from RES, and the use of district heating and cooling when planning, designing, building and renovating industrial or residential premises. Cross Cutting Team Policies and Implementation's objectives are to collect and evaluate MSs' experience in the above fields and stimulate the development of new ideas based on the exchange of opinions from MSs.

3. Analysis of Insights and Main Outcomes

3.A. Analysis and insights

3.A.1 *Financing based on structural funds*

The analysis of financial incentive programmes from EU and national sources, and their effective implementation for increased building energy efficiency in MSs was a complex process that required the involvement of the national representatives with a holistic view on the implementation of the EPBD and its connections to building related provisions in the EED (Directive 2012/27/EU). The European Structural and Investment Funds (ESIF) are financial tools for the implementation of the European Cohesion Policy. The aim of the Cross Cutting Team Policies and Implementation was to create an insight into the use of these funds in MSs for the improvement of the energy performance of the EU building stock. The European Commission indicated that this type of financing is not being used equally in all MSs to leverage the

potential for energy efficiency actions in the building sector, though the overall investment in the low carbon economy under the Cohesion Policy financing for the period 2014 – 2020 has doubled compared to the 2007 – 2013 period. Access to funds requires compliance with the EPBD and technical guidance documents linked to EPCs and to these funds.

After an evaluation of the success of the 2007 – 2013 programme period, 2014 – 2020 marks the transition from grants to investment-based mechanisms. The Cohesion Policy exists to ensure better access to existing funding (mobilisation of investment). MSs select and implement projects with private co-funding. This has not always led to successful results in all MSs, as there are wide ranging needs and challenges that are different in each country. Against this background, the aim of the analysis carried out by the Cross Cutting Team Policies and Implementation was to get an insight into the situation and see why financing based on structural funds is not used more often. MSs representatives discussed the following topics:

- types of buildings (i.e., public, social housing, other non-residential) that are subject to financing from structural funds in a particular MS;
- criteria and awarding methodology in the calls for tenders (for optimum use of available funding for energy efficiency in buildings);
- capacity of the public and private investors to apply for funding (of projects in the pipeline);
- monitoring of the achieved results (actual vs. planned building energy performance after renovation).

MSs delegates indicated that the Cohesion Policy funding is a very complex system and that it is difficult to obtain a comprehensive overview of the financial instruments at national level. In general, there was low awareness of other available sources of EU funding. EPBD experts from MSs stressed the importance of permanent sharing of information about funding options, financing criteria and funding rules in a particular MS. Capacity building of public and private investors is essential for the successful applying for funding from ESIF, and for the correct implementation of building energy renovation projects. It was felt that there was often a high degree of complexity involved during the tendering process. Tenders may be of a variable quality, and conditions for funding can restrain potential investors. Overall, professional support to public authorities seems necessary for a successful application.

Monitoring was a topic that engaged most of the participants during the Cross Cutting Team Policies and Implementation sessions, i.e., the advantages of different types of monitoring, reasons for non-compliance, e.g., change and variation in use, occupants' behaviour and the rebound effect. Penalties for not achieving savings as planned were discussed, but a general opinion was that such rigorous measures would not lead to the desired outcomes, while some other activities may act as motives for meeting the expected energy savings (i.e., exchange of best practice, neighbourhoods competitions in energy savings, retrocommissioning, etc.). Checking that the works have been carried out to an agreed standard was seen as valuable by all participants and would be more straightforward to implement and regulate.

Highlights of 3.A.1

- Capacity building of the public and private investors is essential for successful application under ESIF.
- Call for tenders procedures are demanding (for developers and applicants) and need professional support.
- Further coordination is needed between different national administration levels distributing public funds for energy efficiency.

3.A.2 Policy packages for existing buildings

Policy packages supporting the implementation of EPBD provisions on investments in energy renovation and early NZEB differ for public and residential buildings. Each group of buildings is characterised by specific needs and opportunities that must be considered in the development of MSs tailored policies and measures.

3.A.2.1 Public Buildings

Public buildings are required to meet ambitious energy efficiency targets and are subject to a 3% annual renovation objective if owned and used by central governments, as defined in the EED¹. As such, they should play the role of best practice examples for other sectors, in particular as regards the obligation to display EPCs. In addition, they are eligible for Cohesion Policy funding in many MSs.

The focus of MSs delegates in the Cross Cutting Team Policies and Implementation was to look for national examples of policy packages, to discuss and compare them, as well as point out their successful elements, related to risks and threats, and mitigation actions.

A change of ownership (and/or use) in existing public buildings occurs less frequently than in residential and other tertiary sector buildings; therefore, effective policy packages address existing public building owners, building managers and users. Policy packages in public buildings aim to stimulate investments in deep/NZEB renovations and to generate more effective building operation (including enhanced energy efficiency). MSs representatives gave special attention to schools and heritage buildings, and discussed relevant strategies through presentations of case studies:

- The Croatian case combined the use of the European Regional Development Fund (ERDF) and Cohesion Fund for the renovation of public buildings. To facilitate the use of the funding schemes, two pilot projects were developed, one for the preparation of detailed design documentation for energy efficiency and RES measures in buildings, and the other for the investment in energy renovation of school buildings. Two specific pilot projects were launched in 2015 and, out of 240 applications, 12 pilot projects were selected for funding (5 for design documentations and 7 for investments in schools).
- The Slovenian approach consists of a positive discrimination for public heritage buildings in the screening of applications for funding under the Cohesion Policy. Namely, heritage public buildings are numerous and have a large energy savings potential. On the other hand, they are usually treated as exceptions under the EPBD and, if the energy efficiency measures are acceptable from a conservation point of view, such buildings may not easily meet technical and economic thresholds for support under EU structural funds. The Slovenian policy package covers guidelines for energy renovation of heritage buildings (technical recommendations for conservators and designers), and includes positive discrimination that enables heritage buildings to qualify for EU funding and implementation of a demonstration project on energy renovation of a heritage building.

For better insight into the application of policy packages for public buildings, MSs representatives discussed the framework conditions for school and heritage buildings. The findings are summarised in Table 1.

Building Type	Schools	Heritage buildings
Characteristics of the approaches in presented case studies	- Limited budgets - Predictable usage patterns/energy consumption - Intensively used	- Preserving historic value is important - All are individual/unique; many types of owners and occupants - Old and often in need of repair
Strengths	- Extensive holiday periods allow renovations to be planned - Often a hub for the neighbourhood; they offer opportunities to raise awareness on energy efficiency in the community, educate and inspire pupils and involve teachers and parents - Renovation offers improved learning conditions and can be combined with measures to improve acoustic and visual comfort, etc. - High energy savings potential	- Long lifetimes expected therefore money invested gives better value - Opportunities for tourism - High energy savings potential
Risks	- Subsidies can cause market inflation/distortion - Expensive/long payback times - Low visibility of works - Lack of skilled craftsmen - Compliance with high health and safety requirements	- High costs - Lack of skilled craftsmen - Permits needed from other agencies - High risk of technical issues once work starts
Solutions	- Energy management - Better information for owners, stakeholders, educational staff - Training for craftsmen - Expert advisors	- Provision of technical guidelines (Slovenia gives a good model) - Training for craftsmen - Expert advisors - Different approach used to judge financial eligibility
Other approaches/policy packages	- Standard packages - Energy Performance Contracts with guarantees	

Table 1. Framework for the development of policy packages in schools and heritage buildings

The high interest of MSs delegates in this field is reflected in the topics proposed for future discussion:

- In-depth analysis of appropriate solutions for heritage buildings.
- Management of energy systems in heritage buildings.
- Energy Performance Contracting – in general, for schools, and for heritage buildings.
- Technical guidelines for heritage buildings.
- Innovative public procurement.
- Pre-commercial procurement.

Highlights of 3.A.2.1	Pilot projects are important in holistic policy packages for the facilitation of energy renovation of public buildings.
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3.A.2.2 Residential buildings

The locked-in potential of residential buildings demands subtle policies for the mobilisation of private investments into energy efficiency actions to achieve anticipated savings. Policy options can cover different legislative, technical, social and financial categories and have a variety of influences at many levels. A large range of policies in the residential sector have already been put in place, however in order to make a step forward and trigger comprehensive energy renovation with use of RES in buildings, there is a need to design even more comprehensive policy packages particularly tackling:

- financial and economic barriers;
- fuel poverty;
- awareness-raising;
- information and knowledge gap;
- missing workforce skills as well as skills of staff operating and managing the building and of those installing energy efficiency and RES technologies;
- differences in urban and rural framework;
- investment motivation for single-family and multi-apartment buildings.

Thus far, two holistic policy packages were discussed within the Cross Cutting Team Policies and Implementation: the Danish initiative “BetterHouses” and the UK’s “Green Deal” policy. Both programmes support homeowners in planning and financing the energy renovation of their buildings with the implementation of various policies that offer a comprehensive support.

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|---|
| <ul style="list-style-type: none"> • “BetterHouse”² is a one-stop-shop initiative to accelerate energy renovation in private homes in Denmark, where trained consultants help homeowners throughout the entire renovation process. The scheme is voluntary and, to some extent, market driven with an initial 7 million € funding from the Danish government, mostly spent on training consultants and on television advertisement. After 2016, the scheme will be purely market driven. BetterHouse consultants offer: |
|---|

	1. screening of the building with a mapping of the potential; 2. a plan for energy renovation that covers dialogue with the client, mapping of the energy savings potential, a plan for investment including calculation, recommendations and budget planning, documentation for the bank, and 3. a project design, tendering, construction process management, hand over and follow up.
	The BetterHouse's consultants are from a wide variety of backgrounds (e.g., architects, engineers, craftsmen and current EPC assessors) and are approved by the Danish Energy Agency. Calculations are based on actual consumption and data from an existing EPC, and can be used as a basis for a renovation plan. Conversely, a BetterHouse's plan can be used to create an EPC. A plan costs around 800 €, which is comparable to the cost of an EPC assessment in Denmark, and is paid for by the building owner. By the end of 2015, approximately 400 plans were undertaken and 20% of clients are expected to start refurbishment.
•	The "Green Deal" is a UK Government initiative that provides finance to homeowners for energy efficiency improvements. A Green Deal Advice Report (GDAR) is created by an accredited assessor based on the building's EPC and additional occupancy data. Suitable improvement measures are suggested in this report together with expected savings. The householder can then choose what to have installed. A loan is taken out via a Green Deal finance company and paid back through the household energy bills. The finance available depends upon the "Golden Rule" calculation, which ensures that repayments do not exceed the amount of money saved through the installed energy efficiency improvements. In this way a household can have improvements installed with no upfront cost; they continue to pay the same for their energy while their actual energy use decreases and the excess pays for the loan. Over the last 2.5 years, approximately 15,000 Green Deal assessments have been carried out. In mid 2015, the new government decided to discontinue the scheme. The reasons were that the Green Deal loan was considered to be a barrier in case of property sale as it is tied to the property rather than to the person who took out the loan; the loan repayments could exceed savings and endanger the Golden Rule principle. Additional obstacles included non-competitive interest rates due to profitable interest of accredited companies providing finance to the scheme, the ineffective operation and complexity of the scheme (high costs and numerous assessments, difficulties and delays with carrying out the investments) and, finally, the lack of consumers' confidence and awareness.

Highlight of 3.A.2.2	• The costs for the implementation of complex policy packages can exceed the rent ability threshold. • There are many stakeholders involved which may reduce transparency and blur the real motivation of those involved. • A balance between "free" and "full price" services for consumers may be an important success factor for the long-term operation of the scheme. • Advice for investments were given based on measured consumption while EPCs were used as an additional source of information.
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3.A.3 Financing from cohesion and other funds - Support for deep renovation

The topic under consideration related to policies stimulating investors to go for more comprehensive, deep renovation of buildings, while at the same time complying with the cost-effectiveness principle. MSs representatives in the Cross Cutting Team Policies and Implementation were looking for policy solutions that would trigger such investments.

The absence of an adequate, financially supportive environment and the lack of competent experts involved in the renovation process were identified as the biggest obstacles in today's market. The challenge is twofold. On one hand, to prepare a simple and easily accessible financial mechanism for substantial or nearly zero-energy renovations, as the lack of sufficient financial resources often means that the scope of the implemented measures is limited to actions with a relatively short payback time. On the other hand, to ensure that building owners with sufficient or available financial resources recognise the full potential of improving their building's energy efficiency.

Examples from Bulgaria, Poland and Germany were presented with a view to identify the policy elements that stimulate holistic energy renovation projects. Although their approaches and financial arrangements were different, the common denominator was that a key component for success was to keep the process simple. The application process and paperwork should be minimised and the burden of responsibility for management should be taken away from the homeowner.

- In the Bulgarian case, the funding of an energy renovation is up to 100% and the targeted class after renovation is C, which involves a straightforward list of measures. Due to the high level of funding, homeowners are not actively involved in the technical solutions applied. Once funding is reduced and the target class increased, solutions are likely to be more complex and homeowners will have a greater involvement. The renovation process in Bulgaria is closely controlled, regular check-ups are done at all steps, so there is a very small risk for non-compliance with energy saving targets, however if this occurs, penalties are foreseen for contractors.
- Polish funding under the "thermomodernisation programme" is very straightforward, as the scope of the renovation is determined by an energy audit. The thermomodernisation fund is operated by a national bank whereby the loan applications are similar to other available loans. The loan must cover 100% of the renovation costs (no lower and upper limit), 20% subsidy is paid upon completion of the project.
- The German *KfW* programme involves a sliding scale to determine the refund corresponding to the energy savings achieved. Special focus is placed on quality assurance of the scheme and the need to follow the results of renovation and achieved savings. Based on experiences, *KfW* concluded that the more transparent and simple the promotional scheme is, the better it is to understand and the easier to distribute. The mandatory involvement of an energy expert is very important to provide comfort to the investor regarding his energy efficiency project and to assure a high degree of quality and reliability regarding energy savings as well as to assure target-oriented use of public funds and the promotional impacts.

MSs representatives share the common impression that deep energy renovation of existing buildings is more frequently undertaken in residential buildings (no big differences between housing and apartment buildings), while only two countries reported significant achievements in non-residential buildings, regardless of whether they are public or private (Figure 1).

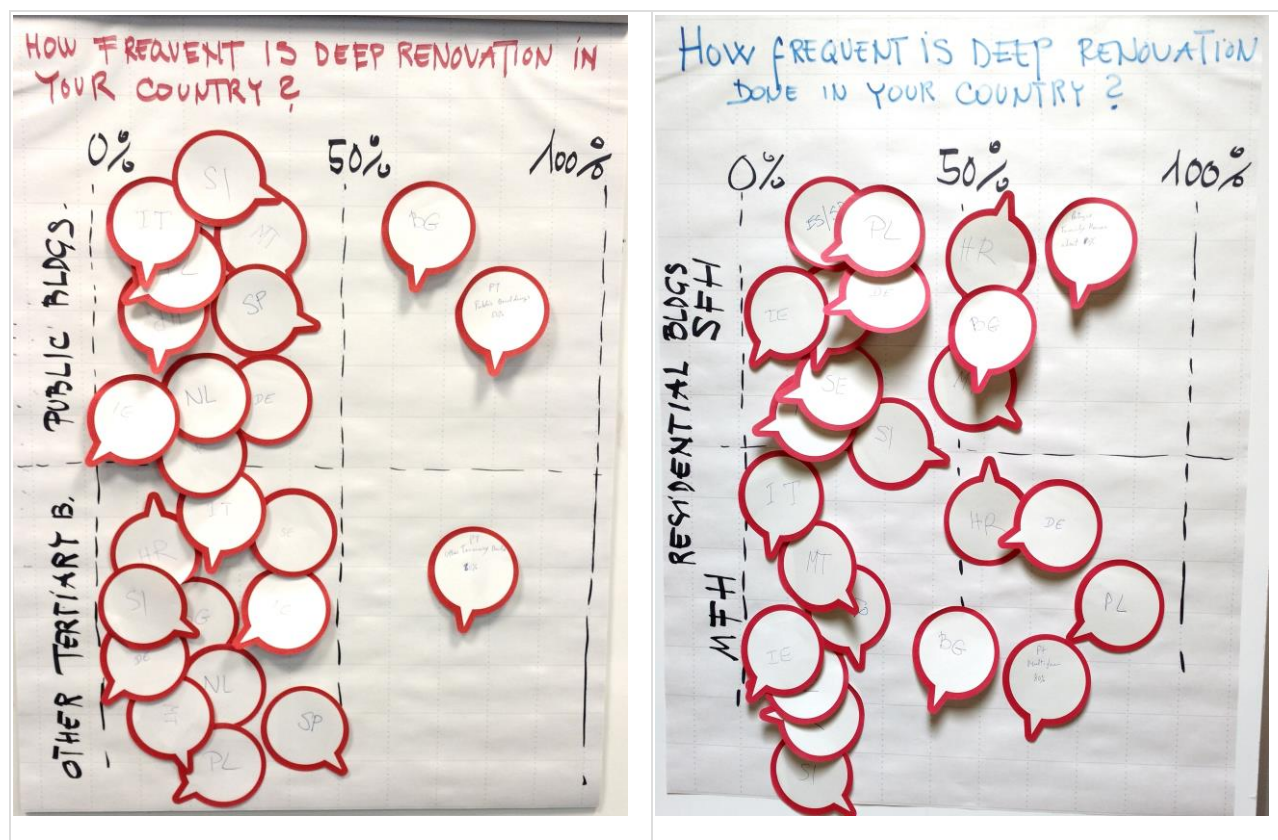


Figure 1. Countries impression on how frequently deep renovation takes place in investments in various building types.

Highlights of 3.A.3

- Allow for progressive funding for projects with better achieved savings.
- Keep the process as simple as possible.
- Make the involvement of an energy expert mandatory.
- Ensure that monitoring takes place.

3.B. Main Outcomes

The work of MSs in the Cross Cutting Team Policies and Implementation focused on financing from structural funds and, moreover, on the smooth national application of Cohesion Policy funding. Countries found the system very complex and pointed out the need for capacity building of all stakeholders, and in particular of public and private investors, for the successful application and implementation of the projects. The challenge of investing in energy renovation is to stimulate deep renovation. This may be done by progressive financial incentives for a number of cost-effective measures implemented in the renovation. Examples from MSs showed how deep renovation is organised and financed. Two possible solutions were exposed: strict and well-defined rules for the energy performance of funded renovation projects, and permanent quality control or progressive financial incentives for more comprehensive renovation investment. Further recommendations showed the necessity of keeping financing systems as simple as possible, the need to involve an energy expert in the deep renovation project, and the obligation to establish energy monitoring. Further discussions led to some additional topics for consideration: measuring of energy savings and what makes a building renovation programme successful (percentage of refund or

loan, state vs. privately managed financing scheme, long vs. short-term programme, other types of motives for deep renovation).

Policy packages for public and private buildings were studied based on presented best practice cases. A common point was the need to include pilot projects on investment. The major topics of discussion focused on success factors of policy packages developed around financing of energy renovation projects from EU and national funding, diversified for public (non-residential) buildings and residential buildings. Policy packages for existing buildings pointed out the benefits of well-balanced support for investing in renovation.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Financing based on structural funds	- Capacity building for public and private sector investors to be able to apply for Cohesion Policy funding. - Which types of buildings are subject to ESIF financing? - Criteria and awarding method in calls for tenders - Monitoring of results	- The Cohesion Policy funding is a very complex mechanism. - High degree of complexity involved in the tender process. - Public authorities need professional support to prepare successful applications.	- Discuss, optimise and introduce the monitoring of impact – checking energy savings after renovation is completed. - Effective capacity building of stakeholders in Cohesion Policy funded renovation projects.
Policy packages for existing buildings – public buildings	- National examples of policy packages in public buildings. - Highlight the particular successful elements related to risks and threats, and mitigation actions. - MSs representatives put most attention into schools and heritage buildings and discussed the relevant strategies based on case studies.	- Cohesion Policy funding is complex and involves many stakeholders. - Demonstration projects are very important to facilitate the uptake of this funding. - Heritage building policy packages have demonstrated big savings potential in other MSs.	- In-depth analysis of appropriate solutions for heritage buildings. - Management of energy systems in heritage buildings. - Energy performance contracting in general. - Innovative procurement and pre-commercial procurement for development of service.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Policy packages for existing buildings – residential buildings	• Main barriers are financial and economic, fuel poverty, gaps in information, skills and knowledge. • Holistic package of policies are needed as illustrated by Danish and UK case. • Advice on investments is planned based on actual energy use and calculated data from EPCs.	• The Danish “BetterHouse” scheme is a voluntary programme, initially supported by the state (training of consultants, marketing). The support can be obtained for planning and implementation of the investment. Consumers pay the cost of advice. • The UK “Green Deal” provided advice reports free of charge for the end user, but loans from financing institutions in the scheme were not competitive enough compared to other bank offers. Management of the scheme was expensive.	• A holistic set of policies to be used as a basis for successful long-term schemes that support renovation of existing buildings. • How to make companies involved in the financing scheme and ensure a win-win project (transparent motives and benefits for all).
Financing – support for deep renovation	• Learning from financial schemes in other countries. • Policies stimulate the investors to undertake in more comprehensive and deep renovations.	• EU MSs representatives’ opinion is that investments in deep renovation have so far been more successful in residential than in public buildings. • Progressive funding is a successful policy initiative to mobilise deep renovation potential.	• Keep the process of funding deep renovation as simple as possible. • Involve a mandatory energy expert in a system. • Ensure that monitoring takes place.

4. Lessons Learned and Recommendations

The following lessons learned have been identified with regards to the development and implementation of financial incentives and information measures as part of the EPBD implementation:

- Cohesion Policy funding rules are considered to be complex and are often seen as a large administrative burden.
- Capacity building for public authorities on how structural funds work is necessary for the successful application of these funds.
- Public authorities need professional support from an energy expert in the management of a renovation project.
- The precondition to successful use of EU and national public funding and other financial mechanisms is to have a reliable assessment of energy performance measures.
- Monitoring of energy savings achieved in a renovation project supported by Cohesion Policy funding is often not implemented in a comprehensive way, as the indicators might not include energy savings but rather the amount and quality of implemented work, such as renovated m². Results in savings should always be required.
- Funding programmes need to be combined with other policies addressing soft measures – both in the preparatory phase and in the post-implementation phase– to fully support the investment in deep renovation.
- Financial incentive rules need to be complemented with the tools for the determination of cost-optimal building energy renovation scenarios.
- Demonstration projects are valuable in supporting the successful implementation of renovation to cost-optimal or NZEB level.
- Some MSs use a relatively high share of Cohesion Policy funding, while others combine the incentives with financial instruments (e.g., soft loans, energy performance contracting).
- Main stakeholders may be interested in participating in policy packages like “one-stop-shop”, however too many market actors with different economic aims may endanger the project economics.
- A holistic set of policies is a basis for a long-term successful scheme supporting renovation of existing buildings.

Endnotes

1. Article 5 of Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC Text with EEA relevance (<http://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex%3A32012L0027>)
2. <http://sparenergi.dk/forbruger/vaerktoejer/bedrebolig>



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CONCERTED ACTION ENERGY PERFORMANCE OF BUILDINGS

(CCT3) Compliance, Capacity and Impact Status in November 2016

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1. Introduction

The first steps in the implementation of independent control systems in EU Member States (MSs) focused on the development of national regulations emphasising on the importance of quality and effectiveness of controls in order to achieve full impact and reliability of EPCs and inspection reports. In practice, various control systems were tailored according to the specific procedures for EPC issuance and capacities available in different central bodies that have to implement EPC controls. Hence, the way MSs integrate sanctions into their legal framework depends on their national context. Today, several years of enforcement have given insight into the effectiveness of different control systems and an overview of the quality of EPCs on the market. Additionally, the experience revealed that checking compliance through the enforcement of control systems and sanctioning non-compliance is becoming urgent, i.e., it is not efficient to tighten requirements if, in practice, non-compliance is tolerated and thus the regulation loses its intended impact. The best-designed policies only work well if they are complied with. All MSs tend to have an effective and dissuasive sanctioning system, or on the other hand a system of rewarding in order to maximise compliance.

This report contains information about the progress made regarding the organisation and management of an independent control system, as well as the enforcement of sanctioning systems. However, to be able to assess progress in compliance checking and sanctioning systems, the comparison to the last known situation (2013 situation identified within the Concerted Action EPBD III) was made.

2. Objectives

Article 27 of the EPBD (Directive 2010/31/EU) states that MSs shall lay down the rules on penalties applicable to infringements of the national provisions adopted pursuant to the Directive and shall take all measures necessary to ensure that they are implemented. These provisions should have been applied from 9 January 2013 (EPBD Article 28). The main conclusion of the work on compliance and sanctioning performed within the CA EPBD III was that there was clear progress in the evolution of national legislations, however, in practice, there is still a long way to go, as to have a fully operational compliance checking and sanctioning system. The objective of the Cross Cutting Team Compliance, Capacity and Impact is to look into different experiences of MSs regarding the policies and implementation of control systems, capacities and resources of MSs on national and local level for compliance check, as well as the impact of MSs' control systems on the improvement of the EPC quality (EPBD Article 18, Annex II).

2.1 Compliance Checking & Sanctioning Systems

Most of the MSs consider that sanctions are essential in their enforcement strategy. Therefore, it was necessary to investigate the current state of compliance checking and sanctioning systems in different national legislations and to evaluate progress among MSs in tackling sanctions and penalties compared to the 2013 situation. However, besides having compliance and sanctioning systems on paper, all MSs should ensure that these sanctions are actively enforced in practice.

There are several targeted actions:

- the determination of the current state of compliance and sanctioning systems in legislation among MSs;
- the evaluation of progress in tackling issues regarding sanctions & penalties, compared to the situation in 2013;
- the identification of obstacles and challenges faced by MSs when enforcing the sanctions and penalties in practice;
- the rethinking of the concepts behind penalty systems (identification of the system of rewards).

2.2 Control System Improvements

There are several targeted actions to be considered for improvement of the control system:

- define alternative measures for introducing fines;
- develop cost-effective and smart control systems.

2.3 EPC Quality Improvement

There are several targeted actions for the EPC quality improvement:

- achieve higher market demand for high quality EPCs;
- filter poor quality assessors and faulty EPCs.

3. Analysis of Insights and Main Outcomes

3.A. Analysis and insights

Comprehensive investigation was conducted in order to collect valuable information on how different MSs integrate compliance checking and sanctioning systems into their legal framework. An analysis of the 2016 situation regarding these systems for 21 MSs was compared to the 2013 situation, as illustrated on Figure 1 below. Additionally, comprehensive discussions were performed among the MSs delegates in order to identify specific procedures, best practices as well as a common understanding among MSs on the possible solutions regarding the emerging issues related to compliance, capacity and impact.

3.A.1 Progress in enforcement, applying sanctions and penalties

The comparison of the 2013 and 2016 situation can be summarised as follows:

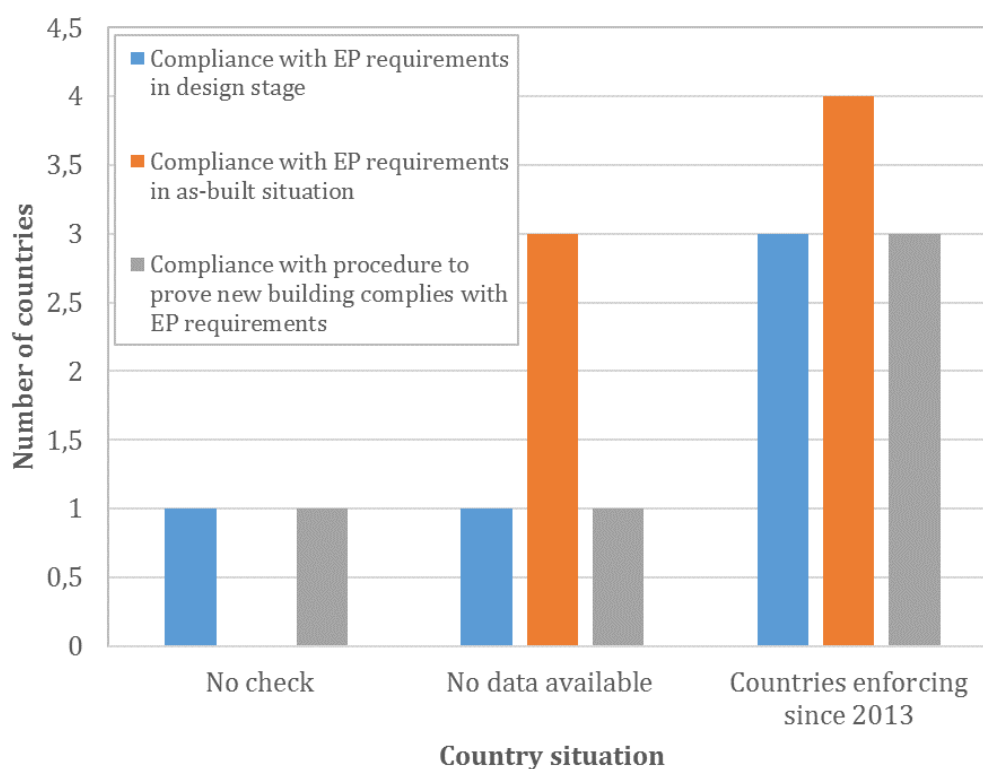


Figure 1. Compliance with energy performance requirements, procedures and guidelines.

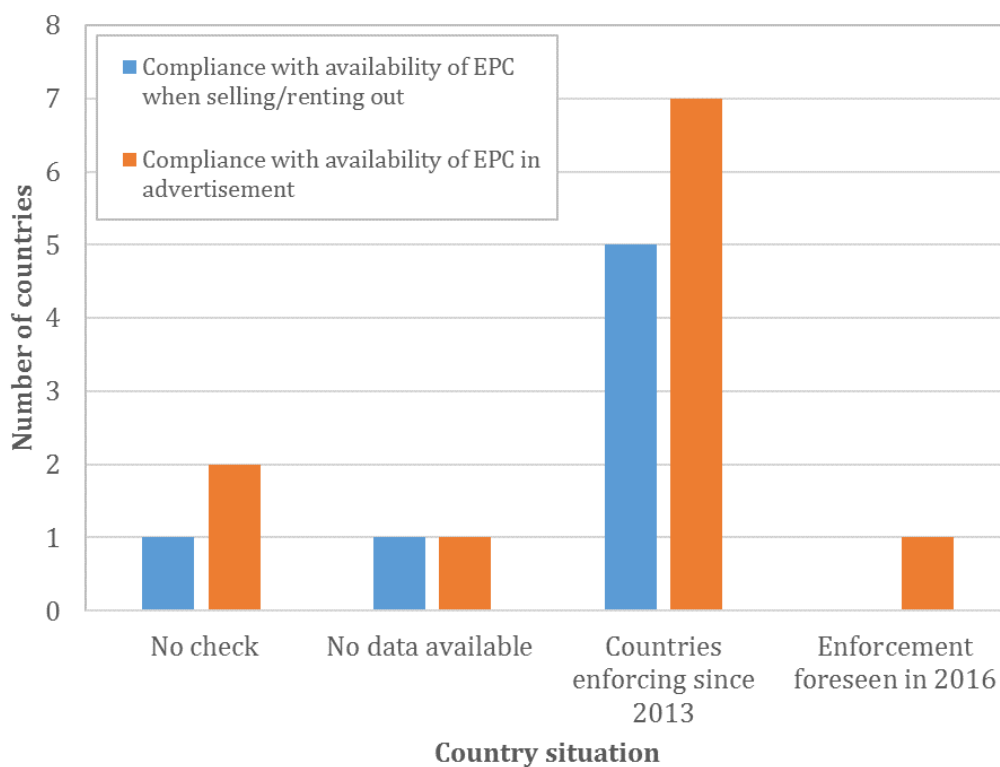


Figure 2. Compliance with availability of EPC by time of selling, renting out and advertising.

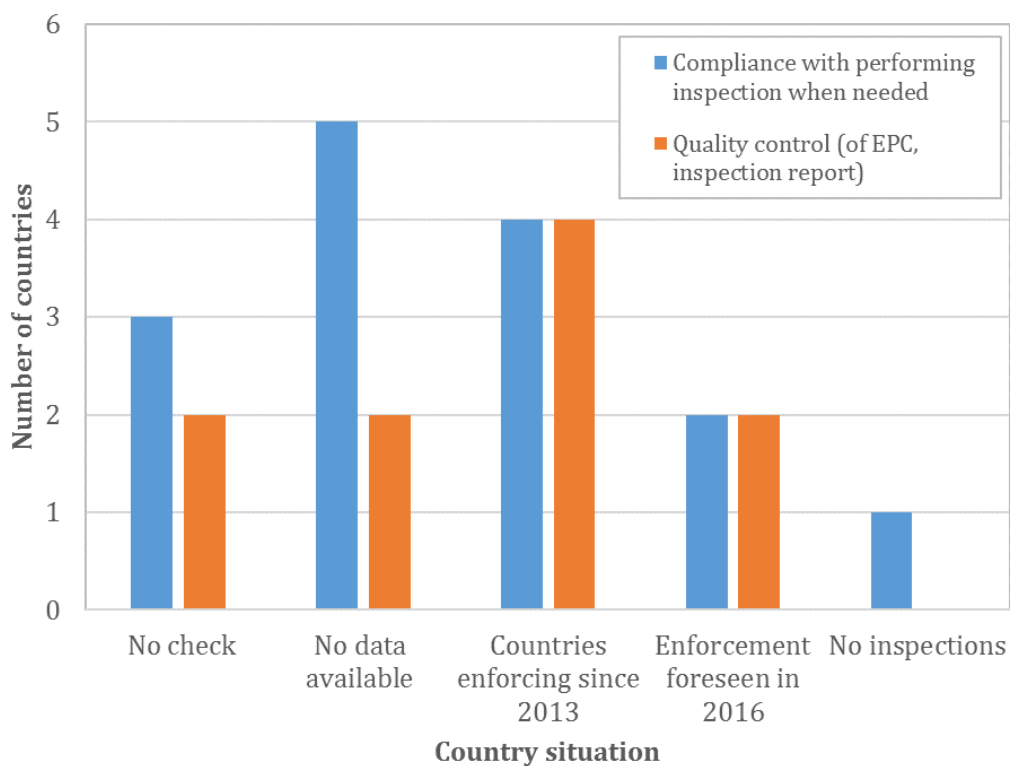


Figure 3. Compliance with performing inspection when needed and quality control.

Both the level of control and sanctions have increased.

In general, the number of MSs who check for EPC compliance and impose sanctions (regarding all the aspects of energy performance compliance) has increased since 2013. As presented in Figure 2, since 2013, 12 countries have implemented EPC systems that can be seen visually either in the form of advertisement or published when the building is being sold or rented, while one MS has foreseen to implement it by the end of 2016. These 13 countries in total also check compliance by using quality control systems or by inspecting the building.

While controls might lead to higher compliance rates, it is necessary to have a well-functioning sanction system in place to achieve the full potential. There are examples that, even with the introduction of small sanctions, a much higher compliance rate immediately takes place. There are still some MSs that do not have a system of sanctions in place. Positive progress is however evident in individual countries and in Europe as a whole. With more control systems being adopted, it is now important to concentrate on how these sanctions are practically working so as to enhance their implementation and to ensure their positive impact.

There is a great variety of penalties among the MSs, e.g., warnings, withdrawal of work licences and fines ranging from ~200 – 2,000 € for individual assessors and up to a potential 64,000 € for companies. As it can be seen on the example of Italy, sanctions imposed to owners in the form of fines are ranging from 3,000 to 18,000 € when an apartment/building is sold and the EPC is not available. When it comes to renting, fines are lower and range from 300 to 5,000 €. The responsible for the advertisement is fined between 500 and 3,000 € if the EPC does not appear in commercial advertisement for the apartment/building on sale or offered for rent. Since even large fines do not seem to always have the desired impact, there is a general agreement among MSs that fines are not the only option for sanctions. This means that the concepts of penalty systems need to be reconsidered. Alternative/additional penalties to fines could include the following:

- Sanctions that involve an aspect of education for the expert could be applied, e.g., additional education of poor quality assessors, to avoid the same mistakes being repeated.
- Banning experts from working on EPC assessments for a short time.
- The creation of an award/reward system as well as penalties rather than relying on penalties alone.
- Compliance being checked at the design stage and also at a second stage after construction, either at as-built stage or when the permit to use a building is awarded (this is becoming more common in MSs). This was seen as a good evolution, as there is room for improvement in defining the type of sanctions imposed at design and as-built stage.
- Defining fraud in cases of issuing and quality control of EPCs in order to be able to tackle it efficiently as well as to limit neglect of the assessors.
- Promotion of good quality EPCs and enhancement of the importance of customer protection rights.

Some countries expressed interest to trigger discussion among MSs about the issue of free movement of professionals, i.e., how to control the work of foreign energy assessors and how to ensure the enforcement of inspections in the case when the owner does not allow access to HVAC systems or fails to provide the required documents.

Highlights of 3.A.1

- Positive progress is evident regarding the integration of penalty systems in the legal framework among MSs when compared to the 2013 situation.
- Penalty systems did not make desired impact on the market regarding the compliance and EPC quality improvement.
- There is a need to reconsider the concepts of penalty systems in order to have a greater impact.

3.A.2 Levels of control system

Crucial for the control system is the determination of whether the non-compliance is a result of negligence or fraud in order to define proper action. Different levels of control and action are proposed and some examples are highlighted below:

- **Administrative control** is the action of checking the compliance with administrative rules and guidelines of the certification or inspection of technical system. If deviations are found only on this level it can be defined as neglect. In practice, there are many deviations that are not crucial for the final results but these deviations do not represent correct description of a building in terms of inputs and precise description of building elements and/or systems.

Action: Some MSs have defined effective procedures for submitting improved EPCs. Denmark requires a pre-check in the assessor company by a quality control manager to reduce the administrative mistakes. In Portugal, there is a software-based validation of inputs when submitting an EPC.
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- **Calculation checks** are the checks of compliance with calculation procedures and the use of default values. Some MSs (e.g., Bulgaria) check the calculation in all of the submitted EPCs, and others (e.g., Estonia) only those of new buildings when building permits are issued. On the other hand, in some MSs (e.g., Croatia) a calculation check is done for randomly chosen EPCs based on the percentage (0.25%) of yearly issued number of EPCs. If the calculation leads to a derivation for overall performance but stays within the same energy class (usual variation is less than 30%) then the EPC is declared accepted and when the calculation mistake is higher and energy efficiency measures are not given, the EPC is annulled. In Portugal, the calculation check is done for specific input data range and for a ratio of primary energy needs and its limit. If the variance is found higher than 5%, the assessor is fined.

Action: The building owner is responsible for acquiring a new certificate either from the same or newly appointed accredited assessor/assessor company (e.g., Estonia). In other countries, the reissuing of the new EPC after annulment is the responsibility of the original assessor/assessor company.
--
- **On-site inspection or a full control** is the action of checking calculation and administrative procedures, as well as collected information through an on-site visit. In some MSs (e.g., Denmark) full control on-site collection of data is undertaken at random and in the number of the percentage (0.25%) of EPCs issued yearly. Both building owner and individual assessors/assessor company are invited to participate in the control process. In other cases, such controls are a response to mistakes found by initial controls.

Action: If found faulty, the EPC assessor/assessor company is obliged to issue a new EPC and receives the appropriate penalty (e.g., Denmark).
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There is a common understanding that an effective control system should be organised as a three level control system, as follows:

- Administrative compliance checks should be implemented for every EPC submitted.
- Calculation compliance checks should be undertaken on a representative statistical sample.
- Targeted on-site inspections or full control should be completed, if the previous control level has shown major deviations.

Furthermore, MSs have defined differently both the control volume (i.e., statistically significant percentage of all energy performance certificates issued annually, according to Annex II) and the level of control (administrative, calculation check and on-site inspection, according to Annex II). An option to perform a calculation check for every building permit issuance is a highly reliable approach to communicate the accurate energy performance of a building. On the other hand, the high percentage of faulty certificates found in many MSs indicate that the control volume must be bigger in all levels of control to increase EPC accuracy and reduce non-compliance issues in regular practice.

3.A.2.1 Fraud and neglect issues

General definitions were discussed among the MSs and there was a general agreement on the definitions as shown in the textboxes.

Fraudulence refers to intentional faulty data inputs made to present a false energy performance level (i.e., results in better label) or to issuance of false documents. Besides faulty calculations of EPCs, which are found in the databases of different MSs, there are also cases of EPCs issued that are not reported into a database. This can be deemed as a case of severe fraud or identity violation and can influence customer rights and the reliability and safety of the energy performance certification system in general.

Fraudulence should be penalised and most MSs have already defined high financial fines and/or authorisation withdrawal for the expert or the company that produced a false EPC. Additionally, financial fines are normally imposed by the court system, while authorisation withdrawal or other non-fiscal sanctions might be possible to be regulated by the control body directly.

When submitting an EPC, a specific number or QR-code should be acquired stating its legality (e.g., Denmark, Greece).

Negligence refers to non-compliance of input data (i.e., important technical aspects or inappropriate use of binding definitions). Such inputs should be prevented either by using software databases with automatic control of most important input data related to technical aspects or regulatory definitions, or can be regulated by a quality control manager / procedure in the assessor company before submitting the EPC.

Defining range values for the most important technical aspects is a qualitative control mechanism and should be in place on administrative level control. If an assessor company undertakes this, the responsibility lies with them and obliges them to make post-corrections if needed (e.g., Denmark).

Results of administrative checks should be stored in the database and this should be done for every energy assessor/assessor company (e.g., Portugal). If a continuous trend of mistakes is noticed, a warning can be issued to improve the quality of EPCs, or further operation of the assessor will not be permitted.

Both fraudulence and negligence issues should be defined in national regulations so that proper actions can be taken against it.

3.A.2.2 Cost-effective and smart control system within EPC database

In the discussion among the CA experts it was identified that one control body seems to be the best way to enforce and implement the control system effectively. Third party control has not yet been proven to be effective, since there are multiple bodies involved in the system, one regulatory body and another enforcing compliance checks and possibly fines, but this could still be a possible approach.

An automatic quality control system integrated in the EPC database is identified as a smart, efficient and relatively cheap tool, which can be implemented and used to enhance the quality of issued EPCs. Cost-effectiveness and smartness is achieved by an automated check of specific elements such as major technical aspects and regulatory definitions. Smartness is assured so no EPC is accepted in the database without complying with a range of values for technical aspects and regulatory definitions. More in-depth quality check schemes include calculation checks and are more costly thus requiring continuous flow of funding and technical experts to be available. Funding of the control system is often performed through EPC registration fees and fines imposed. If the control system includes automated check of specific elements for every EPC then the possibility of issuing a faulty EPC is low, which is also an improvement of safety and reliability of the EPC system. Also, only initial costs for developing such a system are needed while operation costs are low, resulting to more available funds for the next level of control when expert knowledge needs to be applied for pre-checked cases.

Highlights of 3.A.2

There is a common understanding that an effective control system should be cost-effective, smart and organised as a three level control system, whereby:

- An automated administrative check should be implemented for every EPC submitted.
- A calculation check should be done on cases filtered through a previous control level and should include a representative statistical sample.
- On-site inspection and full control should be done only if the previous control level has shown major deviations.

3.A.3 EPC quality improvement

3.A.3.1 Achieving higher market demand for a high quality EPC

The focus of EPCs should be on grading into energy classes and providing straightforward information on energy efficiency measures. Poor quality EPCs do not provide clear information on energy savings and do not contribute to awareness-raising of building users. The market seeks for information related to future operational steps in the following ways:

- Future energy grading after implementation of cost-optimal energy efficiency measures.
- Up-to-date financing mechanisms available for energy efficiency measures and use of RES.
- Local initiatives for energy efficiency and RES to achieve NZEB levels (energy networking, public or citizens cooperative for development of decentralised RES energy generation).

Information should in any case be included by 2020 but should be adapted to the local availability of these concepts. If the market demand for high quality EPCs is low, and predominately poor EPCs are issued, then in most cases the policies do not actually result in energy savings and efficiency gains.

Additionally, consumers' rights protection should be addressed in order to protect consumers from fraudulence and/or negligence. Some MSs are facing special challenges as implementation of improvements of regulations in terms of EPC reliability needs to progress faster to meet the set deadlines on NZEB from 2018/2020 onwards, or because other systems are changing simultaneously. This results in a large number of EPCs being issued in a very short time, and if the capacity of the MS is not adequate (i.e., the number of assessors, databases, control system in place, etc.) it could mean that even though the policies are implemented (and the market demand is high), the quality of EPCs is poor. Quality control should be an integral part of EPC assessment and can be the responsibility of either the assessor/assessor company at the point of EPC issuing (e.g., Denmark) or predefined by the administration system's database at the point of EPC submission. Only after quality control (a simple and automatic screening of data and results) should the EPC be considered legal and can be delivered to the consumer. In case of mistakes, there is a request to review, correct and resubmit. A manual or automatic quality control system can be achieved through the specification of the most important input data to achieve high quality EPC, and then the comparison of the values entered to the applicable value span.

3.A.3.2 Filter poor quality assessors and faulty EPCs

In the case of poor quality assessors and faulty EPCs, one of the penalties (which is clearly not being properly implemented in practice in many MSs) identified as a plausible measure was education of poorly performing assessors. Another measure to consider is the use of faulty certificates as case studies for training seminars, where commonly occurring mistakes could be shown to the future assessors. Reporting any technical errors and faulty procedures in a central database after control results are entered could provide useful statistical presentation of common mistakes. Based on reporting from the control, training can be improved to tackle areas of common issues and voluntary top-up training can be offered to assessors. The reoccurring mistakes and procedures could be used to develop automatic software check, which would then, over time, replace the detailed control procedures. Equally, providing FAQs for common errors with clarifications, as well as identifying and focusing on good assessors can improve the assessors' performance.

Highlights of 3.A.3

- Achieve higher market demand for high quality EPCs.
- Filter poor quality assessors and faulty EPCs.
- Use the knowledge gained from the EPC quality control procedures to improve the training, as well as the quality control itself.

3.B. Main Outcomes

Even the best designed policies can only work well if they are complied with. The way policies are enforced and monitored is hence of highest importance for their impact. MSs have developed various systems of building codes, certification and inspection schemes to ensure that energy performance of buildings policies have a real impact and actually result in energy savings as well as efficiency gains. In recent years, many MSs have realised that some issues exist regarding the quality, compliance, and impact. Thus, MSs have increased their focus on monitoring and improving existing policies. The work performed by the Cross

Cutting Team Compliance, Capacity and Impact focused on the exchange of experiences and definitions of best practices of compliance regimes, capacity building and measurement of the impact and success of the existing policies.

Additionally, some topics were emphasised as interesting so as to be addressed in the future in order to give more positive examples that could be used by MSs still working with this challenge. Also, some common issues for many MSs were identified for future discussion.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
Organisation & management of independent control systems	There is progress in the implementation of national regulations, emphasising the importance of quality and effectiveness of controls for full impact and reliability of EPCs and inspection reports. Sharing of experiences.	Gain of insight into what has and has not been effective, in practice.	How to implement automatic checks to ensure compatible inputs and provide warning flags to the assessor. Specify the right balance between the detail of Quality Assessment and credibility/sustainability of the system
	Avoid using fines-identification of other available measures (alternatives to fines). Define a control system that gives enough information but at a reasonable cost. Increase the market-demand for high-quality EPCs. Filter out poor assessors.	Rethink the penalty system concepts. Use an effective three level control system. Use the knowledge gained from the EPC quality control procedures to improve the training, and the quality control itself.	How to simplify the control process and lower the administrative costs. How to focus on good assessors and change attitude instead of just disciplining faults found. Training of assessors. A smart quality control system integrated in the EPC database and based on automated check of specific elements as major technical aspects and regulatory definitions.
Enforcement & compliance – Sanctions & penalties	Identification of difficulties and challenges faced by MSs in enforcing the sanctions and penalties → basis for future work.	There is a clear progress in the evolution of the national legislations, however, in practice, there is still a long way to go to have fully operational compliance checking and sanctioning systems completed.	Methods of enforcing sanctions to replace EPCs, which fail in compliance. Training of assessors as result of miscompliance.
	Discussion on the lessons learned from creating the penalty systems.	Recognition of importance to develop the enforcement system in	Different entities in charge of control and sanctions.

Topic	Main discussions and outcomes	Conclusion of topic	Future directions
		parallel to the legislation to avoid confusion over roles and responsibilities. Efficient enforcement through the use of an electronic EPC database.	Enforcement of inspections if the owner does not allow access to HVAC systems or fails to provide documents.
	Discussion on the lessons learned from enforcing the penalty systems.	Lack of enforcement will lead to a lowering of quality. Loop holes must be tracked down and closed. Checks and controls are made more efficient and effective if a single entity is responsible for databases, assessor accreditation and control.	Compliance of new buildings with energy performance requirements at the design and as-built stage. Interesting examples of fraud/misconduct.
	Discussion on the effectiveness of enforcing the penalty systems.	More success achieved from a system of award/reward plus penalties rather than relying on penalties alone. Communication of the details of the sanction system is important to ensure compliance and trust.	Communication about the penalty system. Penalties other than fines. Reward systems rather than only penalties.

4. Lessons Learned and Recommendations

Despite the recent improvements in penalty systems in the MSs, the efficiency and effectiveness of compliance checking should still in general be improved across the whole of Europe. To achieve this, MSs have to identify and communicate the obstacles that hinder them from having a fully operational and effective compliance and sanctioning system. Exchange of experience among MSs helps to achieve a common goal – the smart and effective enforcement of the energy performance requirements. Another important goal is to ensure the EU building stock has overall low energy consumption, and in order to do so, it is vital that the MSs improve their compliance systems.

Some of the lessons learned by MSs while creating and enforcing their penalty systems include:

- Sanctions of more than ~1,000 € were found to be difficult to enforce, but conversely some MSs reported that enforcement was not cost-effective for smaller amounts.
- It is important to develop the enforcement systems as an integrated part of the legislation. If the checks and penalties are developed independently, then this can lead to a system, which is difficult to enforce and to confusion over roles and responsibilities.
- Enforcement is made efficient through the use of smart and cost-efficient quality control systems integrated in the EPC database. Primarily, checks on data and calculation can be carried out automatically and for every EPC submitted.
- Lack of enforcement leads to the EPC system having a poor quality and a bad reputation.
- Loopholes must constantly be tracked down and closed.
- More success can be achieved from a combined system of award/reward plus penalties rather than relying on penalties alone.
- Open communication of the details and results of the control and sanction system is important to ensure compliance and trust in EPCs and inspection reports.
- Controls have been found to be more efficient and effective if a single entity is responsible for databases, assessor accreditation and the control system.
- Double-check of compliance (at design and as-built stage) represents a good evolution in the way MSs check compliance with energy performance requirements in new buildings.
- A smart and effective control system should be organised as a three-level control system:

1.	electronic screening of values entered on major technical aspects and regulatory definitions for all EPCs submitted, including verification of legality;
2.	performance calculation check for reference sample; and, lastly
3.	on-site inspections for most poorly done EPCs or as final control.
- It is important to use the knowledge gained from the EPC quality control procedure to improve the training, as well as the quality control aspect itself.
- There is a need to stimulate market demand for high quality EPCs at MS level.
- It is important to filter poor quality assessors and faulty EPCs and apply re-certification of experts and educational measures.
- Current penalty systems have not had the desired impact on compliance nor have they ensured sufficient EPC quality improvement.
- There is a need to reconsider the concepts of penalty systems in order to have a greater impact



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CONCERTED ACTION ENERGY PERFORMANCE OF BUILDINGS

(CoCa) Synergy and Networking to maximise impact of the EPBD - 2018 Status in June 2018

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1. Introduction

A shared focus on building performance is within the scope of several initiatives that aim to facilitate the implementation of EU energy policy. The coordination of resources can maximise impact and avoid duplication of work occurring in Europe and, beyond that, focuses on improving building energy performance. This is pursued by monitoring projects and initiatives funded at EU and national level that contribute to the successful implementation and uptake of the EPBD, by promoting capitalisation of actions and providing opportunities for brainstorming sessions and knowledge transfer during the CA EPBD IV plenary meetings and the back-to-back stakeholder events.

The Central Team on “Collaboration with other Concerted Action (CAs) programmes and EU projects” (CoCa) investigates elements that are common with the other CAs (CA RESD¹ and CA EED²). This notably includes RES integration in buildings, energy efficiency policy for monitoring and development, integration of databases, strategies for energy renovation of existing buildings, the role of consumers, financial instruments to activate the market, smart meters data collection and the role of flexible buildings for smart grids, training and accreditation.

Exemplary country initiatives that support the coordinated implementation of the EPBD and other directives also provide data for this analysis.

The interaction of the EPBD with CEN standards is also briefly analysed. CA EPBD IV supports the national implementation of CEN standards by discussing typical conditions and values for calculations.

The collaboration theoretically covers most of the EPBD articles and mainly focuses on EPBD Articles 2, 3, 4, 5, 6, 7, 9, 10, 11, 18, 19 (review) and 20 in this reporting period.

2. Objectives

An effective implementation of the EPBD can only be achieved if key stakeholders are engaged in the process. In order to support this, the CA EPBD collaboration and networking with other EU initiatives aims at:

2.1 Creating synergies with other Concerted Actions for EU energy policy implementation

Collaboration with other CAs aims at pooling different expertise and facilitating the joint implementation of common/complementary topics of the directives, maximising impact and avoiding redundancy.

The aim is to investigate and discuss topics that appear in the directives, collecting views and insights from MSs through discussions in plenary meetings, and sharing outcomes with the other CAs. Specific objectives included:

- investigating barriers and solutions for wider penetration of RES in NZEB and smart buildings;
- highlighting EPBD links with and contributions to long-term renovation strategies (EED Article 4);
- providing guidance to measure and promote energy performance in public buildings (EED Article 5);
- raising new ideas for collaboration on building renovation-related articles in the EED and the EPBD and ensuring maximum use of related results in the CA EPBD and the CA EED.
-

2.2 Maximising impact of various initiatives in the EU

A lot of experience on EPBD implementation has been gained through EU funded research and innovation programmes and projects (IEE, Horizon 2020), involving a wide range of stakeholders. Dissemination of best practices and knowledge management of outcomes from these initiatives is key to stimulate new ideas for the most efficient implementation of the EPBD.

The engagement of key EU stakeholders is particularly important in the search for better data, methodologies and tools to monitor the progress of energy performance of buildings and to improve decision-making in the building sector.

Contributions from specific initiatives (e.g., QUALICHeCK project, CEN)³ have been considered, insofar as they analysed energy performance requirements' enforcement "on the ground" and the national viability of EU common energy performance calculation standards.

Improved knowledge of innovation and new technology initiatives on building digitalisation and optimisation of building systems allows exploring the principles of - and the barriers to - smart ready buildings and their potential to further supporting a more efficient and consumer focused energy system.

Results of various EU projects (mentioned in the following paragraphs) have been presented and discussed to investigate wider use of EPBD databases and to show the effectiveness of innovative approaches on financial mechanisms promoting energy efficiency, RES integration, advice to homeowners, policy making, and other issues related to EPBD provisions.

3. Analysis of Insights and Main Outcomes

3.A. Analysis and insights

The following paragraphs describe topics and results of discussions in the CA EPBD IV on common or complementary issues with other CAs as well as EU initiatives and projects, carried out from November 2015 to June 2018.

3.A.1 Commonalities and complementarity with other CAs

The first CA EPBD IV plenary meeting (Copenhagen, November 2015) allowed for an overview of collaboration priorities between the three CAs, which were all represented during the meeting. This was actually the only common meeting opportunity, but bilateral exchanges were also ensured during that period.

3.A.1.1 Coordinated implementation of the three directives and collaboration priorities with the other CAs

Coordinated implementation of building-related articles in the three directives depends on the specific national institutional framework and on how responsibilities are assigned and coordinated.

A questionnaire sent to the experts of the CA EPBD IV showed that in 50% of MSs implementation of the three directives lies within the same ministries or organisational teams or at least with teams frequently liaising with one another during their work.

The same survey, answered by 16 MSs in November 2015, allowed for the prioritisation of topics for collaboration:

- methodologies for measuring the progress of energy efficiency, including regular reporting to the EU Commission on NZEB (EPBD Article 9), on financial incentives (EPBD Article 10) and on monitoring and verification (EED Articles 4, 5, 7, 14);
- RES in buildings (EPBD Articles 2, 3, 4, 6, 7, 9, Annex I; RESD Articles 3, 13, 14, 16; EED Article 14);

- use of EPCs and integration with other datasets like heating and air-conditioning inspection data (EPBD Article 18), governmental buildings data and existing building stock (EED Articles 5, 4);
- financial instruments and policy packages (EPBD Article 10, EED Articles 4, 7, RESD Article 3);
- synergy between inspection of heating and air-conditioning systems (EPBD Articles 14-15) and energy audits of enterprises (EED Article 8);
- intelligent metering of technical building systems (EPBD Article 8) and smart metering of customer energy consumption (EED Article 9) that can potentially share data display, transmission, and storage;
- modelling of the building stock and developing/monitoring action plans for the energy performance of buildings (EED Articles 4-5, EPBD Article 9);
- coordination of capacity building actions (EPBD, EED, RESD).

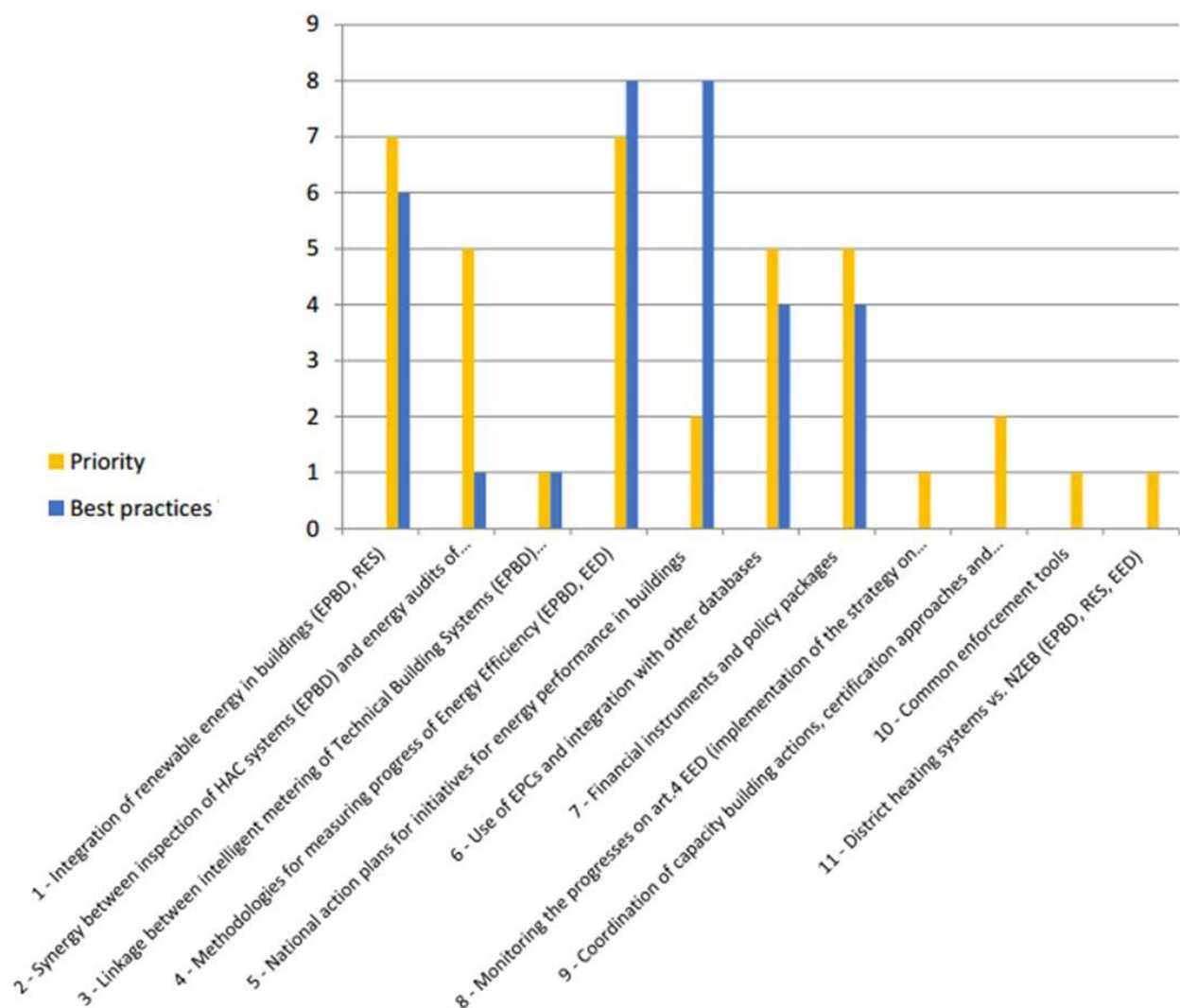


Figure 1. Priorities for collaboration with and experience from other CAs. From CA EPBD CoCa session, at the CA EPBD IV plenary in Copenhagen, November 2016: Reply by 16 MSs).

3.A.1.2 Vision on collaboration priorities from CA EED and CA RESD

During the first CA EPBD IV plenary meeting in Copenhagen, the above listed topics found support by CA EED members. Moreover, it was underlined how the RES and the EPB Directives can complement and help each other to achieve respective goals: high RES integration and high energy performance. CA RESD further indicated that support schemes for district heating and cooling (RESD Article 3) and the role of the consumers (and prosumers⁴) including information and training (RESD Article 14) are collaboration priorities.

In particular, comprehensive assessment of alternative measures, district heating and cooling (DHC) and combined heat and power (CHP), was raised as a common interest between the three directives.

3.A.1.3 Lessons learned on renovation-related articles in the EED and the EPBD

Increased, deeper and better uptake of building renovation is addressed at different levels in the EPBD (at building level) and the EED (at stock level). Different topics are addressed: long-term renovation strategies, the improvement of energy performance and methodologies for measuring progress, training, information and advice to consumers, data collection, and energy efficiency measures to achieve the long-term ambition. During the CA EPBD IV meeting in Bucharest, in October 2017, the results of a CA EED survey on new (2017) renovation strategies (EED Article 4) and ideas for future collaboration (also following the amended EPBD)⁵ were presented and discussed.

Thus, a non-comprehensive list of topics and sub-topics that would improve effectiveness of building renovation if approached in a synergistic way was discussed: the link between the individual and the collective level of building renovation, the exemplary role of public and heritage buildings, consumer-centred approach and capacity building, programmes to stimulate investment, smart buildings and the multiple benefits of an improved building stock.

CA EPBD delegates prioritised the following topics for future collaboration:

- consumer first: links between the smart readiness indicator (SRI) and consumer behaviour, as well as among EPCs and energy audits, inspection, metering/billing (including the role of ICT and IoT), and related issues, such as consumer's privacy and feedback);
- building stock data: quality/origin/availability/terminology/links to the EU Building Stock Observatory;
- mechanisms for smart financing (aggregation, de-risking, leveraging investments).

New ideas for synergy also included: involving cities in building renovation aggregation for financing and better use of the EU Smart City Information System, long-term renovation strategies, links to other policies including local-level policies, impact of Research and Development, definition of cost-effectiveness levels.

Highlights of 3.A.1

The overall strategy for collaboration of the three CAs is set during a yearly meeting between the coordinators, while other opportunities for collaboration and information exchange are considered when setting up the relevant CA plenary meeting agendas. Because of differences in timing of the ongoing contracts for the three CAs, no formal joint Working Group could be established between them, but continuous interaction was ensured through mutual participation in CA meetings and information exchange.

MS delegates agree that reinforced collaboration among the CAs concerning building renovation issues is required, starting from mutual experience on the role of the consumer, on smart financing, on data quality and management. Involving the city level and bringing specialists from outside the CAs are also seen as beneficial.

3.A.2 Better data to monitor and take action on building performance

There is often limited access to good quality data on the building stock characteristics, although this is needed to efficiently monitor EPBD implementation and to enable sensible decisions on the energy use of the building stock. The following paragraphs describe relevant initiatives that were presented at CA EPBD meetings in the period 2015-2018 to capitalise MSs' knowledge in this field.

3.A.2.1 The EU Building Stock Observatory – data collection by the CA EPBD

The **EU Building Stock Observatory**⁶ was launched by the European Commission on 30 November 2016, as part of the "Clean Energy for All Europeans" policy package. The Observatory monitors the energy performance of buildings across Europe through a range of indicators and tracks several aspects including: energy efficiency of buildings (at national and EU level), certification schemes, available financing for building renovations, energy poverty levels, etc. A second stage (2017-2018) is running, which will produce relevant bottom-up statistical building data, and update and expand the snapshot produced in the 1st phase (February 2015 – July 2016). The CA contracts on the EPBD had already been collecting relevant information on some of the key characteristics of the European building stock from MSs. These data were referred to as "Key Implementation Decisions" (KIDs), as they aim at measuring the status of EPBD implementation in each EU country. The CoCa Central Team worked on creating better interaction between the CA EPBD KIDs and the EU Building Stock Observatory, to avoid duplication of efforts. MSs agreed to improve KIDs using interactive, searchable databases and data mapping. This should allow for the EPBD *Key Implementation Decisions* indicators to become more accessible and reliable in providing information on the EU policy impact. In particular, EPBD data will be included, such as minimum requirements for new buildings and existing building renovations, NZEB levels, number of EPCs and of heating/air conditioning inspections. The main concerns during the collection of the new set of CA EPBD IV *Key Implementation Decisions* were the need for routine assessment and recording of data quality and origin, as well as the use of consistent terminology and definitions (e.g., definition of public buildings).

3.A.2.2 Integration and use of EPBD databases

MSs are currently establishing building-related databases with different purposes, data structure and administrators, as well as different access rights and formats for users. EPBD repositories, mainly recording EPC and Inspection data, have already been managed for several years and are increasingly used, not only for control and compliance goals (EPBD Article 18), but also to complement other sources with the aim of enabling evidence-based policies and monitoring the progress of energy efficiency in buildings. EPC data in its raw format is potentially misleading, and it is usually necessary to refine and combine EPC information with other data before use in a wider context. Barriers include datasets with no common identification and issues concerning accuracy (outdated, default and incomplete data), privacy (restricted or limited data access), management skills of resources. Integration of different existing datasets (census, inspections,

cadastre, incentives, gas registers, energy networks, bills, revenue agencies, etc.) is technically difficult and costly. Efforts remain, however, rather uncoordinated and there is a general lack of information on buildings in relation to energy issues.

The IEE **EPISCOPE**⁷ project (involving 17 EU countries), started from the classification of building typologies according to their energy related properties (based on the previous IEE TABULA project) and developed a methodology to monitor the progress of building energy performance with regards to national targets. The project modelled the building stock from three main data sources: full inventories of buildings, surveys and the EPC database. In Slovenia, this resulted in finding differences among data sources, proving the advantages of the use of EPC data for the EED's National Energy Efficiency Action Plans (NEEAPs) and for the renovation strategies mentioned in Article 4 of the EED. This led to the creation of an energy registry of buildings (EnRen). This is a comprehensive database which integrates the national real-estate registry (REN) 2008, with renovation data from Eco-fund subsidies, EPC data from 2015 and the results of the REUS 2015 survey on energy efficiency on a sample of households. In the EnRen registry, moreover, data is updated at each regulatory assessment or inspection and is stored in open XML format to enable commercial software tools to support the assessment process. Thus, multiple people can access and review the data, resulting in error reduction.

IEE **REQUEST2ACTION**⁸ (involving 9 EU Countries) investigated the use of EPCs to target retrofit funding and programmes. Improved access to EPC-related datasets and services are expected to facilitate analysis and decision making by financiers in The Netherlands, by local authorities in Slovakia and by regional authorities in Italy and Scotland (UK). In Scotland, the EPC database was combined with 10 other datasets, including RES and fuel poverty, to create a comprehensive, reliable, up-to-date energy performance profile for all the properties. The project found solutions to remove erroneous records, establish EPC representativeness and statistically predict performance when EPCs were not available. In Italy, a pilot web-based planning support system (DIPENDE⁹) was developed, which integrates top-down and bottom-up territorial data from EPCs, from census and from governmental incentives in the Lombardy region (2 million EPCs in 2015). This geo-referenced tool aggregates data at municipal level, allowing insight into links between age, typology, and average building energy performance after retrofit. The Portuguese web portal (CASA+) promotes the implementation of the energy efficient measures recommended in the EPC, letting the consumer contact suppliers and report on achieved renovations and impacts (savings, quality, comfort), and simultaneously gathering new data. This is part of a broader EPC data use in Portugal, which includes developing and monitoring policies (see Figure 2). As a result of the same project, in the Greek portal (EnergyHubforall), different sources of information are brought together, including EPCs issued before and after renovation. In Austria, in order to monitor building retrofit, available information from different province sources (including regional EPC data) was combined to the national declaration scheme *klimaaktiv*, issuing a certification of energy efficiency, good design and execution, material quality and comfort (also see “EPC to access savings” in the thematic [Report CT3 – Certification, Control system and Quality](#)).

EEPPA¹⁰, the Climate KIC study on the commercial and technical potential for an EU wide EPC services company, showed that access to relevant EPC data is still difficult. In particular, privacy issues still impede disclosing data to the private sector (banks, property portfolio holders). While current technical challenges of an EU wide EPC database is prohibitive, commercial services based on national/regional EPC data are practicable mostly for local administrations.

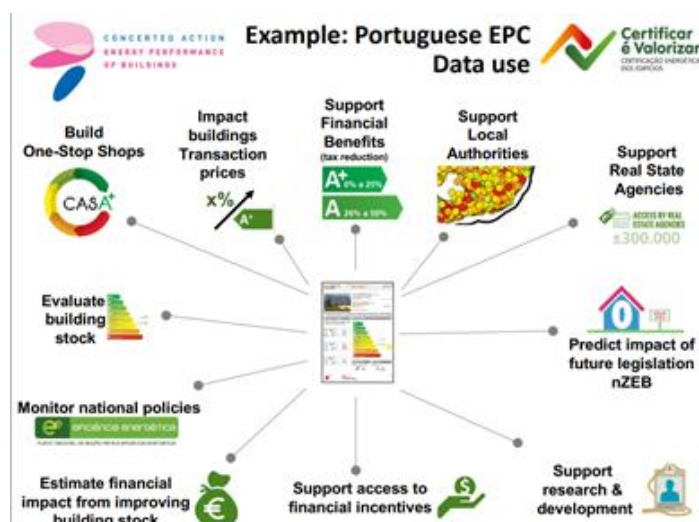


Figure 2. EPC data use in Portugal (source: ADENE).

As reported by **BPIE**¹¹, widespread EPC registers in the EU are a precious source of information. However, they are dramatically different in scope and comparison at EU level is currently challenging. The setting up of a database for EED Article 5 is a less common approach: only ten MSs in 2015 had a database for public buildings and some of them include only governmental buildings. In spite of the potential overlapping, possible links between an EPC database and EED Articles 4 and 5 are not fully utilised and considered.

3.A.2.3 Impact of the EPC on property value

According to a survey elaborated in the context of the preparation of the CA EPBD meeting in Bucharest, in October 2017, several studies have been carried out in 19 MSs to analyse the impact of the EPC rating on property value, after the one commissioned by the European Commission (EC) in 2013. Most of the studies used a "*hedonic price framework methodology*". This method can be applied to quantify the value that people are willing to pay for each characteristic when the price is known, and to predict prices of an item before it is known. Nevertheless, few delegates are aware of this impact, since this issue has been investigated by governmental bodies only in 5 MSs. Experience using data collected from real estate agencies, as cost information is not usually stored in the EPC database, has been reported from 5 countries, all stating that both high and low EPC ratings affect the property price.

According to real estate agents surveyed as part of the IEE **ZEBRA2020**¹² project, several aspects rated in the process of home appraisal can be linked to the EPC; for example, running costs as well as the cost surplus associated with high energy performance rating for renting or buying a building unit. The 2016 study made both survey and data analysis, and covered 12 MSs. The study also revealed that real estate agents do not generally believe that there is a cost surplus associated with buildings with high energy performance rating for renting or buying (except in Germany).

A self-paid research titled "*What will you pay for an 'A'?*" by **BALLARAT Consulting**¹³ performed a cross analysis of existing studies related to the impact of the EPC on property value. The comparison findings were not as clear as it was expected, due to different factors and parameters used in the various studies. Beyond energy efficiency as an independent parameter, key parameters to account for were: location, period of construction and date of sale. Many of the studies expressed prices in different ways. When related to the energy class, this could occur as percentage price increase comparing successive classes (e.g.

upgrade from D to C class), or referring to the average or lowest class ('C' rating or 'G' rating, generally). All studies agreed that properties with a higher EPC rating gain a higher price. For example, in the case of Finland, the price premium for the top three EPC ratings (A, B, C) compared to the D rating, varies from 3.3% to 1.3% depending on location, age and date of sale of the flat, whereas the price difference between the same ratings (A, B compared to D) is 6.6% in Denmark and 11.3% in Wales.

Highlights of 3.A.2

MSs have taken advantage of their participation in EU funded projects on building stock data both to develop harmonised databases and/or to integrate existing databases. Although wider use of EPBD databases is not common practice in MSs, new services provide trustworthy easy-to-use building performance data from EPBD databases and can contribute to monitoring retrofit and the impact of governmental incentivising programmes, and to developing or adjusting policies (R&D, NZEB, transaction prices, long-term renovation strategies, etc.)

The CA EPBD enhanced the use of and the access to national EPBD Key Implementation Decisions (KIDs). Integration into the new EU Building Stock Observatory, a comprehensive framework of building and energy data, appears to be an interesting opportunity. Cost information is not usually stored in the EPC database, so the impact of EPC rating on property value is assessed through data collected from real estate agencies or market surveys. Studies are not comparable, but a link between property value and the EPC rating is proved.

3.A.3 RES integration in buildings and smart buildings

Buildings are playing an increasingly active role in the transition of the energy sector from a fossil-fuel based supply and passive consumer role towards:

- energy flexible buildings supporting RES-based energy systems, matching energy demand and generation from various renewable sources;
- empowered users/occupants who can interact with the building through control, anticipate operation or maintenance and ultimately contribute to a higher building performance;
- automated maintenance and efficient operation of buildings thanks to electronic monitoring and control.

Business models can provide investment opportunities for building owners (e.g., facilitating access to capital, financing of up-front costs, outsourcing of technical and economic risks, and offering further energy related services) and for other actors involved. A CA EPBD IV technical session in Vilnius investigated existing business cases and provided evidence of the main barriers to the wider introduction of RES and building energy flexibility. The topic is relevant for EPBD Article 10 on financial incentives and market barriers, but also Articles 6 and 7 on economic feasibility of high-efficiency alternative systems in existing and new buildings, Article 9 on NZEB (action plans) and Article 19 on the EPBD review.

3.A.3.1 Business models for RES integration

Some countries have legislative frameworks that may support new business models, but there is low awareness across the CA EPBD participants about these mechanisms. Examples include:

- A business model for heat pumps rolled out by energy service companies (ESCOs) in Denmark that can raise consumer's awareness on heat pumps and at the same time create a new way of funding where the consumer will just pay for the service while the selected ESCOs will be responsible for investment and maintenance.
- Croatia has a regulatory framework for green electricity purchase and an action plan for green public procurement. According to this legislation, local governments should consider district-heating projects using RES for new development areas. RES integration is encouraged by green electricity certification. Large companies buy guaranteed green electricity and benefit from marketing their social responsibility and sustainability.
- In Portugal, a 'one-stop-shop' is being created to connect the supply-and-demand side for the implementation of RES measures (solar thermal, PV, biomass). Political and market conditions highly influence the role of the various actors for RES penetration.
- ESCOs are currently being involved in some countries (Greece, Slovenia, Italy) for public buildings. MSs complain that some of the actors (e.g., heat suppliers) are motivated more by financial benefits than by energy efficiency or emissions reduction. Moreover, the split incentives barrier is to be taken into account by business models and their feasibility varies according to the country-specific regulation in the rental sector.
- In all the presented cases, the development of new business models took advantage from existing governmental schemes that are considered as a value to capture, provided that they are steady enough. Therefore, governments play an important role in supporting business models, facilitating access to capital and changing legislation.

3.A.3.2 Business models for smart buildings

Traditionally, energy companies matched demand and supply of electricity by controlling the rate of generation. This is becoming harder since more and more renewable electricity is produced in periods when there is low need to use it. The importance of storage is dramatically growing and the decrease in prices for decentralised solutions could change the demand-response ratio.

According to a presentation from BPiE in the second CA EPBD IV meeting in Vilnius¹⁴, *"in 4-5 years, a growth of 70% is expected in demand-response, with a high potential in the heating and cooling sector. Dynamic energy pricing is needed to provide incentives to modulate demand"*. Smart metering and controls enable a reduction of the energy consumption and a smart interaction between buildings, their occupants and the energy system. A pilot project in Ireland using smart meters, dynamic prices and consumer information showed that the participants who had an in-home display were able to reduce consumptions by 3.2% overall and by 11.3% at peak-time¹⁵.

In Germany, the use of grid-optimised storage systems, helping to reduce grid stress and increase local grid capacities is incentivised through a repayment grant covering up to 100% of investment costs with a term of 5, 10 or 20 years. Both heat storage and battery storage with PV and grid connections are supported. Electrical systems that are eligible for this scheme include new PV systems with batteries, new electric

battery systems for existing PV (installed after 2013), and PV systems smaller than 30 kWp. Only stationary storage systems are eligible for funding but consumers who are generating surplus electricity can use it for any purpose, including charging electric cars.

3.A.3.3 RES integration - Attractive District Heating and Cooling solutions

District heating and cooling is highly efficient and allows the use and combination of different energy inputs and RES. Opportunities and service concepts that make district heating and cooling from RES attractive to both users and suppliers were investigated in a CA EPBD IV session in Valletta (February 2017).

Work undertaken as part of the CA EED found that the main barriers to wider adoption of district heating and cooling are investment costs, low return on investment and low heating demand in mild climates. According to the 2016 CA EED survey, investors find district heating an attractive opportunity in 25% of applicable MSs, although the level of interest depends on the energy source and technology used. Moreover, RES are the most interesting energy source of district heating to investors.

The **EU IEE SmartReFlex**¹⁶ project has investigated a range of political, financial, skill-based, organisational, social and physical barriers. Key requirements to transition to 100% RES district heating and cooling were identified as heat planning at local level (GISs provide an opportunity), low temperature district heating grids, early recognition of available land and direct involvement of consumers.

The **H2020 SDH**¹⁷ project showed that a cooperative model has been introduced where the utility service is owned by the users in Denmark. In Salzburg (Austria), two social housing companies, the city and the utility sustained the initial investments to develop a microgrid for new buildings, where the cost of 30% solar fraction of annual heat demand is included in the rent. In Sweden, a municipality has promoted net metering of heat from distributed solar plants (solar thermal collectors feed heat into the city's district network and subsystems at several locations) via a contract with the utility company. Moreover, increasing urban density and rising oil prices have encouraged the expansion of district heating, so that today 50% of the heat market and 90% of multi-family houses are served by district heating, mostly privately owned.

Highlights of 3.A.3

According to MSs, the main barriers to a wider introduction of RES for NZEB and solutions for smart buildings reside in cost, information, grid capacity, lack of skills, dealing with social acceptance, usability and political barriers.

Relying on the individual response of households will not work without aggregators and innovation driven by technology companies. Technical regulations, clear guidance and RES integration with smart buildings are needed in the EPBD.

Strategic local and regional heating and cooling planning, effective regulation and financial support measures are key success factors for district heating and cooling. Nowadays, only a few different district heating and cooling investment and ownership models are known. GISs look like an opportunity for new business models within the "Big Data" challenge, as well as the direct involvement of consumers.

3.A.4 Long-term renovation strategies

3.A.4.1 Best practice and remaining gaps in long-term renovation strategies

Amendments to the EPBD adopted in May 2018 move the obligation to produce a long-term strategy for building renovation from the EED (Article 4) to the amended EPBD (new Article 2a). In May 2016, in Vilnius, the CA EPBD analysed the relationship between long-term strategies for “cost-effective deep renovations of buildings” (EED Article 4) and the goals of achieving savings within the EPBD. Within the first 2014 long-term renovation strategies, a few countries (e.g., Spain, Denmark, Croatia, Lithuania) appeared to better respond to the EED Article 4 (a) to (e)) requirements of the strategy, also linking them to the EPBD implementation experience. Nevertheless, the relationship between the implementation of EED Article 4 and EPBD Article 9 (plans for NZEBs) but also between EPBD cost-optimality and cost-effective approaches of renovation remained insufficiently explored. According to the first evaluation of MSs renovation strategies¹⁸, elaborated by the Joint Research Centre (JRC), a range of innovative approaches to stimulate investment already existed. These regulatory, financial, and communication schemes are often mentioned in MSs lists according to EPBD Article 10. Some outstanding examples, like the Horizon 2020 **SUNSHINE** project¹⁹ proved feasibility of ambitious renovation (65% energy consumption reduction through measures on space and water heating) and innovative bankable and aggregated investment projects. In Latvia this resulted in encouraging the homeowner through a simple and transparent process, including a central IT platform to store data, benchmarks, and stakeholder networking. Guidelines, inbuilt monitoring and standardised contracts, were considered to be elements of the successful model for stimulating deep renovation. Important improvement suggestions highlighted from the first long-term renovation strategies evaluation included scenario analyses that can be further linked to EPBD implementation, monitoring data and a clearer picture of the non-residential sector. Links between achieving increased renovation rates, funding and data use (e.g., from the EPC) were recommended to be strengthened in the future.

The recent ongoing long-term renovation strategies evaluation, presented by JRC at the CA EPBD workshop in Frankfurt, in May 2018, shows progress from the first to the second (2017) version. According to the JRC, MSs updated their first strategies in different ways: 21 of them provided full revised strategies, while 9 just updated some sections. Compliance to EED Article 4 requirements has generally improved in the second versions, as showed in Figure 3.

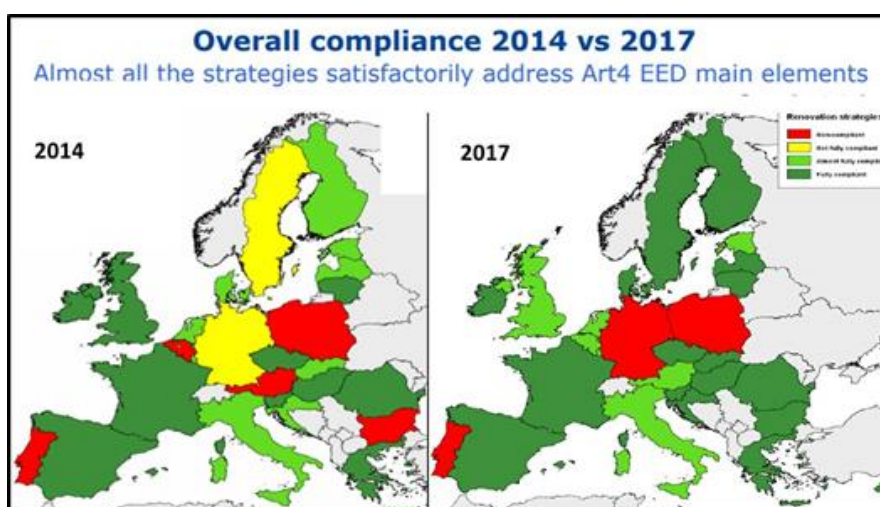


Figure 3. Compliance of 2014 and 2017 MS long-term renovation strategies (source: JRC).

The majority of the strategies now include a 2050 goal (15 MSs) and measures to alleviate energy poverty (17 MSs). Data collection and analysis, e.g., for the non-residential building stock, are better covered and improved. More MSs included scenario analysis in the renovation options for deciding the most appropriate cost-effective interventions. Forward-looking perspectives to guide investment decisions (Article 4d) and expected energy saving and wider benefits (Article 4e) can still be improved. Remaining gaps are mainly evaluation and monitoring, which can be further improved (e.g., through proper indicators). It has also emerged that while, in 2016, national teams working on renovation strategies were rarely the same as those working on the EPBD (see paragraph 3.1), in 2018, half the CA EPBD delegates' organisations had been recently involved in the second long-term renovation strategies, with 4 delegates playing a key role.

In light of the amendments proposed by the European Commission in the context of the Clean Energy Package (including the proposal to transfer long-term renovation strategies requirements from EED Article 4 into the EPBD Article 2a) the CA EPBD discussions in Bucharest (October 2017) and Frankfurt (May 2018) looked into how building renovation strategies have been dealt with so far under the EED. This included looking at the challenges, successes and areas for improvement, aiming to establish a foundation for new work in the CA EPBD V. In these meetings, delegates highlighted particular areas for valuable collaboration with the CA EED.

According to the CA EED experience, factors preventing the uptake of renovation are mainly based on financing and the lack of credible data on the performance of energy efficiency measures. Effective long-term renovation strategies should gain the consensus of all stakeholders and their cooperation, secure long-term political commitment and the availability of stable financing, and be based on reliable and objective analysis of the impact of renovation work, such as energy and cost savings, air quality or thermal comfort improvements. Moreover, data collection and management (preferably by independent bodies) need to be increased – an inventory of best practices on building renovation would be beneficial. This could help reduce the perceived risk of energy efficiency measures and, therefore, increase financial investment. Potential collaboration with the CA EPBD was identified in policies linking the national and local level of renovation, innovative policy measures to overcome the existing barriers to renovation, integrated approach in heating and cooling, smart buildings-cities-grids concepts, heat and electricity market integration, energy efficiency mechanisms addressing property owners with low income, low credit ratings and liquidity. As for 2050 scenarios, based on the results of the CA EED workshop on modelling (Munich, March 2017), multiple approaches are used in MSs, which can support energy efficiency implementation in the medium-long term. Nevertheless, within their National Energy Efficiency Action Plans, MSs rarely use modelling for single sectors (12.7% of modelling purposes), so the application of these approaches to long-term renovation strategies appears impracticable. Top-down data has higher availability and is cheaper to collect, although bottom-up energy demand models are essential for projecting trends in energy end use sectors. Ireland and The Netherlands use a combination of top-down and bottom-up approaches: top-down for projections and bottom-up to assess the impact of sectoral policies. Coordination of various inputs, ministries and agencies, as well as double counting, remain the main barriers to scenario making.

3.A.4.2 New Article 2a, one-stop shops, building passports, energy poverty

The new EPBD Article 2a on long-term renovation strategies intends to provide greater consistency and coherence to the EU building energy performance policy. New obligations and elements were added compared to EED Article 4; for example, considering potential trigger points in the life-cycle of the building for renovation and stimulating the option for staged deep renovation through schemes such as the building

renovation passport. There will also be a greater focus on accessible and transparent advisory tools, as well as assistance instruments to owners and investors (the so called “one-stop shops”) and actions to target the worst performing segments of the national building stock.

In Valletta (February 2017), the Energy Advice Exchange presented an analysis of good practice in energy advisory services²⁰ all over Europe, highlighting, moreover, the links to EPBD, EED, RESD articles and the importance of the consumer-centred approach in renovation strategies.

During the Frankfurt in-depth workshop (May 2018), a review of existing examples of one-stop shops that can assist building owners and investors, from renovation planning and financing to delivery, monitoring and quality checking, has been provided. Hence, clusters of services exist (e.g., in Belgium), which are available to clients through a single contact point and are led by architects, contractors, energy providers and public authorities. Success of one –stop shops seems to reside in the right combination of a business model and the customer’s understanding of the need to renovate.

[RenoWatt](#), partner of the **H2020 CITYNVEST**²¹ project, was seen as the best example of a one-stop shop at the moment, but still not covering the whole concept. It is a programme for the renovation of public buildings enhancing energy efficiency by grouping smaller projects to remove all kinds of barriers, technical, legal, administrative and financial. The financial model is based on Energy Performance Contracting. One-stop shops can have a theoretical top-down approach, but, at present, bottom-up approaches are more commonly led by market parties, even if not fully structured.

According to MS delegates, one-stop shops should target and adapt to the situation (e.g., tenure, building type and financial situation), define a standardised minimum service package and explain the different steps of renovation in a user-friendly way, including links to incentive schemes, grants and loans. The concept also has a potential conflict of interest: an independent entity or public authorities to ensure quality assurance were both mentioned. One-stop shops need to be relevant at a local level by having both a physical and a digital presence and be attractive for customers. Many stakeholders were mentioned as key one-stop shop players: energy and climate advisors, energy suppliers and municipalities. Direct actors can also be homeowners and building associations, financiers, energy assessors and installers. Several different players were mentioned as possible responsible authorities for one-stop shops: building energy authorities, municipalities and housing companies.

Step-by-step (or staged) renovation works could be the solution to achieve the full potential of benefits from retrofit that is not generally undertaken in one single stage. Some inspiring step-by-step mechanisms, also linked to the concept of the building renovation passport, are already being practiced in Germany and Belgium and in EU projects. In the first case a ‘**renovation roadmap**’ is generated, providing an overview of the measures for the specific building, implementation assistance and supporting material for the energy consultant. The measures selected also take into account the homeowner’s financial status. A step-by-step scheme provides the owner with information on measures’ prioritisation, indicating, for each measure: energy and cost savings, capital investment required, subsidies available and pay-back period (also see CA EPBD Thematic Report “[Certification, Control system and Quality](#)”).

The IEE [EuroPHit](#)²² project (Deep energy efficiency step-by-step retrofits to EnerPHit standard) developed a standard to enable the certification of renovation works to existing buildings in order to achieve quality. The EnerPHit standard promotes high component criteria, based on certified Passive House components. The standard criteria can differ among countries, e.g., with tailored U-value standards. The project developed several pilots on single-family homes (cost range from 7,000 – 95,000 €) and both residential (single and multi-family buildings) and non-residential buildings. CA EPBD delegates estimated the main

advantages of current step-by-step models: standardised and holistic approach, expert training and guidance, minimum improvement required (and pre-certified), integration in a broader quality approach widely applicable to different climates, user-friendliness and owner involvement.

The ongoing **H2020 iBRoad**²³ project designs, develops and demonstrates building renovation passports, customised individual roadmaps (on a 15-20 years horizon) in support of deep renovation. This new approach will generate useful insight for forward-looking policies by providing data from energy audits and building logbooks (5 layers of information, 23 topics, 66 sub-topics).

As for **energy poverty**, most MS delegates are not aware of the official definitions. MSs seem to use definitions that are not officially quantified. External presentations from **DOOR**²⁴, a Croatian NGO, recommended that energy poverty should include consideration of household income and dwelling conditions. It was emphasised that energy poverty should not be targeted as a separate area and be rather integrated into the general policy for the improvement of the whole building stock. Some current programmes are sharing examples and data: the **European Energy Poverty Observatory**²⁵ and the **ENGAGER Network**²⁶ (European and wider).

Highlights of 3.A.4

To establish a foundation for the new work, the CA EPBD looked into how building renovation strategies have been dealt with so far under the EED, including challenges, successes and areas for improvement.

Compliance to EED Article 4 requirements have generally improved in the second versions of long-term renovation strategies, including long-term scenarios and data management recommended within CA EED discussions. Guidance to investment and de-risking, monitoring and wider benefits of building renovation can still be improved.

Particular areas for valuable collaboration on long-term renovation strategies in order to get experience from the CA EED were identified: linking the national and local level, building and district smartness, heat and electricity market integration, energy poverty.

New elements in the new EPBD Article 2a have been analysed and exemplified with the contribution of external initiatives: existing examples of one-stop shops, first experience in step-by-step renovation roadmaps, definitions and indicators for energy poverty.

3.A.5 Contribution from other initiatives

Further dialogue and collaboration occurred on other topics addressed over the 2015-2016 period. They are presented below and further detailed in other Central Team reports.

3.A.5.1 Improving the energy performance of heritage buildings

When dealing with major renovation, the EPBD and the EED contain an exemption for heritage buildings. EED Article 5 (Exemplary role of public bodies' buildings) allows two approaches, either compiling a default inventory of relevant buildings or an alternative approach including estimate of improvements. CA EED contributed to the CA EPBD debate to give policy guidance for advancement in energy performance of heritage buildings, highlighting the existence of energy efficiency programmes (eight within the NEEAPs) that also include military and historic buildings. CA EED also showed the results of an internal survey

compiling knowledge of energy consumption data, level of importance of different heritage buildings, pros and cons from the MSs' experiences about the "default" or the "alternative" approach.

Definition of cost-effectiveness of the governmental buildings renovation projects, incentivising programmes, information on "before-after" energy performance in EPCs for public funding of Article 5(1) projects and deeper knowledge of actual energy consumptions that can help de-risking investments (e.g., from ESCOs) were identified as possible common fields of interest between the two CAs.

3.A.5.2 CEN Standards

The CA EPBD IV Core Team members also had the opportunity to discuss relevant developments of CEN/TC 371 standards on energy performance of buildings, in particular the study carried out on behalf of the European Commission on their usability, based on example cases. Comments from the MSs about practical implementation of the new CEN standards and on the transition from the current ones were collected and communicated to the contractors developing the study. The outcomes of this work are summarised in the Central Team Report on "Technical Elements".

3.A.5.3 Reliability of EPCs and quality of the works

The **IEE QUALICheck**²⁷ project (involving 9 EU Countries) collected best practices in relation to the quality of the EPC input data and the construction works, including compliance with applicable standards and application of penalties. CA EPBD feedback on key success factors was aligned with the recommendations from the project that are not common practice in all MSs yet, e.g., systematic and targeted control on the quality of the construction work, collection of EPC data in a central database or certification of products.

Other external contributions occurred under other Core Teams and are described in the related reports.

		
<u>Concerted Action for the Energy Efficiency Directive - CA EED</u>	<u>Concerted Action for the Renewable Energy Sources Directive - CA RES</u>	<u>European Committee for Standardisation (CEN)</u>
		
<u>Buildings Performance Institute Europe - BPIE</u>	<u>EPISCOPE project</u>	<u>QUALICheck project</u>
		
<u>REQUEST2ACTION project</u>	<u>EEPPA project</u>	<u>SUNSHINE project</u>
		
<u>European Commission, Joint Research Centre - JRC</u>	<u>SmartReFlex project</u>	<u>Energy Advice Exchange project</u>
		
<u>ZEBRA2020 project</u>	<u>Citynvest project</u>	

Figure 4. List of external stakeholders and projects contributing to CA EPBD IV.

3.B. Main Outcomes

The main areas to be considered for a coordinated implementation of EPBD, EED and RESD have been identified and discussed within the CoCa Central Team:

- Priorities among collaboration practices (CA EED and CA RESD at CA EPBD, Copenhagen November 2015);
- Cost-optimality/cost-effectiveness of measures for EED Article 5 (CA EPBD at CA EED, The Hague March 2016);
- Role of RES in NZEBs (CA EED at CA RESD, Vienna May 2016);
- Management of public heritage buildings regarding energy efficiency (CA EED at CA EPBD, Vilnius June 2016).
- RES integration - Attractive district heating and cooling solutions (CA EED at CA EPBD, Valletta February 2017);
- Other CAs: Analyse EED articles – lessons learned on renovation (CA EED at CA EPBD, Bucharest October 2017);
- Long Term Building Renovation Strategies - Highlights from CA EED (CA EED at CA EPBD, Frankfurt May 2018);
- MSS' modelling approach and how they can support energy efficiency implementation - Highlights from CA EED (CA EED at CA EPBD, Frankfurt May 2018);
- Overview of CA EED financing issues, focus on renovation (CA EED at CA EPBD, Frankfurt May 2018).

CA EPBD IV covered all topics on CAs commonalities identified at the beginning of the action (Copenhagen 2015) with the exception of the topics *“Synergy between inspection of technical building systems and energy audits of enterprises”* and *“Intelligent metering of technical building systems and smart metering of customer energy consumption”*. The latter raised interest for future discussion on changes and innovation (e.g., smart building, building automation and control systems) entailed by the amended EPBD.

Collaboration with the other CAs and EU initiatives contributed to the following outcomes:

Topic Contribution from/to	Main discussions and outcomes	Conclusion of topic	Future directions
Complementarity with other CAs - CA EPBD - CA EED - CA RESD	Discussion about priorities for collaboration. A transfer of knowledge occurred during the different CA plenary meetings (in 6 CA meetings) and through continuous informal exchange. The bases for renovation strategy work (new Article 2a) in the CA EPBD harvesting the outcome of CA EED work have been laid.	Common topics have been identified and analysed(*): - promotion and role of RES* - methodologies for measuring progress of energy efficiency in public heritage buildings* - cost-optimality/cost-effectiveness* - smart financial instruments and policy packages - links between local and national policies On building renovation: - role of the consumer; - data quality/integration; - smartness (in buildings, districts, cities) and smart financing.	Future CA EPBD work on RES integration (primary energy factors, attractive district heating and cooling) and smart buildings could feed into the other CAs' work and stimulate further common effort. Future priority in CAs' collaboration: - opportunities for better control, automation, monitoring (links among EPCs, energy audits, inspection, metering/billing, building automation control); - persuasive information for consumers; - role of ICT and IoT; - how to share responsibilities on long-term renovation strategies.
Better data to monitor and take action on building performance - EU Building Stock Observatory - EPISCOPE - REQUEST2ACTION	Discussion focused on: - combination between CA EPBD Key Implementation Decisions and the EU Building Stock Observatory; - integration and wider use of EPBD databases to help	Integration of Key Implementation Decisions in the EU Building Stock Observatory is at study (a CA EPBD IV working group has been set up). Wider use of EPBD databases can help understand the housing stock, monitor energy efficiency progress	Further investigation is ongoing on the benefit of improved display of and access to Key Implementation Decisions. Further debate on wider use of EPBD databases could address interaction

Topic Contribution from/to	Main discussions and outcomes	Conclusion of topic	Future directions
• EEPPA (Climate-KIC) • BPIE • ZEBRA2020 • Ballarat Consulting	energy efficiency progress monitoring and decision making; • links between EPC and governmental incentives databases. Property value assessment methodologies are hardly comparable. Data on property value are mostly collected from real estate agencies.	and develop a strategy, but it is not a common practice. MSs think it is worth linking public incentives with the improvement in the EPC rating as Article 10 of the amended EPBD requires. Half of them are starting using EPC databases in this sense. Recent studies agree that properties with a higher EPC rating gain a higher price in the majority of MSs.	with EED (Articles 3, 4 and 5). Further integration of CA EPBD Key Implementation Decisions into the Building Stock Observatory. Monitor progress in the effective use of EPC data.
Business models for RES integration and smart buildings • BPIE • CA EED • SmartReFlex • SDH	Interests, roles and needs of stakeholders in energy services business are changing, with an emerging tendency among consumers to invest in private energy generation and building automation. Knowledge of innovative business models was investigated. Main barriers and role of actors were discussed. Attractiveness of RES district heating for stakeholders.	Barriers for RES integration reside in cost, information, grid capacity and skills, social acceptance and usability. Low awareness of solutions like business models and how to link them to existing incentives emerged. There is no clear opinion on who should make the initial investment for the transition. Disruptive market change would require aggregators. Although 25% of MSs find district heating an attractive opportunity, business models are little known (with the exception of surveys from EU projects).	Integration of buildings into the wider energy system, relationships to and impacts on other key sectors (e.g., electro-mobility in the transport sector), role of the consumer and of building energy management systems, de-risking investments, are elements of the 2016 Clean Energy for all Europeans policy package. External stakeholders (e.g., automation industry) should be involved in the discussion. RES district heating local planning, best practices, stakeholder participation and the role of GIS to be further investigated. Tracking business models for district heating and cooling.

Topic Contribution from/to	Main discussions and outcomes	Conclusion of topic	Future directions
Long term renovation strategies • EC JRC • SUNShINE • CA EED • Citynvest • EuroPHit • iBRoad	Level of interaction between long-term strategies for “cost-effective deep renovations of buildings” and the goals of achieving savings in EPBD was investigated. The JRC 2014 and 2017 long-term renovation strategies assessment proved the improvement of compliance to EED Article 4 requirements and existing best practice of new EPBD amended Article 2a issues. One-stop shop and energy poverty concepts and examples have been presented. First experience of assisted step-by-step renovation and individual building passports (EuroPHit, iBRoad).	Compliance of long-term renovation strategies improved from 2014 to 2017 and gaps detected within CA EED and CA EPBD discussions are being filled. Some EU projects proved the success and feasibility of a holistic approach to promote investment. One-stop shops should be customised and user friendly, and should combine the business model with high awareness/skills. The step-by-step approach proves to be flexible in terms of tenure, building type and financial situation, so it is promising for replication in MSs. Sectoral modelling and combined use of both top-down and bottom-up data are rarely practiced in MSs. Long-term renovation strategies evaluation and monitoring and evidence of wider benefits can be still improved.	The renovation rate and depth (step-by-step or one-stage) are to be better linked and brought together. This will be further investigated within the discussion on new Article 2a. Preconditions to integrate step-by-step renovation/building passports into the EPCs for higher recommendation uptake (new Article 2a). Assess impact of combined advice and business models in one-stop shops. Track progress in the definition and integration of energy poverty. Investigate renovation targets and forward-looking perspective. Collaboration with CAs on: • coordination of long-term renovation strategies at national-local level; • building and district smartness; • promotion of investment (aggregation and de-risking);

Topic Contribution from/to	Main discussions and outcomes	Conclusion of topic	Future directions
			data management and policy monitoring.
Heritage buildings and public buildings CA EED	Examples of ways to finance heritage buildings and measure progress were provided.	MSs would welcome an integrated approach involving different responsibilities (teams, ministries) and competences (CA EPBD, CA EED).	Coordination and conflicts of integrated solutions covering EED and EPBD might be further addressed. See CT2 report.
EP calculation standards CEN/TC371 Chair	Feasibility of application of CEN standards.	MSs' brainstorming and feedback.	See CCT1 report.
Compliance and quality QUALICHeCK	Success key factors for better quality of EPC input data and quality of construction works were discussed.	General alignment with QUALICHeCK results. Monitoring and control are not common practice in MS.	See CCT3 report.

4. Lessons Learned and Recommendations

Better building data are a prerequisite for monitoring and decision-making, in particular for building renovation and exemplary public buildings. When combined with wider datasets, EPC data are valuable for monitoring and decision-making, especially if these datasets include information on building products, technical systems and real consumption. Experience reported within EU projects on this subject is not a common practice yet.

In the framework of a CA EPBD IV survey on Key Implementation Decision (KIDs), MSs' delegates agreed for the EPBD KID indicators to be improved. Their integration into the EU Buildings Stock Observatory is under investigation and this could help complementing existing statistics. In doing so, current data gaps in MSs could be reduced, and data visualisation and access to EU building performance data could be improved.

Several opportunities for better integration of EPBD requirements with the EED Article 4 in **building renovation strategies** have emerged. Financial packages with a holistic approach, taking into account the responsibility of the building owner are still rarely deployed. Nevertheless, they are regarded as a successful practice to stimulate cost-effective deep renovations of buildings. A unique definition, solving the dichotomy between "deep renovation" and "major renovation", would be well received by the MSs. The renovation rate and the renovation depth should be better linked.

The CA EPBD participants have little experience in linking existing incentive schemes with business models that can stimulate investment in **RES integration and smart buildings**. MSs consider that including clear requirements for both aspects in the EPBD is recommendable.

The opportunity of a univocal method for the assessment of the technical, environmental and economic feasibility of high-efficiency alternative systems for decentralised energy supply systems based on RES could prompt further collaboration between the CAs. In this framework, calculation of primary energy factors and attractiveness of district heating and cooling systems to fulfil minimum levels of RES in NZEBs are being investigated (the CA EPBD has set up a dedicated working group on this subject, at the agenda of the February 2017 plenary in Malta). These topics have great potential to develop synergies between the three directives.

Smart buildings are a priority in the framework of the EPBD amendment. Considering the novelty of the subject, future CA EPBD meetings will allow for brainstorming with particular focus on ICT solutions for optimal operation of the building and interaction with the grid. Such discussions will benefit from involvement of external stakeholders and other CAs' experience on the role of consumers, investors and demand-response service providers.

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