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Good practice in energy efficiency

Accompanying the document

Proposal for a Directive of the European Parliament and of the Council amending Directive 2012/27/EU on Energy Efficiency

{COM(2016) 761 final}

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Glossary and abbreviations

BPIE	Buildings Performance Institute Europe
BAU	Business as usual
CA	Concerted Action
CoM	Covenant of Mayors
DH	District Heating
EED	Energy Efficiency Directive
EEOSs	Energy Efficiency Obligation Schemes
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
EnPC	Energy Performance Contracting
ESCO	Energy Service Company
ESIF	European Structural and Investment Funds
EFSI	European Fund for Strategic Investment
ERDF	European Regional Development Fund (part of ESIF)
GPP	Green Public Procurement
H2020	Horizon 2020
IEE	Intelligent Energy Europe
MS	Member State
MSA	Market Surveillance Authority
PDA	Project Development Assistance
PEC	Primary Energy Consumption
PPI	Public Procurement of Innovation
RED	Renewable Energy Directive
SEAP	Sustainable Energy Action Plans
SPP	Sustainable Public Procurement
SWD	Staff Working Document

1. Energy efficiency policy works

1.1. Executive summary

Energy efficiency and the "energy efficiency first" principle are at the heart of the Energy Union strategy[1]. Nevertheless, recent years' experience has shown that there are considerable barriers to full uptake of economically effective and technically feasible energy savings opportunities across the EU.[2]

Some commentators complain of a lack of political will in the drive towards energy efficiency, while others point to the complexity, cost, and technical difficulties of delivering large scale gains. While these arguments may to some extent be valid, they overlook the significant progress made in decoupling economic growth from energy use.

Since the first analysis of energy saving potential by 2020, set out in the 2005 Green Paper on Energy Efficiency[3], a major upgrade in energy efficiency capacity has taken place throughout the EU. Energy efficiency policies are working, and are delivering not only in terms of reducing consumption, but in terms of safeguarding Europe's security of supply, reducing CO_2 emissions and leading to monetary and non-monetary benefits for Europe's industry and consumers. This includes vulnerable consumers who are affected by energy poverty.

This Staff Working Document (SWD) presents capacity building activities and good practice derived from policy implementation, technology development and investment in energy efficiency across different sectors and throughout all EU Member States (MS). Projects carried out under the Horizon 2020 Energy Efficiency calls, the Intelligent Energy Europe programme, and the European Structural and Investment Funds programmes have produced many examples of good practice at national, regional and local level. These can serve as blueprints for similar initiatives in other Member States thus allowing for a more systematic uptake of good practice across the EU. The Commission has also recently established a number of support tools that facilitate further the sharing of good practices and capacity building. Furthermore, the projects provide valuable messages and 'on the ground' feedback for policy making.

The large body of evidence for this document on successful policies and measures was provided among others by: Concerted Actions on the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD), the ODYSEE-MURE[4] project, which developed databases on energy efficiency measures and policies across the EU; and the EEW3 project, which produced 10 specific case studies of good policy practice carried out by Member States providing market feedback from experts, business stakeholders, and local and regional actors.

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1 COM(2015) 80 final

2 See for example: ICF International (2015): Study on energy efficiency and energy saving potential in industry and on possible policy mechanisms. Contract No. ENER/C3/2012-439/S12.666002. Available at: https://ec.europa.eu/energy/sites/ener/files/documents/151201%20DG%20ENER%20Industrial%20EE%20study%20-%20final%20report_clean_stc.pdf;
US Department for Energy (2015): Barriers to industrial energy efficiency. Report to Congress. Available at: http://www.energy.gov/sites/prod/files/2015/06/f23/EXEC-2014-005846_6%20Report_signed_0.pdf;
Cagno E et al (2015): Barriers and drivers for energy efficiency: Different perspectives from an exploratory study in the Netherlands, Energy Conversion and Management, Volume 102, pp. 26-38

3 Commission Green Paper, 22 June 2005, "Energy Efficiency - or Doing More With Less", COM(2005) 265 final. Available at: http://eur-lex.europa.eu/legal-content/RO/TXT/?uri=uriserv:l27061

4 Available at www.odysee-mure.eu

1.2. Introduction

- ***GDP has been decoupled from energy consumption in Europe***

In the context of this SWD it is worth noting the following key messages[5]:

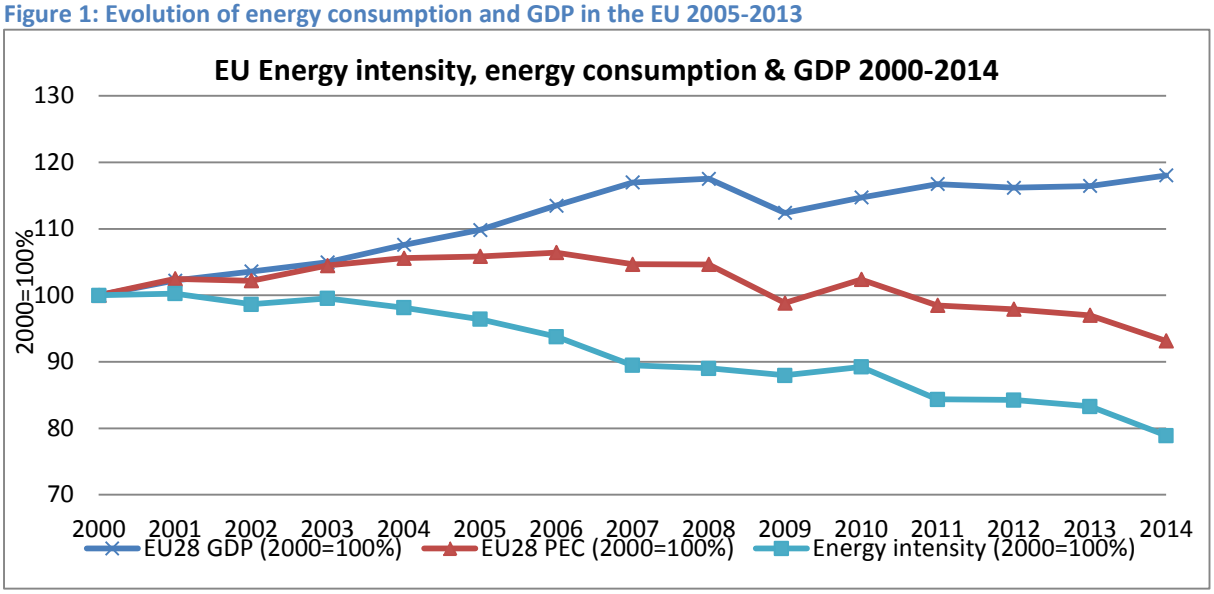
- The EU has managed to decouple energy demand and economic growth[6]. Whereas, in previous years, energy efficiency progress only kept energy demand stable despite economic growth, the present setting clearly underlines that Europe's economy can grow while at the same time achieving absolute energy savings in absolute terms (Figure 1).
- Even during the recent economic and financial crisis, energy savings gained through improved energy efficiency outweighed the demand reduction caused by the economic downturn. As discussed in a variety of literature on 'green growth', energy efficiency can counter the adverse effects of economic downturn and lead to economic growth. Several Member States' energy efficiency action programmes actively rely on this macroeconomic benefit to the economy[7].
- Consumption trends vary – sometimes significantly – from country to country. While this can largely be attributed to supply and demand structures of the energy system, it also reflects the successful experience and early adoption of energy efficiency measures in given sectors. This in turn implies that analysis and exchange of good practice is vital to achieving further energy savings by 2030.

5 COM(2014) 520 final; SWD(2014) 255 final; SWD(2014) 256 final; Saheb Y, Ossenbrink H – JRC (2015): Securing Energy Efficiency to Secure the Energy Union. How Energy Efficiency meets the EU Climate and Energy Goals. JRC Science and Policy Report, Report EUR 27450 EN. Available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC97451/2015-12-09%20securing%20energy%20efficient%20to%20secure%20the%20energy%20%20union%20online.pdf

6 One could argue that energy embodied in imported/exported goods and services of EU28 need to be taken into account when assessing if energy consumption of EU28 decoupled from economic growth. Data on the energy embodies in the imported/exported goods is not available. However it is assumed here that the conclusion that EU28 decoupled energy demand and economic growth holds because Eurostat data shows that exports of goods and services from the EU28 increased more than imports from the EU28 from 2005 onwards.

7 See for example the analysis of the German National Action Plan on Energy Efficiency (NAPE) in Fraunhofer ISI (2015): Identifying instruments to realise final energy savings in Germany based on a cost-benefit analysis. Scientific support to develop the National Action Plan on Energy Efficiency (NAPE). Available at: http://www.isi.fraunhofer.de/isi-en/x/projekte/nape_331600.php; Ringel, Schlomann et al (2016): Towards a green economy in Germany? The role of energy efficiency policies. Applied Energy. doi:10.1016/j.apenergy.2016.03.063

Figure 1: Evolution of energy consumption and GDP in the EU 2005-2013

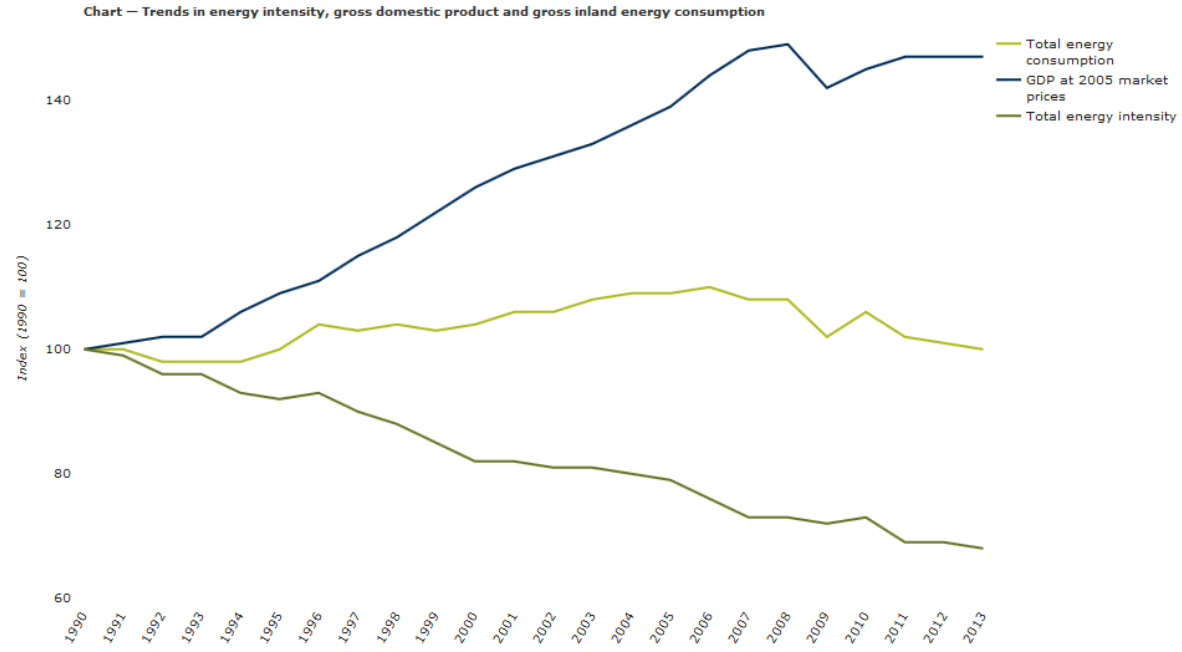


Source: Eurostat

- ***Decoupling: what happened and how it happened***

Decoupling of energy consumption from economic output (GDP) is confirmed by the decreasing indicator of 'energy intensity'. Between 1990 and 2013, energy intensity declined by 1.7% per year in the EU-28 countries. In 2013, energy intensity was 32% below the 1990 level in the EU-28. The period 1990-2005 is characterised by relatively high economic growth and the more modest growth of gross inland energy consumption. The period 2005-2013 is characterised by much smaller economic growth and decreasing gross inland energy consumption (Figure 3)[8].

Figure 2: EU Energy intensity, energy consumption & GDP 1990-2013



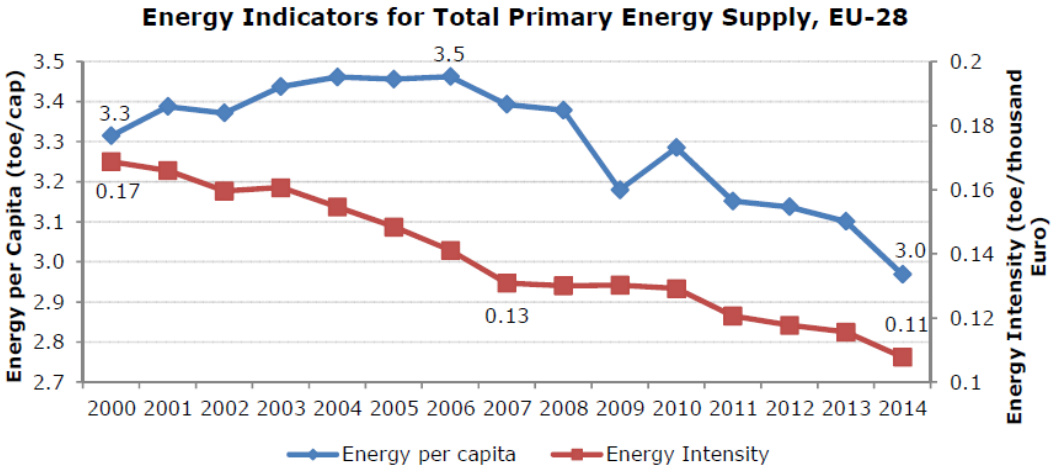
Source: EEA 2015 based on Eurostat data

8 European Environment Agency 2015, http://www.eea.europa.eu/data-and-maps/indicators/total-primary-energy-intensity-2/assessment

Clearly, 2006 marked a turning point in energy efficiency progress. Until then, gains in energy efficiency largely kept energy consumption steady against strong economic growth. From 2006 onwards, energy efficiency gains led to an absolute reduction in consumption while maintaining economic growth at the same time.

According to the recent report from the JRC[9], energy intensity declined from 0.17 to 0.11 toe/thousand Euro in the period 2000-2014 due to several factors such as structural changes in recent years in the overall economy and technological improvements, together with the positive impact of energy efficiency policies both at European and national level.

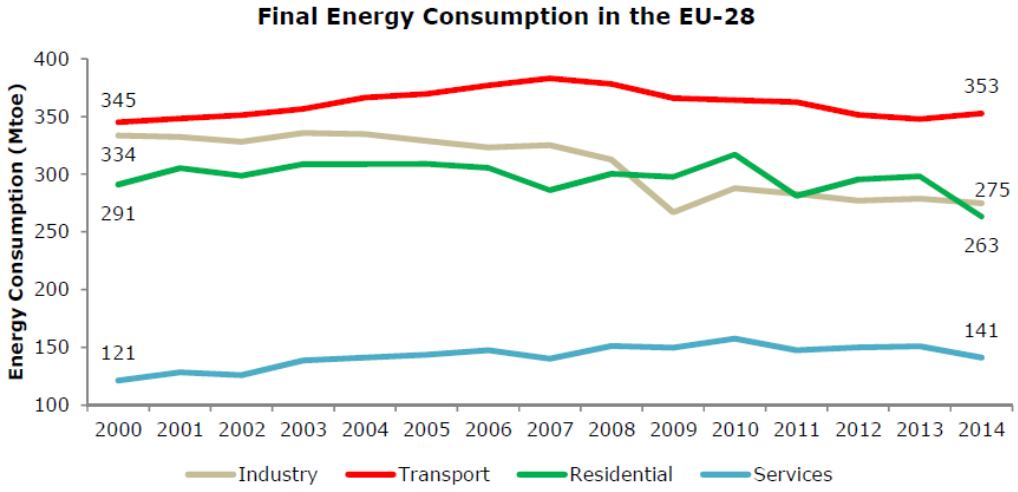
Figure 3: Energy indicators for total primary energy supply, EU-28



Source: JRC (2016): Energy Consumption and Energy Efficiency Trends in the EU-28 2000-2014

The final energy consumption in EU-28 shows a decrease of 6.3% between 2000 and 2014 and the following sectoral decomposition (Figure 4).

Figure 4: Final energy consumption in the EU-28



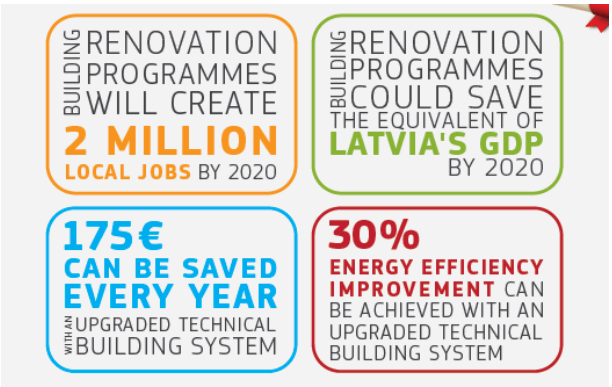
Source: JRC (2016): Energy Consumption and Energy Efficiency Trends in the EU-28 2000-2014

It is hard to distinguish a dedicated policy effect on the individual consumption sectors like

[9] Bertoldi P, Lopez Lorente J, Labanca N – JRC (2016): Energy Consumption and Energy Efficiency Trends in the EU-28 2000-2014; available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC101177/report%20energy%20trends%202000-2014_19.05.2016_final-pdf.pdf

households and tertiary sector as this cannot be deducted from statistics. Still factual evidence can help to trace the large impact of energy efficiency policies:

- With the EU Directive on *Energy Performance of Buildings* in 2004, mandatory efficiency standards for new buildings were introduced and continuously tightened while becoming broader in scope. This implied that all new buildings in the EU needed to perform to minimum standards or above. In many countries this triggered private interest in going beyond the minimum standards or in broadening the perspective to energy-saving refurbishment of the existing building stock. This was for example largely the case with the KfW building programmes in **Germany**.
  The evaluation of the EPBD (2010/31/EU) in 2016 shows clear progress in tackling the efficiency of the buildings sector: the decrease in energy consumption per floor area (kWh/m²) accelerated markedly after 2006 (the application date of the 2002 EPBD), and was further sustained by the effect of the recast EPBD in 2013 and 2014. There is evidence of around 37 Mtoe additional final energy savings in 2013 compared to the 2007 baseline of the recast EPBD. This indicates that the Directive is likely to deliver the expected impacts by 2020.



- *Labelling* in terms of household equipment and office equipment (energy star) increased consumer awareness of energy consumption. This, combined with higher energy costs, led to a clear pull-factor for energy efficient appliances.
  With the *Ecodesign* Directive, minimum standards were subsequently introduced for product groups. The worst-performing energy guzzlers were gradually and very publicly taken off the market. This, in turn encouraged industry to come up with new products complying with or exceeding the minimum standards.

  Analysis of 35 product groups shows the following main results for the EU-28 in 2020[10]:

- Close to 6900 PJ (165 Mtoe, 1918 TWh) primary energy saving, i.e. a saving of 18% for the average product;
- Nearly 52% of the 2020 savings comes from the residential sector, 31% from the tertiary sector, 14% from the industry sector and 3% from other sectors[11].
- 319 Mt CO_2 equivalent (7% of 2010 EU-total) less greenhouse gas emissions;
- EUR 112 billion net saving on consumer expenditure;
- EUR 57 billion extra revenue for industry, wholesale, retail and installation sector;
- 0,8 million extra direct jobs for industry, wholesale, retail and installation sector[12].

Figure 5 shows that there is a good match of the Ecodesign impact accounting and the aggregate Eurostat energy balance data, which starts decoupling the 'business as usual' (BAU) scenario from 2006.

10 The study "Ecodesign Impact Accounting – Status January 2016" Van Holsteijn en Kemna B.V. (VHK)

11 Other sectors include e.g. the energy sector, and agriculture and forestry

12 Direct jobs means jobs in the value-added chain. Indirect employment effects may be higher by a factor of 3 to 5 higher, but no consensus agreed factor is available.

Figure 6 emphasises that, not unexpectedly, space- and water heating products and lighting are the main sources of savings.

Figure 5: Comparison of data from Ecodesign impact accounting (Ecodesign: coloured graph; BAU total: dotted orange line) versus Eurostat energy balance outcomes (dark blue line), for the EU residential electricity consumption in TWh/a (VHK, March 2016)

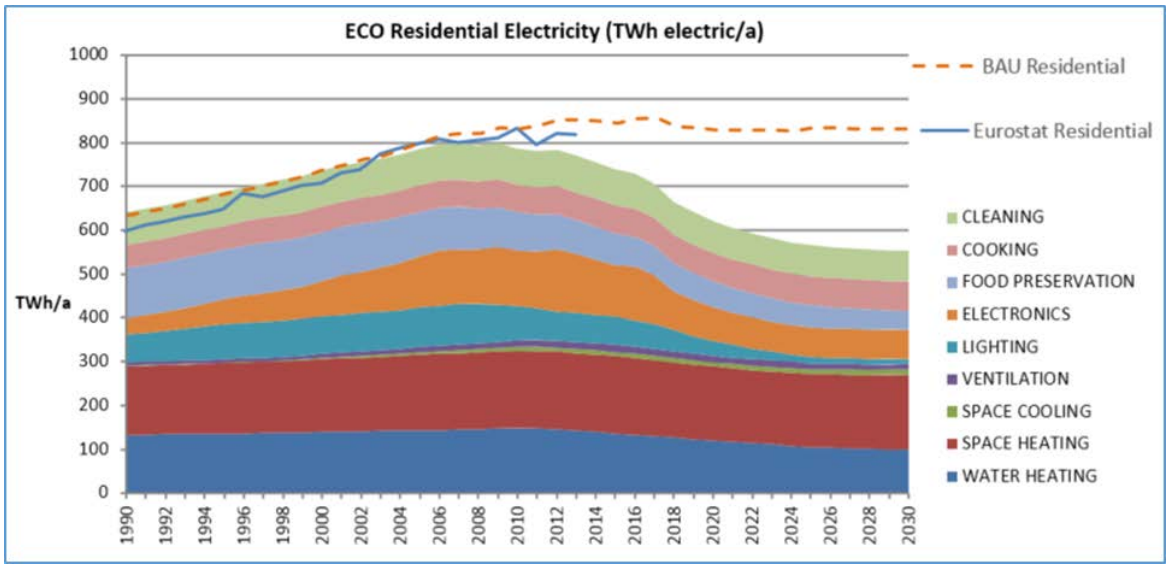
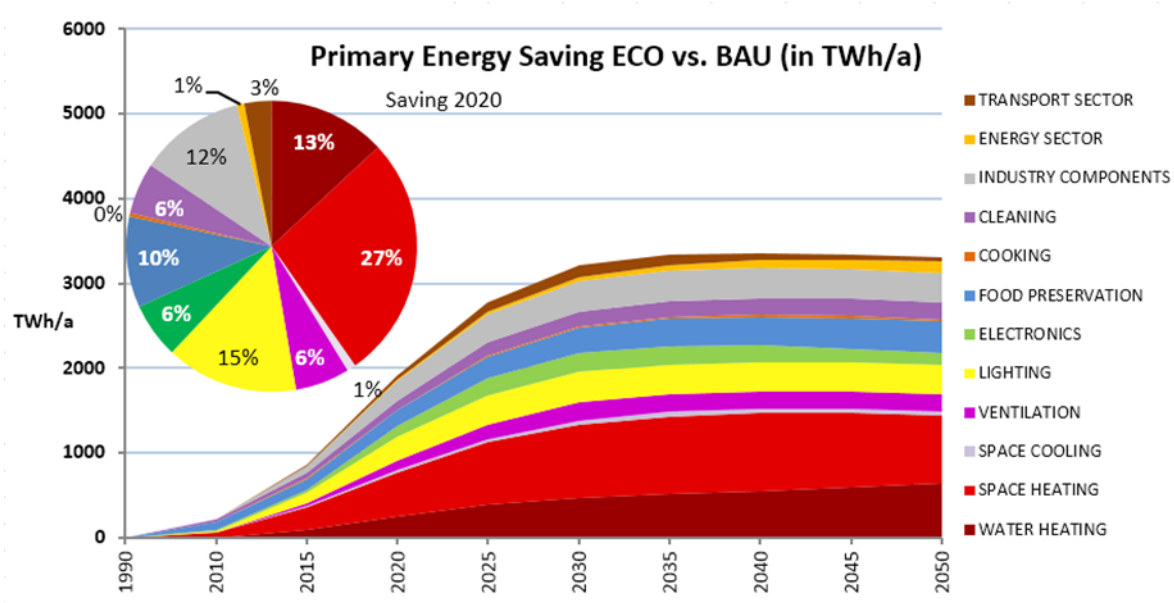


Figure 6: Primary energy saving of products in Ecodesign impact accounting



Source: "Ecodesign Impact Accounting – Status January 2016" Van Holsteijn en Kemna B.V. (VHK)

- Securing *political commitment for energy efficiency*: the 2006 Energy Services Directive introduced many measures and actions aimed at turning government attention for energy efficiency into concrete actions. It asked for the public sector to take a leading (exemplary) role.
- *Capacity building and aligning policies to EU best practice*: with the introduction of regular National Energy Efficiency Action Plans, governments started to systematically analyse and work on their energy saving potential. The process leads to stronger coordination between energy efficiency stakeholders both nationally and internationally. With the Concerted Actions on the EPBD and the Energy Saving Directive and later the EED, good governance and the exchange of best practice instruments became easier and more systematic than before.

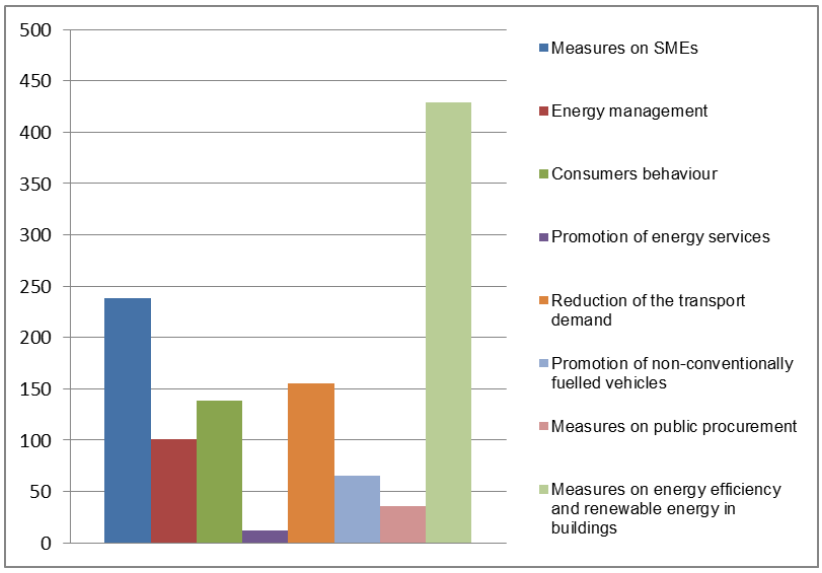
- *Developing marketable energy efficiency solutions*: with the obligation to foster energy service markets, to set up energy audits and notably to reduce energy consumption via energy efficiency obligation, strong signals have been sent to the markets that energy efficiency is a marketable good associated with many benefits for the consumer.

Repeated iterations to improve energy efficiency policy lead to a regulatory framework which delivers the decoupling of economic growth and energy consumption.

- ***Energy efficiency opportunities: policies are working to a large extent and more could be done***

As discussed above, energy efficiency policies play a key role in the transition to a more competitive, secure and sustainable energy system. At present, the MURE database on energy efficiency measures lists some 995 energy efficiency policies and measures in the EU (for distribution see Figure 7 and Figure 8)[13]. This clearly shows the need for good policy coordination, but on the other hand the large pool of policy measures offers the advantage that best practices can be identified[14] and introduced in other countries. This creation of positive synergies and learning curves among Member States has been a central theme of the Horizon 2020 Energy Efficiency calls for proposals and the predecessor programmes Intelligent Energy Europe I and II. In turn, the projects funded under these programmes allow for feedback on policy design from the local level which can help to improve policy-making.

Figure 7: Energy efficiency measures in place in the EU 28- distribution per topic and target group (status 2016)

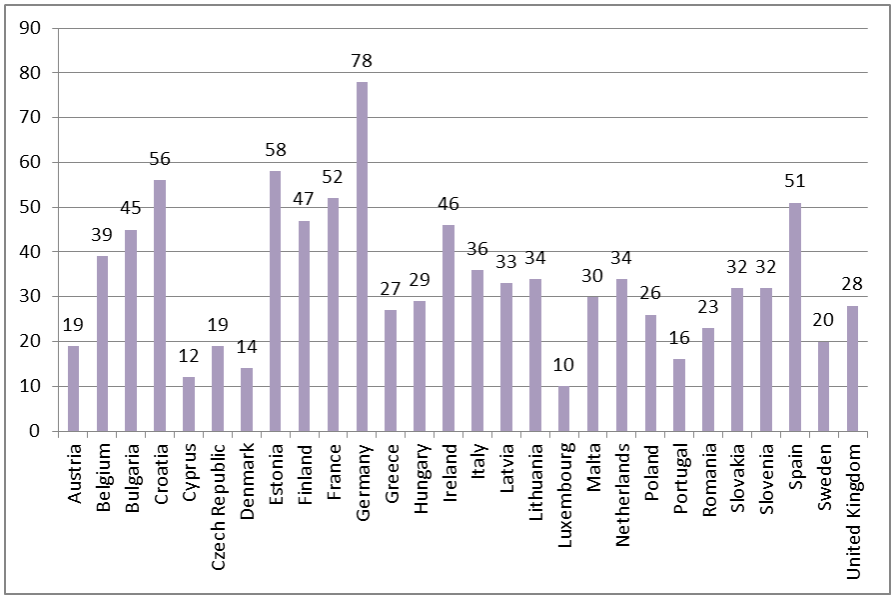


Source: Based on data from MURE database

13 ODYSEE-MURE Project (2016). Available at: http://www.measures-odyssee-mure.eu/

14 In the present tender ODYSEE-MURE has undertaken an in-depth analysis of best practice instruments per Member States based on a scoring system. The measures highlighted as best practices can be found in Annex I. Odyssee-Mure (2015): Synthesis: Energy Efficiency Trends and Policies in the EU. Available at: http://www.odyssee-mure.eu/publications/br/synthesis-energy-efficiency-trends-policies.pdf

Figure 8: Energy efficiency measures in the EU 28- distribution per country (status 2016)



Source: Based on data from MURE database

Barriers often hinder effective deployment of energy efficiency measures as is highlighted in the ODYSEE-MURE project[15]. By contrast to other energy policy fields, effective energy efficiency policies need to address dispersed saving potential in different sectors across the economy as well as dealing with a multitude of actors. This implies that the still considerable energy savings potential of the EU is a sum of many individual actions and projects which would be implemented nationally, regionally or locally.

In addition to applying energy saving measures to current infrastructures and systems, it is crucial to provide the basis for future efficiency gains through targeted research and development. New key enabling technologies need to be developed and deployed, e.g. by substituting currently used materials with advanced materials that inherently would guarantee better energy efficiency of houses or industrial transformation processes. New cost-efficient technological solutions for energy efficient buildings will enable the massive deployment of NZEB or energy-plus buildings, and innovation in resource- and energy efficiency in the process industry will permit to reduce its energy demand and its CO2-emissions.

[15] ODYSEE-MURE (2016). Policy Scoreboard - Output-based scoring (related to 2020 energy efficiency targets). For details on methodology see http://www.measures-odyssee-mure.eu/scoreboard-energy-efficiency-policy_mix.asp?cosa=3

2. Cross-cutting measures to support energy efficiency

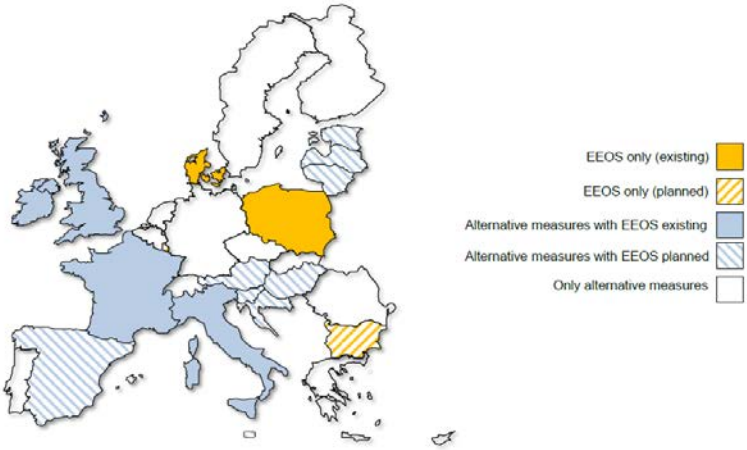
2.1. Energy Efficiency obligations

- ***Policy context***

In order to support final consumers to identify and implement energy savings, Article 7 of the Energy Efficiency Directive (EED) requires Member States to put in place Energy Efficiency Obligation Schemes (EEOSs) or use alternative policy measures to deliver a targeted amount of energy savings[16] amongst final energy consumers. Key rationale of the EEOSs is that energy suppliers, retailers and distributors are best placed to identify energy savings with their customers and will be able to achieve energy savings into business models for energy services.

All Member States have by now submitted their 2020 saving targets which amount to 230.2 Mtoe, out of which EEOSs are expected to deliver 86 Mtoe[17]. Four Member States (**Denmark, Bulgaria**[18], **Luxembourg**[19], **Poland**) intend to rely on EEOSs only, whereas 12 Member States have chosen to achieve the saving targets by a combination of EEOSs and alternative measures or alternative schemes alone (figure 9). The other Member States chose to fulfil Article 7 by using alternative measures[20].

Figure 9: Status of article 7 EED measures



Source: Ricardo AEA/CE Delft (2016)

Overall, some 480 measures have been notified.[21] The cumulative savings expected show that by and large, EEOSs would deliver the largest impact (34% of total savings), followed by financing schemes

16 The energy savings to be achieved by EEOSs and/or alternative measures must be at least equivalent to achieving new savings each year from 1 January 2014 to 31 December 2020 of 1.5% of the annual energy sales to final consumers of all energy distributors or all retail energy sales companies by volume averaged over the previous three consecutive years 2010-2012.

17 http://ec.europa.eu/energy/en/topics/energy-efficiency-directive/obligation-schemes-and-alternative-measures

18 For a description of the planned EEOSs in Bulgaria see Odyssee Mure (2015): BG 25: Energy Efficiency Obligation Scheme. Available at: http://www.measures-odyssee-mure.eu/public/mure_pdf/general/BG25.PDF

19 For a description of the planned EEOS in Luxembourg see Odyssee Mure (2015): GEN-LUX9 EU related : Directive 2012/27/EU – Energy Efficiency Obligation Scheme. Available at: http://www.measures-odyssee-mure.eu/public/mure_pdf/general/LUX9.PDF

20 Ricardo AEA/CE Delft (2016): Study on evaluating the implementation of Article 7 of the EED

21 361 measures are documented in detail in the Odysee Mure database. See http://www.measures-odyssee-mure.eu/output1A_all.asp

or fiscal incentives (19% or 49 Mtoe) and energy or CO_2 taxes (14% or 34 Mtoe).[22] It remains to be seen which scheme will deliver the savings at the lowest prices (cost effectiveness) as this strongly depends on actual implementation on the ground in the different Member States.

- ***Project feedback on Energy Efficiency Obligations***

In order to facilitate and accompany the implementation of Article 7 EED, a number of projects in the Horizon 2020 Energy Efficiency programme have focussed on retrieving lessons learned and establishing best practices on the overall schemes or technical details of them[23]. Contrary to the five EEOSs existing before the EED (**Belgium** (**Flanders**), **Denmark, France**, **Italy** and **the UK**)[24], the seven new EEOSs are presently in their set-up phase which limits the number of lessons learned in these cases. The review and analysis of certain design and implementation features of the existing schemes allowed the projects to identify good practices, even though this is still work in progress.

The **Danish** Energy Efficiency Obligation Scheme (Box 1)[25] shows the following success factors: large choice for the obliged parties to opt for measures; recurring revision and adaptation of the scheme and incentives with target actions with longer lifetimes such as building refurbishment[26]. These success factors help to explain the overall positive mood of **Danish** energy efficiency experts in a survey on the achievement of the Article 7 EED target in Denmark performed by the Energy Efficiency Watch project[27].

22 Ricardo AEA/CE Delft (2016): Study on evaluating the implementation of Article 7 of the EED

23 Concerted Action on the EED; ENSPOL, Energy Efficiency Watch III, Odyssee-Mure, EU-Merci, among others.

24 See ENSPOL (2015): Energy Saving Policies and Energy Efficiency Obligation Scheme. D2.1.1: Report on existing and planned EEOSs in the EU – Part I: Evaluation of existing schemes. Available at: http://enspol.eu/sites/default/files/results/D2.1.1%20Report%20on%20existing%20and%20planned%20EEOs%20in%20the%20EU%20-%20Part%20I%20Evaluation%20of%20existing%20schemes.pdf?v=2.

25 Analysed by the *Energy Efficiency Watch 3* project among its 10 case studies on best practices in the Member States*; Energy Efficiency Watch (2015): Energy Efficiency Policies in Europe: Case study: The Danish Energy Efficiency Obligation Scheme*. Available at: http://www.energy-efficiency-watch.org/fileadmin/eew_documents/EEW3/Case_Studies_EEW3/Case_Study_EEO_Denmark_final.pdf

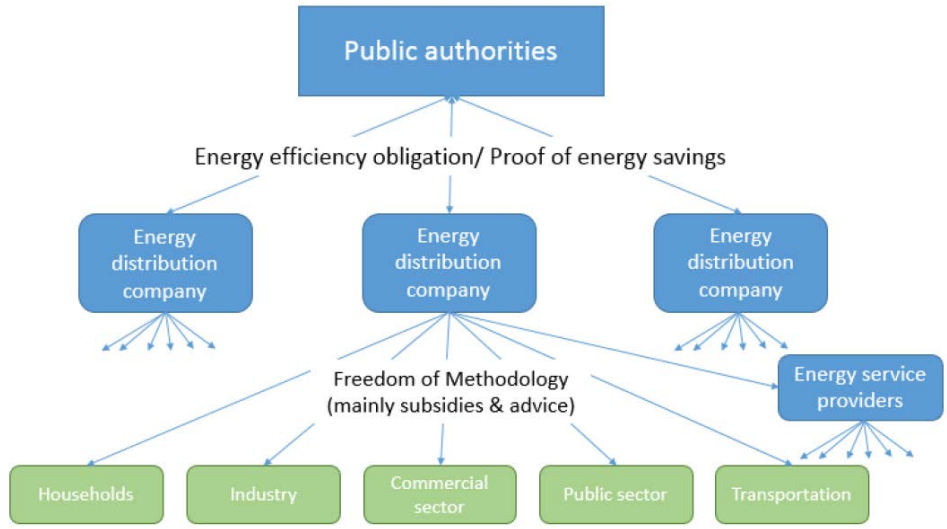
26 big EE (2013): Policy Guide. Online: http://www.bigee.net/en/policy/guide/buildings/policy_examples/42/; Bundgaard, S.S.; Togeby, M.; Dyhr-Mikkelsen, K.; Sommer, T.; Kjærbye, V.H.; Larsen, A.E. (2013): Spending to save: evaluation of the energy efficiency obligation in Denmark. ECEEE Summer Study Proceedings; ENSPOL (2015): Energy Saving Policies and Energy Efficiency Obligation Scheme. D2.1.1: Report on existing and planned EEOSs in the EU – Part I: Evaluation of existing schemes ; Fraunhofer ISI (2014): Kosten-/Nutzen-Analyse von Instrumenten zur Realisierung von Endenergieeinsparungen in Deutschland. Ausgestaltungsoptionen und Bewertung von Instrumenten und möglicher Instrumentenkombinationen für Deutschland; IEA (2012): Best Practices in Designing and Implementing Energy Efficiency Obligation Schemes. Research Report, Task XXII of the International Energy Agency Demand Side Management Programme. Prepared by: The Regulatory Assistance Project

Box 1: The Danish Energy Efficiency Obligation Scheme in a nutshell

Profile

Country	Denmark
Name of policy	Energy Savings Agreement
Type of policy	Energy Efficiency Obligation Scheme
Target sector	All energy sectors (overarching EE governance framework)
Actions targeted	All actions leading to energy savings
Duration	Started in 2006, current period runs from 2012 – 2020, agreement is renegotiated every three years
Overall target and/or achievements	Target: more than 2% of total energy consumption measured as the first year savings relative to annual final energy consumption (0.287 Mtoe/yr (12PJ/yr) of first year savings each year
Overall aim of the policy	Promoting cost-effective energy savings in all end-user sectors of the economy
Innovativeness	Combination with energy audits

Functioning



Source: Energy Efficiency Watch (2015); Fraunhofer ISI (2014)

Given that the EEOSs operate in a national context to trigger additional synergies to other existing policy instruments, many schemes have particular features which can serve as role models or good practice for other countries. In this respect, **Italy** remains the only country which has tradable White Certificates in place. Certificates can be generated by energy managers implementing savings in the industry and buildings sectors, thus creating incentives for putting energy management systems in place[28]. According to the Ministry of Economic Development, from 1 January to 31 October 2013, more than 14 000 projects were completed and 5 million White Certificates were issued. From the

[28] Certificates are not only given to the obligated parties but also to voluntary participants (energy distributors with less than 50 000 customers, energy service companies, entities required to appoint an energy manager, entities which have voluntarily appointed an energy manager, entities that have implemented an energy management system conforming with ISO 500001 (Italian Energy Efficiency Action Plan 2014)). This enhances the effect of the Energy Manager Obligation. Particularly in the two years 2013 and 2014, the total impact more than doubled due to the changes that made the link with the energy manager obligation bear fruit and led to the majority of savings and certificates now originating from the industrial sector. The result was that the industry sector became a main participant in the system with a share of 95% of certificates. See Energy Efficiency Watch (2015): Energy Manager and White Certificate Scheme Italy. Available at: http://enspol.eu/sites/default/files/Lessons%20learnt%20from%20the%20Italian%20white%20certificate%20scheme.pdf

start of the programme until 2014, 6 Mtoe of additional savings were delivered, triggering investment of EUR 600 million per year[29]. Particularly in the years 2013 and 2014, the total impact more than doubled due to the changes that made the link with the energy manager obligation bear fruit and led to the majority of savings and certificates now originating from the industrial sector. The result was that the industry sector became an active participant in the system[30].

A similarly outstanding feature of the **French** Energy Saving Certificates (ESCs or white certificates)[31] is the dedicated inclusion of the transport sector and the strong linking of the system to the end users. This link is established by incentives such as low interest loans for investments in eligible energy savings measures, direct subsidies that reduce the price of eligible measures or rebates[32] to beneficiaries that declare a measure they installed was a result of the obligated party, and bonuses to installers who promote the measures to energy users on behalf of the obligated party. A few chains of hypermarkets or DIY stores grant these rebates to their customers via vouchers exchanged against the invoices for works improving houses energy performance. During the period 2011-2014, the system lead to the installation of 1 million of energy efficient individual boilers, 480 000 wood-burning/biomass stoves and collective boilers in 400 000 apartments. It is expected that the ESC will trigger almost EUR 3 billion worth of investment in the present period (2014-2017).

Figure 10: Rebate voucher "prime énergie"

Source: http://www.hyper-actu.com/prime-energie

There is not one EEOS like the other, this, in turn, allows for the uptake of good practices to fit to national circumstances[33]. For example the **Polish** energy certificate scheme was set up after a thorough analysis of the existing schemes in place. **The UK** is planning to devolve its national EEO system to the regional level, allowing for the uptake of regional and local concerns in the system[34]. **Ireland** and **the UK** have ring-fenced a certain amount of actions triggered by the EEOSs to energy

29 Di Santo, Dario; Tomassetti, Giuseppe; D'Ambrosio, Stefano (2014): White Certificates in Industry. http://www.iepec.org/conf-docs/papers/2014/Dario%20Di%20Santo.pdf

30 EEW3 Case Study *Energy Manager Obligation and White Certificate Scheme – Italy* *http://www.energy-efficiency-watch.org/fileadmin/eew_documents/EEW3/Case_Studies_EEW3/Case_Study_Manager_White-Certificates_Italy_final.pdf*

31 The Energy Saving Certificates (ESCs or white certificates) were introduced in France in 2005 as a means of reducing final energy consumption in sectors with dispersed activity. While the main focus of this policy is to reduce energy uses in residential, commercial, and public buildings, the scheme also includes light industry, agriculture and transport activities. The scheme targets all final energy consumers: i.e. the residential, commercial, public, industrial, agricultural, and transportation sectors. Under the French ESC scheme, obligated energy companies must demonstrate they facilitated the achievement of energy savings in order to gain ESCs. The French energy efficiency obligation is implemented over individual "periods" which are set to run over 3 years with increased savings requirements. For the present period (2014- 2017) a target of 700 kWh cumac, twice as much as for the second period, is to be reached. See Odysse Mure. http://www.measures-odyssee-mure.eu/scoreboard-energy-efficiency-policy.asp

32 Prime-énergie of up to 2000€.

33 The ENSPOL project (http//:enspol.eu) cross-analysed various existing EEOSs

34 http://www.smith-commission.scot/wp-content/uploads/2014/11/The_Smith_Commission_Report-1.pdf

poor households. **Slovenia** intends to follow this stance[35].

The Concerted Action EED, implemented to support the Member States with best practices on the implementation of the Directive, analysed EEOSs in detail and produced a number of publicly available reports and presentations[36]. The 2015 report on Energy efficiency obligation schemes, monitoring impacts of eligible measures contains a collection of good practices identified with present policy actions[37]: Furthermore, the analysis allows to clarify and exchange practices on all technical aspects of article 7 EED, leading to common understanding between Member States and their respective policy instruments[38]. Apart from the support of the uptake of EEOSs by facilitating technical and practical aspects, several projects helped to carve out conclusions aiming at optimising the design of the EEOSs so as to maximise their energy saving impacts (Box 2).

Box 2: Successful design features of EEOSs

ENSPOL underlines "the flexibility of EEO as a policy instrument, and its adaptability to national circumstances and policy priorities. The challenge for EEOSs is adapting to continue to deliver savings, as the low-cost mass market technological savings opportunities reduce." and concludes[39]:

- An effective EEOS needs to achieve a **balance between rules and procedures that are simple enough** for obliged parties to work with, while being complex enough to **meet requirements for additionality, flexibility, auditability and transparency**. Having a catalogue of standardized actions listing best practices in terms of energy efficiency measures and deemed savings that can be expected from these measures can be very effective.
- Policy-makers - certainly in the building sector - have to pay attention to avoid setting up barriers or lock-ins for such interesting, long term solutions, by focusing on only low hanging fruits. In the long term, deep savings are required and therefore, a shift away from low hanging fruit will be inevitable. Therefore, the demand sectors, technology and energy service providers should be **oriented towards long term solutions**.

The above examples show that EEOSs can be combined with alternative measures such as energy audits, energy advice or financial support for energy efficiency improvements so as to create positive synergies[40]. At present it is too early to identify good practices in this field given the strong diversity of the individual policy packages and limited experience with the implementation. On the ground analysis shows that many Member States which have so far opted for alternative measures would

35 ENSPOL (2015): Report on existing and planned EEOSs in the EU - Part II Description of planned schemes. Available at: http://enspol.eu/sites/default/files/results/D2.1.1%20Report%20on%20existing%20and%20planned%20EEOs%20in%20the%20EU%20-%20Part%20II%20Description%20of%20planned%20schemes.pdf?v=2

36 CA EED – Core theme 8. http://www.ca-eed.eu/themes/obligation-schemes-and-monitoring-ct8

37 Thenius G/Concerted Action EED (2015): Energy efficiency obligation schemes, monitoring impacts of eligible measures. Available at: http://www.ca-eed.eu/themes/obligation-schemes-and-monitoring-ct8/energy-efficiency-obligation-schemes-monitoring-impacts-of-eligible-measures3

38 See for example Kulevska T / CA EED (2015): Methods for the calculation of energy savings. Available at: http://www.ca-eed.eu/themes/obligation-schemes-and-monitoring-ct8/executive-summary-8.6-methods-for-the-calculation-of-energy-savings-different-approaches-and-comparability

39 ENSPOL (2015): First Policy Brief. Available at:http://enspol.eu/sites/default/files/1st%20ENSPOL%20Policy%20Brief.pdf

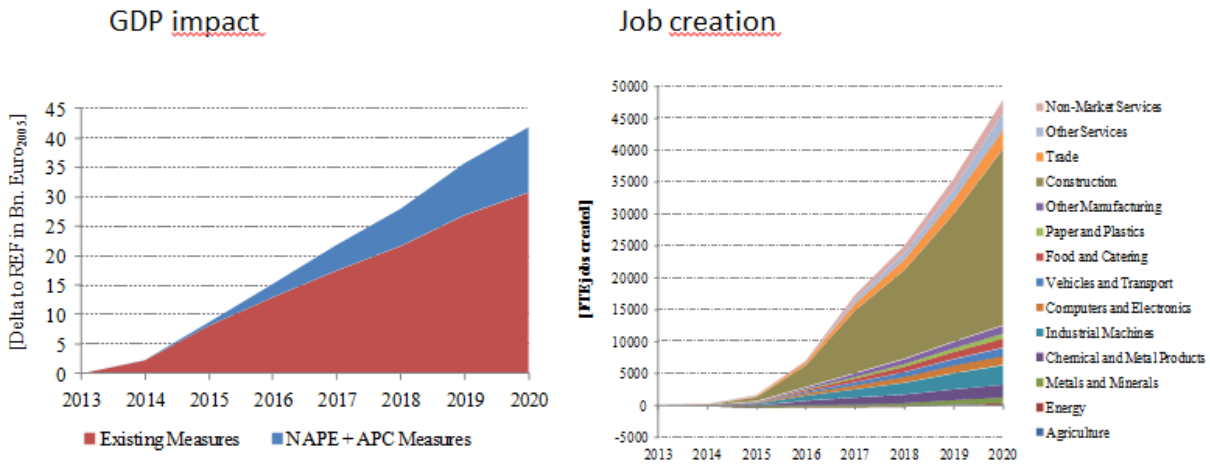
40 For a comprehensive review see ENSPOL (2015): Combining of Energy Efficiency Obligations and alternative policies. Available at: http://enspol.eu/sites/default/files/results/D5.1Combining%20of%20Energy%20Efficiency%20Obligations%20and%20alternative%20policies.pdf

have the institutional, operational and economic capacity to set up a national EEOS[41]. With this it can be expected that further hybrid systems combining EEOSs and alternative measures will be developed.

Whereas all Member States have identified energy saving targets and expected outcomes of the individual schemes, only few modelling estimates on the economic benefits triggered by Article 7 EED and the subsequent upgrade of energy efficiency policies exist. In case of the policy bundle assembled by the **German** NAPE (National Action Plan on Energy Efficiency) and the Action Programme on Climate Change (APC) macroeconomic modelling suggests that the benefits for economic growth and net employment increase are tangible (Figure 11)[42].

It can be expected that similar positive impacts will be triggered in most other Member States as well, underlining the role of Article 7 EED as a policy driver.

Figure 11: Overview of macroeconomic impacts of NAPE and APC policy bundle in Germany



Source: Ringel M, Schlomann, B et al. (2016)

- ***Key findings***

When analysing the set of alternative measures, it shows that many instruments have been upgraded or revised. The same can be found with the existing EEOSs. *"EEOSs have delivered in general very substantial improvements in energy efficiency within the member states. They have demonstrably been a factor in a large fraction of the energy efficiency improvement achieved. Placing obligations on energy suppliers in a competitive market has been successful in that targets have, with rare exceptions, been delivered. In addition, EEOSs have developed incrementally and grown steadily in scale, resulting in growing targets over the years (higher savings realized). Many of the existing schemes started with low targets, but were increased over time, allowing a "learning" period for*

41 ENSPOL (2015): Report on Context Profiles of EU MS countries - Part III Context analysis of countries with EEOSs. Available at: http://enspol.eu/sites/default/files/results/D2.1.2%20Report%20on%20Context%20Profiles%20of%20EU%20MS%20countries%20-%20Part%20III%20Context%20analysis%20of%20countries%20with%20EEOs.pdf?v=2

42 NAPE and APC instruments could achieve cumulated annual energy savings of 241,2 PJ FEC and 394,2 PEC by 2020, leading to a reduction in greenhouse gas emissions of 24,2 Mt CO_2e. Additional NAPE and APC measures could help consumers and industry to avoid fuel costs of EUR 90-100 billion, and trigger additional investments of at least EUR 70-80 billion. These investments in turn mean Germany's GDP would grow by 0,4% to 2,6% and about 48 000 additional full-time-equivalent jobs are created compared to a reference scenario. Ringel M, Schlomann B, Krail M, Rohde C (2016): Towards a green economy in Germany? The role of energy efficiency policies. Applied Energy, doi:10.1016/j.apenergy.2016.03.063

subject under the obligation"[43].

Policy feedback resulting from the good practice analysis

- **Article 7 EED has been a key driver for enhanced energy efficiency action** with tangible energy saving, economic, social and environmental benefits.
- The set-up of EEOSs has necessitated increased capacity building but the **availability of various national models has allowed for the uptake of good practice** features for additional EEOSs. **EEOSs are expected to deliver the highest amount of cumulative energy savings** by 2020.
- EEOSs put a strong emphasis on developing new business models for suppliers and the delivery of cost efficient energy efficiency services at competitive prices.
- Almost all existing EEOSs **were made more stringent by successive revisions** so as to fine-tune the systems.
- Key feature of the revisions where maintaining the cost-effectiveness of the EEOSs while at the same time setting a **framework for targeting long-term savings**, especially in the buildings sector.
- Given the technical complexity of EEOSs, the systems need to strike a balance between ambition and administrative burden. In this sense, a **simplification might be envisaged.**
- EEOSs put a strong emphasis on developing new business models for suppliers and the delivery of cost efficient energy efficiency services at competitive prices.
- With development of the demand-response market the obliged parties could have additional potential to fulfil, in a cost-effective manner, the EEOSs through smart energy management services ensuring energy savings and an optimised energy use.
- Based on the provided examples a conclusion can be drawn that a successful implementation of EEOSs is conditioned to **right channelling of measures** to targeted group of end-users and **building synergies** with other measures or programmes (e.g. central government and local authority funding).

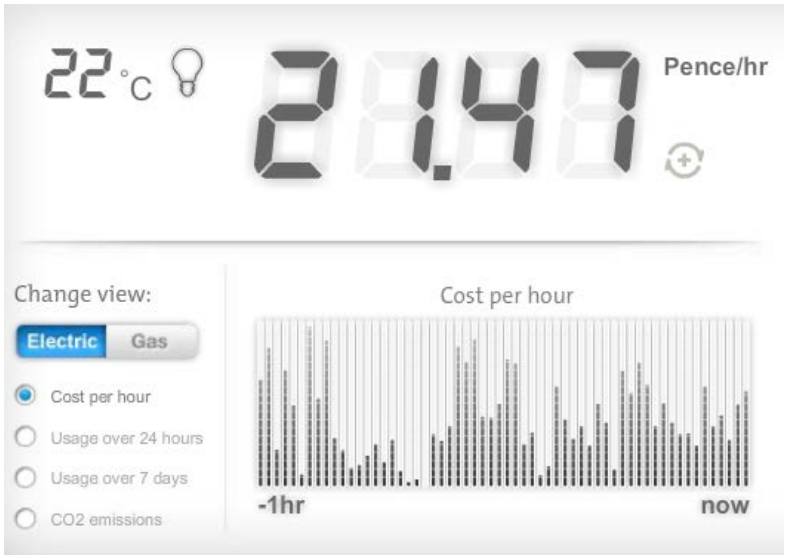
2.2. Informing and empowering consumers through metering and billing

Smart meters allow customers a real time feedback on their energy consumption (Figure 12). This in turn allows consumers to take control of their energy bill and identify and suppress unnecessary energy consumption. Rather than waiting for annual bills, consumers can have an immediate and accurate feedback on their spending on electricity and gas. They will be able to compare this feedback to previous consumption periods or benchmark values to detect and implement energy saving options.

Real time and direct feedback is necessary to harness the full energy savings potential of smart meters with the direct feedback through In-House Displays presenting the bigger savings[44].

[43] Source: ENSPOL

Figure 12: Smart meter display



Source: British Gas[45]

Art. 9-11 EED refer to the roll out of smart meters which is basically foreseen in the internal electricity and gas market directives (2009/72/EC and 2009/73/EC). As a consequence, a majority of Member States have started large-scale roll-out programmes (Figure 13). According to analysis by the European Commission, EUR 195 million electricity smart meters will be installed in 16 Member States covering 72% of consumers. The early actors have been Sweden and Italy, followed by Finland and Malta. For gas, 45 million smart meters will be installed in seven Member States with wide roll-out announced by 2020. These meters will cover 40% of gas consumers in the EU[46].

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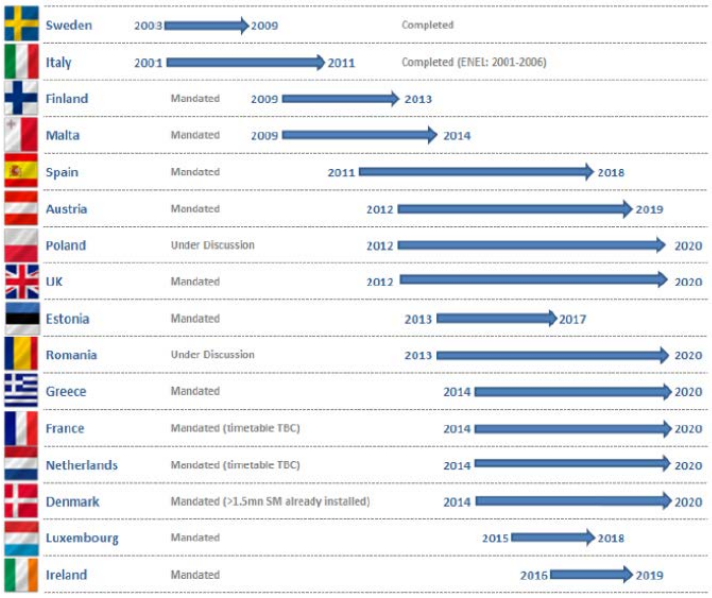
44 Serrenho T, Zangheri P, Bertoldi P – JRC (2015): Energy Feedback Systems: Evaluation of Meta-studies on energy savings through feedback, available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC99716/ldna27992enn.pdf

45 https://www.britishgas.co.uk/smarter-living/control-energy/smart-meters/benefits-of-smart-meters.html

46 SWD (2014) 189

Figure 13: Roll out timing of smart metering in EU Member States



Source: Odyssee Mure (2015)[47] *based on European Commission (2014)* [48]

The provisions of the EED on metering and billing largely aim at supporting consumers to become more aware of their actual energy consumption and consequently to change their use of equipment and their patterns of behaviour.

As the concept of smart metering is technically demanding and raises many implementation questions on legal and consumer protection issues, the Concerted Action EED found two cases of good practice[49]:

- In **Luxembourg**, mass rollout and meter replacement will start on July 1st 2016 and will end December 2019 for electricity and end of 2020 for gas. 95% of all e-meters will be replaced and 90% of all g-meters[50].
- **Finland** undertook a study on 'Cost Effectiveness of Individual Heat Meters and Heat Cost Allocators in Apartment Buildings in Finland' which helped to demonstrate heat metering costs and benefits for individual consumers[51].

Several projects from Horizon 2020 Energy Efficiency and Intelligent Energy Europe have been supporting innovative billing and smart metering[52].

47 European Commission, Borchard KD (2014): Benchmarking smart metering deployment in EU. European Conference on Smart Metering Deployment in the EU Brussels, 26 June 2014.

48 Odyssee Mure (2015): Energy Efficiency Trends and Policies in the Household and Tertiary Sectors. An Analysis Based on the ODYSSEE and MURE Databases. Available at: http://www.odyssee-mure.eu/publications/br/energy-efficiency-trends-policies-buildings.pdf

49 http://www.ca-eed.eu/themes/metering-and-billing-ct3

50 Concerted Action EED (2015): Smart Metering Project for Luxembourg, Luxembourg. Available at: www.ca-eed.eu/themes/metering-and-billing-ct3/smart-metering-project-luxembourg

51 CA EED (2015): Study of Cost Effectiveness of Individual Heat Meters and Heat Cost Allocators in Apartment Buildings in Finland. Available at: www.ca-eed.eu/themes/metering-and-billing-ct3/metering/study-of-cost-effectiveness-of-individual-heat-meters-and-heat-cost-allocators-in-apartment-buildings-finland

52 See for example: SMARTREGIONS which ran until 2013 http://ec.europa.eu/energy/intelligent/projects/en/projects/smartregions#results

The *EMPOWERING*[53] project developed a comprehensive, flexible approach for billing information service development at utility companies and a set of services and open source software tools adapted to the wide European market.

During the project development, the availability of the metering data from smart meters and the effective handling of the customer consent for data access have been identified as the main challenge for the widespread adoption of informative billing services for end-user efficiency. Feedback services based on smart metering data have been provided to 344 000 customers in six countries in Europe.

The project highlighted the possibilities for empowering consumers when receiving more information about their energy consumption. However, it also showed the limits of engaging consumers and that feedback about energy consumption needs to be well designed and tailored to the needs of the customer.

- In **Linz (AT)**, for example, the regional utility offered online information based on data by electronic meters. Customers could switch to a "smart metering" tariff with variable time of use tariffs. However, it was very difficult to get the customers' opt-in for these services and customers' interest in their detailed electricity consumption was low.
- The Spanish partner was a utility on the island of **Mallorca**. The utility offered detailed consumption information, monthly and yearly comparison, last year comparison and outdoor temperature comparisons on the website and also as printed consumption information. The average energy savings from billing information was around 6%. The achieved savings for both billing and online information was around 11% compared to the consumption of a control group. The project recognised not only the technical challenges but also the social aspects and the need to develop a stronger two way communication between customers and utilities.

USmartConsumer[54] (You are a smart consumer project) running until 2017 intends to empower 220 000 householders to benefit from smart meters services, saving average 10 % energy in their homes during project lifetime, over 125 000 MWh/year, in a cost-effective way. Thus, every euro from the budget of this project would save almost 100 kWh/year. The project works on developing at least 40 commercially available smart meter services to households clearly defined and promoted, so as to activate the market and transfer the best practises across Europe.

Energy data is a valuable asset not only for households or other end-user groups but also for policy makers to effectively monitor and target their measures and efforts on reducing energy consumption. Access to energy data has been a problem for public bodies across Europe often due to an insufficiently developed legal framework that is explicitly aimed at energy data sharing and that would foster cooperation between local authorities and energy data providers such as utilities/Distribution System Operators (DSO).

ENEL Distribuzione is the largest and first Distribution System Operator (DSO) in **Italy** that has put in place an energy data sharing system with municipalities developing their Sustainable Energy Action Plans within the EU's Covenant of Mayors (CoM) initiative. The company has elaborated an online template in line with CoM reporting requirements under the *MESHARTILITY*[55] project to share electricity consumption data and has established a unified way of sending data requests. ENEL provides data that can be used for the Baseline Emission Inventory development or for monitoring purposes assisting over 3 100 municipalities in better targeting their energy efficiency efforts and improving their reporting capacity. The portal is unique in Europe and illustrates effective voluntary

53 http://iee-empowering.eu/

54 http://www.usmartconsumer.eu/

55 http://www.meshartility.eu/

collaboration between the public and private sectors[56]. The *MESHARTILITY* project aims at the development of solutions and tools facilitating exchange of energy data between energy utilities and local authorities that are to help assessing local greenhouse gas (GHG) emissions and planning action to address this through energy savings, energy efficiency and the use of renewable energy.

Policy feedback resulting from the good practice analysis

- Strong **coordination mechanisms between all actors** involved are needed for effective roll-out.
- **Consumer engagement and consumer acceptance is key** to delivering energy savings by behavioural changes**.**
- More straightforward and unified **regulation of the data exchange** between DSOs, retailers, customers and service providers is necessary in order to assure easier market penetration of end-user energy efficiency and billing information services.
- **Energy data is a valuable asset also for policy makers** to effectively target, monitor and evaluate their measures and actions.
- Key barriers such as **data protection concerns** need to be taken into account in the rollout strategies.

[56] https://eneldistribuzione.enel.it/it-IT/Pagine/paes.aspx

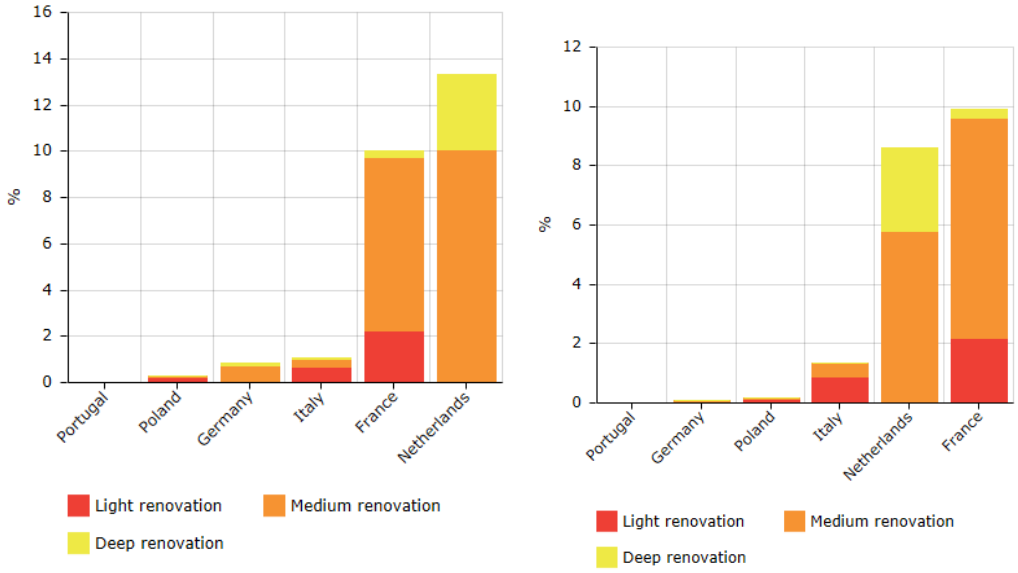
3. Energy efficiency in buildings

The European building stock is responsible for 30% of the EU greenhouse emissions[57] and approximately 404 Mtoe of final energy consumption in 2014, i.e. around 40% of the total consumption[58]. The building stock is expanding in size and its energy consumption and CO_2 emissions are bound to increase in absence of tighter energy performance minimum requirements. Hence, addressing the energy performance of buildings remains relevant to address the 2020-2030-2050 energy and climate policy objectives and boost energy security.

The construction industry provides 18 million direct jobs and contributes to about 9% of the EU's GDP. Up to 95% of construction, architecture, and civil engineering firms are micro-enterprises or small and medium-sized enterprise (SMEs)[59]. Improving Energy performance of the building stock can stimulate economic recovery and promotes growth and creation and retention of jobs.

Depending on the policy intensity at EU and National level, it is estimated that the 2030 energy saving cost effective potential for heating, cooling, ventilation and lighting of buildings ranges from 33 to 80,5 Mtoe[60], mainly in existing buildings. The challenge in achieving energy efficiency targets in Europe remains in the existing built environment. Residential buildings dating between 1945 and 1980 in particular have the largest energy demand. In the context of the economic crises the renovation rate of existing buildings is low.

Figure 14: annual stock renovated by level of renovation in residential in 2012 and 2015



Source: The project ZEBRA2020[61]

57 GHG emissions in the overall inland GHG emissions for Commercial/Institutional/Residential sectors (without LULUCF and without international aviation and international maritime transport). Source: Eurostat.

58 Source: calculations based on Eurostat's data

59 DG Growth, http://ec.europa.eu/growth/sectors/construction/index_en.htm

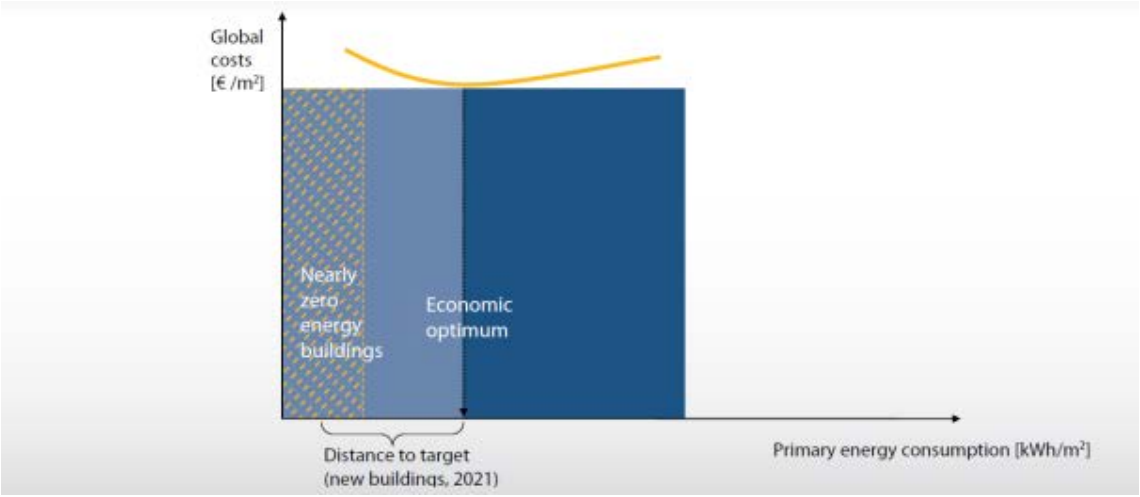
60 Study evaluating the current energy efficiency policy framework in the EU and providing orientation on policy options for realising the cost-effective energy efficiency/saving potential until 2020 and beyond, 2014, Fraunhofer ISI.

61 http://www.zebra-monitoring.enerdata.eu/overall-building-activities/share-of-residential-buildings-with-epc-labels-a-or-b.html#share-of-non-residential-buildings-with-epc-labels-a-or-b.html

The cost-optimal[62] level is the energy performance level which leads to the lowest global cost during the estimated economic lifecycle. This means that when assessing cost-efficiency of different packages of measures (combinations of compatible energy efficiency and energy supply measures) the whole lifecycle should be considered and not just the up-front investment.

In the figure below, the lowest part of the curve represents the economic optimum for a combination of packages, so these are packages of solutions with the lowest cost during their lifecycle. The area of the curve to the right of the economic optimum represents solutions that underperform in both aspects: energy performance and lifecycle cost[63].

Figure 15: cost-curve and beneficial areas in relation to cost optimum



Source: BPIE, Assessing cost-optimal levels within the new Energy Performance of Buildings Directive

Proper implementation of cost-optimal levels in national legislations, efforts in ensuring enforcement and compliance with the minimum requirements is crucial to reap the full benefits of the EPBD. The cost-optimal calculation should also be used to set the level of ambition of NZEBs[64].

As regards new buildings a significant number of Member States are falling short in their preparations to meet the Nearly Zero Energy Buildings (NZEB) target, mainly due to the need to adapt current practices in sufficient time to ensure that all new buildings by the end of 2020 are NZEB.

Therefore there is a need for continued and systematic research and innovation efforts with a strategic orientation to develop and promote new technologies. This requires a regular dialogue and cooperative activities of all stakeholders. The existing European Platform for such a cooperation is the Energy-efficient Buildings contractual Public-Private Partnership initiative (EeB cPPP), aiming to develop affordable breakthrough technologies and solutions at building and district scale. Funded by the EU under FP7 and Horizon 2020, EeB has demonstrated its value as a source of new knowledge and promising effective solutions[65,66].

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62 The cost-optimal level shall lie within the range of performance levels where the cost benefit analysis calculated over the estimated economic lifecycle is positive (EPBD, Article 2(14)).

63 BPIE, *Assessing cost-optimal levels within the new Energy Performance of Buildings Directive*

64 Commission Recommendation (EU) 2016/1318 of 29 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.

65 http://ec.europa.eu/research/industrial_technologies/energy-efficient-buildings_en.html

66 http://e2b.ectp.org/fileadmin/user_upload/documents/E2B/EeB_PPP_Project_Review_2016.pdf

According to the Concerted Action on the EPBD[67] **Finland** provides good practice of early involvement of relevant actors also to increase acceptance of jointly developed measures. As the Finnish National Building Codes are developed, professionals and major organisations in the field are consulted and take an active part in the work, through preliminary studies and consultation forums. The proposals for national definitions and guidelines for NZEBs are being developed with active involvement of professional organisations from the construction industry, the building design and planning fields. The involvement of professionals is also visible in the implementation of EPCs. Organisations in the building ownership as well as the building maintenance sectors are involved in both developing the national transposition and disseminating EPCs. Cooperation with the building and construction sectors and active involvement of field professionals has ensured that there is a high degree of compliance with the legislation – laws, decrees and building codes.

In **Brussels-Capital Region** all new buildings and large renovations have to be built according to passive house standards[68], which is a result of the long-term vision and a wide range of measures taken to stimulate sustainable and high energy performance buildings in the region[69]. The Region has initiated numerous actions stimulating demand as well as improving supply such as training programmes for construction sector professionals and subsidy schemes.

From 2007 to 2012 **Brussels** launched a yearly "Exemplary Buildings" call with the intention of stimulating the construction or renovation of buildings. The selected projects received funding and support from experts. This initiative was a major driving force in the construction and renovation of buildings with very high energy and environmental performance. It resulted in more than 800,000 m2 of passive buildings, 2,365 buildings with high energy performance, 2 144 very low energy buildings. 90% of these results were achieved through renovations. First results show a 10% reduction in energy consumption between 2004 and 2010. It is encouraging evidence for **Brussels** energy policy which was rewarded with a EUSEW Award by the European Commission in 2012.

Based on three rounds of successful trials with Exemplary Buildings, on July 12 2009 the Brussels government passed an order imposing the passive standard on all regional new public buildings by 2010, and on May 3, 2011 adopted new energy target regulation for all new construction (housing, offices and schools) by 2015[70].

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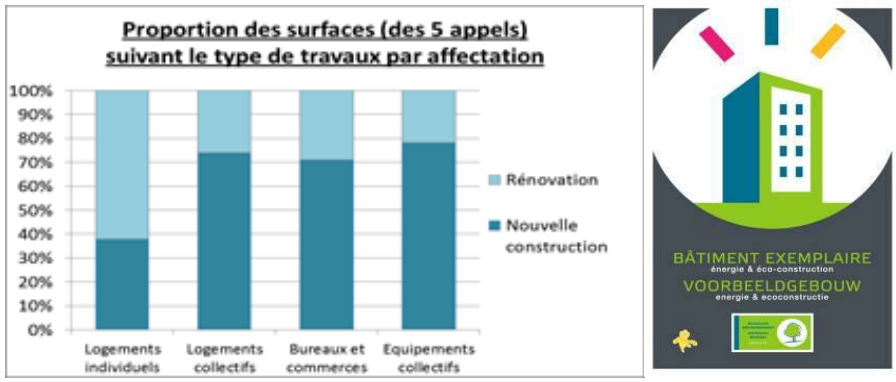
67 Implementation of the EPBD in Finland, CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

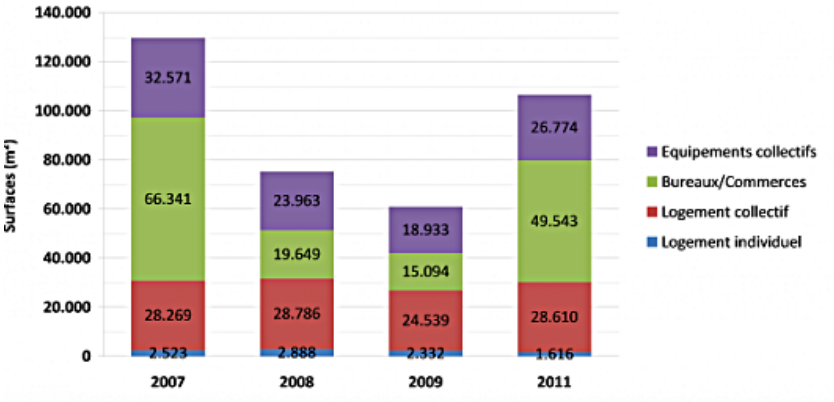
68 *23 Régions de Bruxelles-Capitale* – Brussels Hoofdstedelijk Gewest, Ministerie Van Het Brussels Hoofdstedelijk Gewest N. 2011 — 2445 [C − 2011/31430], May 5, 2011.

69 http://bpie.eu/wp-content/uploads/2015/11/ The-Brussels-Region-Case-Joke-Dockx-Brussels-Environment-Belgium.pdf

70 *PassREg* project *Success Model of Brussels- Case Study*, available at: http://www.passreg.eu/index.php?page_id=374

Figure 16: Results of 5 "Exemplary Buildings" calls





Source: Bruxelles-environnement, Région de Bruxelles-Capitale

3.1. Renovations

- ***Long-term renovation plans and strategies***

Long-term renovation strategies are important to set a vision and mobilize actions in the renovation of national buildings stocks. While a pathway has been set by legislation for new constructions in terms of energy performance improvements, a similarly clear vision is needed for existing buildings. This was recommended in the Public Consultation on the Evaluation of the EPBD[71].

As reported by the Buildings Performance Institute Europe (BPIE)[72] the importance of energy renovation of buildings is exemplified by the fact that existing buildings are responsible for as much as 40% of the EU's energy requirements, and over a third of greenhouse gas emissions. Furthermore, as Europeans are spending 90% of their time indoors, it is important that energy renovation supports healthy indoor climates in buildings. The report chose best practice examples for each article's requirements. **The UK** strategy was commendable for its overview of the national building stock. Cost-effective approaches to renovations were the best in the strategy of the **Brussels Capital Region**. The **Danish** strategy had the strongest policies to stimulate deep renovation. The Spanish strategy was highlighted for its forward-looking investment perspective. A unique feature of the **Romanian** strategy is that it has sought to quantify the wider benefits of building renovation.

The ODYSEE-MURE project identifies as good practice the strategy for energy renovation for

71 Public Consultation on the Evaluation of the EPBD – Final summary report, 2015, European Commission (written by Ecofys) https://ec.europa.eu/energy/sites/ener/files/documents/MJ-02-15-954-EN-N.pdf

72 RENOVATION STRATEGIES OF SELECTED EU COUNTRIES a review of the implementation status of Article 4 EED published in November 2014 (BPIE 2014).

households in **Denmark**. The objectives of the Danish government are that the energy supply in 2050 must be based on renewable sources and that the electricity and heat supply must be independent of fossil fuels by 2035. As a major step towards the goals, the Strategy for Energy Renovation was adopted in May 2014. The strategy contains 21 initiatives which will promote the renovation of the Danish building stock and ensure that energy efficiency measures are implemented in buildings. These are: revision and upgrade of building regulations and energy requirements that apply to renovation and retrofitting of existing buildings; new requirements on the energy efficiency of windows; information to building owners, construction companies, financial institutions etc. on how to improve energy efficiency; revision of the energy certificates scheme to improve its efficiency, and promotion of the ESCO concept; measures to improve professional skills in the building sector, development and demonstration of new technologies. These are expected to reduce the net energy consumption for heating and hot water by 35% by 2050.

- The *BUILD UPON*[73] initiative, a two-year Horizon 2020 project, aims to help European countries design and implement long-term national strategies for the renovation of their existing buildings. Key stakeholders from all 28 Member States are actively involved, and an innovative 'Regional Action Network' model will evolve to scale and continue this work after the project's lifetime. A Wiki tool, "RenoWiki", providing a quick overview of the many diverse renovation initiatives in each country (e.g. regulation, finance, training, research), has been developed, in order to exchange best practices. The project commits a significant budget for each participating country to familiarize experts involved with best practice European renovation initiatives.
- The *EPISCOPE* [74] (Energy Performance Indicator Tracking Schemes for the Continuous Optimisation of Refurbishment Processes in European Housing Stocks) project aims to help maximise the effectiveness of energy refurbishment projects for European housing. Building on the work of IEE project *TABULA, EPISCOPE* has developed a common methodology to compare renovation rates of residential buildings across countries and to make recommendations for future monitoring activities. This is to be used as a basis for assessment and comparison of different refurbishment strategies and their impacts, using pilot projects at the local, regional and national levels. *EPISCOPE* helps to track the progress of renovation and to assess current and future policies. BPIE has been integrating the work of *EPISCOPE* into its Data Hub and also the Building Stock Observatory service contract. The final result should facilitate compliance with regulations, evaluation of real energy savings, and should ensure that energy refurbishments are carried out in an efficient and cost effective manner.
- City action plans have been developed in the *NeZeR*[75] project for the cities **Stockholm** (SE), **Rotterdam** (NL), **Helsinki** (FI), **Porvoo** (FI) and **Espoo** (FI), **Sestao** (ES) and for the municipalities **Amersfoort** (NL) and **Timisoara** (RO). Guidelines will be published for other European cities on how they can develop similar action plans. The action plans focus on decision makers (city authorities and real estate owners/housing associations) and their work on improving the energy efficiency of the existing building stock. The action plans will facilitate the implementation of the Energy Performance of Buildings Directive. In each participating country the most relevant building types have been identified where the biggest impact of Nearly Zero Energy Building Renovation is seen. The project's focus lies on residential buildings.

• *Promising stories of deep renovations initiatives*

The EPBD defines "major renovations" as renovations where the total cost of the renovation relating to the building envelope or its systems is higher than 25% of the value of the building, or if more than 25% of the surface of the building envelope undergoes renovation. Member States may decide to define a major renovation in terms of the value of the building; values such as the actuarial value, or

[73] http:// www.buildupon.eu
[74] http://episcope.eu
[75] http://www.nezer-project.eu/actionplansforcities

the current value based on the cost of reconstruction, excluding the value of the land upon which the building is situated, could be used.

The implementation of the "major renovation" definition differs a lot between Member States, and is in some cases not even transposed. The project ZEBRA2020[76] created a calculation method to compare renovation equivalents to overcome the limitations of various national definitions of renovation measures. As the EPBD requires a definition of major renovation, this renovation equivalent allows comparison between different countries[77].

- *Transition Zero*[78] is based on the Dutch concept 'Energiesprong' realising mass deep renovations with pre-fabricated, standardised modules in order to achieve major cost and time savings. In **the Netherlands**, Energiesprong[79] brokered a deal for bringing 110 000 buildings to a NZEB status. The initiative, thanks to a 3 years EU Horizon 2020 grant, is planned to be rolled out in other EU countries, e.g. the **UK** and **France** (planned deals for 5 000 houses in **the UK** and **France** and building a pipeline of more demand[80]). The approach is based on organising mass demand for cheaper (paid for by energy cost savings) and quick to install (one week) NZEB prefabricated refurbishment solutions with a long-term performance guarantee and no subsidies. The heart of the concept is an energy performance contract to guarantee the performance of the improvements over a long-term period (minimum 30-year). This provides financial security to the property owner, giving an assurance that the property will perform at the expected level. In order to reduce the costs and the construction time, only 5% of retrofit work is to be carried out on-site. The major retrofit elements (e.g. roof, facades, plants) are modular, industrialized, plug-and-play products. By creating a system that addresses regulations and financing in parallel, the construction sector is driven into a quick and transformative innovation process based on prefabrication and mass produced, but customised products.

- The project *BEEM UP - Energy Efficiency for Massive market Uptake*[81] develops the technology and all necessary collaboration schemes leading to reducing energy consumption in building by 70% with huge replication potential. This could considerably speed up the renovation of the EU building stock. The project demonstrated in one of the case studies that energy consumption can be reduced by 76% while increasing the rental payment by only EUR 50/month.

- An estimated 43% of the European population live in apartment blocks. Retrofitting apartment blocks tends to be more complex than other domestic buildings and there are additional challenges to overcome, mostly of a non-technological nature. Still, there are also great opportunities for replication and achieving significant energy savings and reductions in greenhouse gas emissions. Often, apartment buildings are rather similar in all EU Member States and represent a significant portion of the building stock. The *LEAF* project is working on overcoming technical, practical and organisational barriers when it comes to energy efficiency improvements in apartment blocks with mixed ownership. To that end, it has developed a technical and an engagement toolkit explaining not only the technical background, but also providing tools to support the decision-making and procurement process for energy-efficiency renovations in multi-owner buildings. A key challenge the

76 http://zebra2020.eu/

77 http://www.zebra-monitoring.enerdata.eu/overall-building-activities/share-of-new-dwellings-in-residential-stock.html#equivalent-major-renovation-rate.html

78 http://energiesprong.nl/transitionzero/

79 http://www.energiesprong.eu/index.php/what-we-do/

80 Transition Zero, financed under Horizon2020, no project website yet, but information can be found here: http://www.housingeurope.eu/section-100/transition-zero

81 http://www.beem-up.eu/

project has worked on is how to ensure quality of the EPCs to make them a reliable basis for financial calculations. The project worked with 24 case study buildings across six European countries. In **Saint-Etienne**, **France** for instance, a concreate buildings from 1951 was renovated achieving energy savings of about to 72%[82].

- The *Total Concept* [83] project developed smart packages for deep renovation of non-residential buildings by combining tailored energy efficiency measures to fulfil the profitability expectations of the investor. Implementing the *Total Concept* method opens up new opportunities for property owners to carry out major energy performance improvement retrofitting in a profitable way. The method thus creates a market driver for major refurbishment of existing buildings towards Nearly Zero-Energy Buildings. The approach overcomes one of the main non-technical barriers for finding economically profitable solutions for investments in energy performance improvements in the non-residential building sector.

Figure 17: *Total Concept* pilot building- Denmark

Source: Total Concept

The basic idea of the *Total Concept* is that the depth of energy efficiency measures during renovation can be increased by combining different energy efficiency measures into smart packages. A new *Total Concept* Tool features packages of measures which re-inforce each other and taken as a whole fulfil the profitability expectations of the investor. The package typically identifies measures enabling deeper savings than when only looking at the profitability of individual measures. Depending on the buildings energy performance before renovation, the refurbishment package can cut energy consumption by half or more. The method thus demonstrates how ambitious energy efficiency renovation measures can be profitable. In **Denmark**, the energy authorities plan to include the *Total Concept* method in their official guidebook for large retrofits.

The *Total Concept* tool has so far been applied to the renovation of more than 20 buildings in **Sweden, Norway, Denmark, Finland and Estonia**, amongst them offices, schools, a town and a concert hall as well as a prison. Estimated energy savings after renovation rage from 15-56%. One of the pilot buildings is the Tampere congress and concert hall. It was built in 1990 and is since then the largest congress centre in northern Europe with over 28 000m^2.

- The *COHERENO*[84] project looked into the strengthening of collaboration between companies in innovative business schemes for realizing nearly zero-energy building renovations for single family owner-occupied houses. The aim was to eliminate barriers for collaboration and

82 http://www.lowenergyapartments.eu

83 http://www.totalconcept.info, www.youtube.com/watch?v=0ns1Uo5x6R4

84 http://www.cohereno.eu

to provide companies with guidance on how to collaborate and develop services for different customer segments. The project covered five countries: Austria, Belgium, Germany, the Netherlands, Norway and two business collaboration events have been organised in each country gathering stakeholders from the supply chain i.e. architects, contractors, consulting or informing actors, manufacturers, policy actors etc.
In total, 24 very diverse collaboration structures/business models were set up between the various actors of the supply chain as a direct output of the project. Besides, the action triggered other businesses to do so as well.

- *STEP-2-SPORT*[85] aims to facilitate the step by step refurbishment of existing sports buildings to nearly zero energy levels. Energy audits have been performed on 22 sports facilities in seven countries in order to identify energy improvement opportunities as well as to determine their energy rating and produce an Energy Performance Certificate (EPC). Action Plans for renovation are being developed, identifying specific measures needed to become a NZEB, which will also be subject to monitoring. The project culminates in a Renovation Roadmap for sports buildings, together with a Replication plan with tools and training to support owners/managers of sports buildings. A number of pilot renovations are being carried out in the project. In total, more than 11 000 MWh per year can be saved in the 26 pilot sport buildings evaluated through the implementation of energy efficiency measures and renewable energies[86].

Policy feedback resulting from the good practice analysis

- The renovation of the building stock is an opportunity to improve energy efficiency, create jobs and to stimulate the market of energy services companies.
- The projects reviewed show that many possibilities exist to **incite home-owners to invest in deep renovations**.
- Governmental support is needed to ensure that the **many barriers** that still exist to building renovation can be overcome.
- **Tailor-made solutions** dedicated to particular building types (public buildings, sport facilities, etc.) can provide blueprints for scaling up refurbishment efforts.

3.2. Minimum energy performance requirements create a market and trigger innovation

According to the EPBD, Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. The cost-optimal level is defined in Article 2.14 as "the energy performance level which leads to the lowest cost during the estimated economic lifecycle" from two different perspectives: financial (looking at the investment itself at the building level) and macro-economic (looking at the costs and benefits of energy efficiency for society as a whole)[87].

Minimum energy performance requirements shall be reviewed at regular intervals and updated in order to reflect technical progress in the building sector.

The pathway set towards nearly zero-energy buildings by 2020 is perceived as an important signal by

85 http://step2sport.eu

86 http://step2sport.eu/?page_id=30

87 Implementation of the EPBD in Finland, CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

the respondents to the public consultation on the Evaluation of the EPBD[88] that call for a similar vision for existing buildings.

It is expected that all MS will produce an NZEB definition before 2020. However, the late transposition in many MS might not give enough time for the building sector to adapt. The MS progress towards the establishment of NZEB definitions has been evaluated by the European Commission based on National Plans, the Commission reports of 2013 and 2014, as well as information from the EPBD CA, Energy Efficiency Action Plans (NEEAP), and National Codes. Progress may be seen in many EU Member States compared with the very first attempts to establish NZEB definitions (Table1).

Table 1: Status of NZEB definition development in EU Member States.

MS	Included in an official document	Under development	To be approved
AT	✓		
BE - Brussels	✓		
BE - Flanders	✓		
BE - Wallonia	✓		
BG			✓
CY	✓		
CZ	✓		
DE		✓	
DK	✓		
EE	✓		
EL		✓	
ES		✓	
FI		✓	
FR	✓		
HR	✓		
HU		✓	
IE	✓		
IT	✓		
LV	✓		
LT	✓		
LU	✓		
MT		✓	
NL	✓		
PL	✓		
PT		✓	
RO	✓		
SI	✓		
SK	✓		
SE		✓	
UK		✓	

[88] Public Consultation on the Evaluation of the EPBD – Final summary report, 2015, European Commission (written by Ecofys) https://ec.europa.eu/energy/sites/ener/files/documents/MJ-02-15-954-EN-N.pdf

Source: *JRC synthesis report on national plans for NZEB, 2016*[89]
Different system boundaries and energy uses are the cause of high variations within definitions. The level of energy efficiency, the inclusion of lighting and appliances, as well as the recommended renewables to be implemented vary among MS.

As demonstrated below, setting ambitious requirements for new buildings towards NZEBs and showing a clear direction of progressive tightening of energy performance develops markets for the building industry and investors as well as stimulating technological innovations and developments.

However, the challenge is also to ensure enough flexibility when defining the NZEB level to take account of these future market and technology developments, because energy performance requirements for NZEBs should be based on the cost-optimal level foreseen in 2021 (and 2019 for public buildings).

Within the EPBD CA MS reported[90] that when using current costs, technologies, and primary energy conversion factors the currently available national applications of the NZEB definition are not fully in compliance with the cost-optimal requirement, because there is no certainty about the evolving influence factors for the calculations for the year 2019/2021. Only one country, **Denmark**, reported that it had used the study on evolving factors to adjust its national application of the NZEB definition. The **Danish** example of setting minimum energy performance requirements for new buildings was analysed under the Case Study produced by the *EEW3* project[91].

Numeric indicators of energy performance expressed as primary energy in kWh/m^2/y use have been defined in MS and appear not comparable because different energy performance calculation methodologies have been used[92]. Some MS have included non-mandatory energy uses, e.g. energy use in appliances. Evidence shows how inclusion of lighting and appliances can result in more optimal solutions, especially for electricity use[93].

In 1960, **Denmark** was one of the first countries worldwide to introduce nationwide energy efficiency standards for energy use of buildings; today it has one of the most ambitious energy performance standards (MEPS) for new buildings among comparable countries[94]. The MEPS contain definitions of 'Low-energy Class 2015' and 'Building Class 2020' preparing the **Danish** industry for future requirements almost 10 years in advance, thanks to that new very energy-efficient components are main stream, e.g., windows or heat pumps. The energy requirements in the **Danish** Building Regulation for new buildings have been tightened by using a step-by-step approach and introducing the new requirements as voluntary energy classes before they become mandatory.

A number of initiatives and policies aim to increase the number of NZEBs, including energy saving initiatives for the energy supply companies, a strategy for the energy renovation of the existing building stock, the changeover to renewable energy, information campaigns and public action, a Knowledge Centre for Energy Savings in Buildings targeting the construction supply-side actors,

89 available at: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/synthesis-report-national-plans-nearly-zero-energy-buildings-nzebs-progress-member-states; doi 10.2790/659611

90 CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

91 http://www.energy-efficiency-watch.org/index.php?id=213

92 On-going standardisation work and projects such as the GE2O project (http://www.geoclusters.eu/) try to overcome this limitation while acknowledging natural differences such as climate

93 Modelling of optimal paths to reach NZEB for new constructions in Europe, D'Agostino D., WSED conference 2016 (http://www.wsed.at/en/programme/young-researchers-conference-energy-efficiency-biomass/).

94 Danish Energy Agency 2010; WWF Scotland 2011

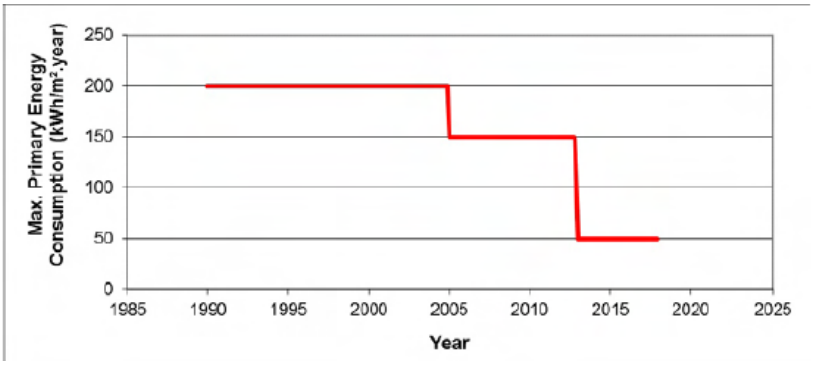
grants and subsidy programmes implemented by both the government and the energy companies.

Through the long-term goals, and especially by way of announcing a concrete roadmap for the further tightening of the Building Code early on, the **Danish** Government sends a clear signal to the building sector and allows its actors to prepare themselves for these next steps motivating them to make critical, long-term investment decisions.

France also provides a good practice example of step-by-step tightening of minimum energy performance requirements towards NZEB level and successful NZEB market introduction. The EPBD CA reported[95] that:

- the first thermal regulation, RT 2005 (Réglementation Thermique 2005), was introduced in 2006 and was replace by RT 2012, the result of a two year-long dialogue with all stakeholders, mandatory for all new constructions since 2013 setting maximum energy consumption along with minimum requirements on some elements (envelope insulation, HVAC systems).
- the next thermal regulation is planned for 2018 and it will require all new buildings to be "positive energy buildings" to be applied first in 2016 to public buildings.
- cost-optimality of the **French** thermal regulations has been analysed in compliance with the EPBD.

Figure 18: Evolution of energy performance requirements for new construction in France



Source : CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD)

In France, NZEBs are called "Low Consumption Energy Buildings" (Bâtiments Basse Consommation - BBC), and were originally a quality seal for buildings with very low energy consumption (maximum primary energy consummation of 50 kWh/m2/year) with a view to being generalised to all new construction by the regulation RT2012. In the case of individual houses, it included in particular a great proportion of Renewable Energy Sources.

Since 2013, all new buildings are mandatory NZEBs since requirements for 'BBC' match the RT2012. 335 000 new houses (300 000 apartments and 35 000 individual houses) were certified NZEBs (BBC) before the RT2012 enforcement and there have been around 465 000 new houses certified since then. Hence, the number of new NZEB houses can be estimated to be approximately 800 000.

The **introduction of the 'BBC' label** enabled the follow-up and scaling up of actions and best practices in NZEB before the requirements were extended to all new construction. The particular approach of the BBC label is that it can be applied to both new (BBC-Effinergie) and existing (BBC renovation) buildings, thus aiming to promote buildings' refurbishment to NZEB.

[95] CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

The EPBD CA also highlights experiences in **Norway.** They show that energy performance requirements set in 2007 have had various effects on the Norwegian construction market. The requirements were perceived as especially harsh on Norwegian window manufacturers, setting requirements for U-value to 1,2 on average. At the time, no manufacturers in Norway were able to deliver windows meeting this requirement. By the end of the transition period, most if not all producers had started developing new technology and were able to meet the new requirements. Continuing to develop new technology, producers were soon able to deliver windows that were good enough to help buildings fulfil the requirements set in the Norwegian passive house standard for residential buildings, NS 3700. This standard was published in 2011, followed by a standard for non-residential buildings published in 2012. Both standards were followed by public support schemes. Passive houses are now being built all over the country by a large variety of builders as opposed to being considered a rare special niche market only a few years previously.

Norwegian window producers continue to develop cutting edge technology, and are now developing windows to meet the NZEB requirements, which are set to be announced before 2020. This includes windows with integrated solar collectors.

- ***Introducing Nearly-Zero Energy Buildings (NZEB) into everyday life***

The previous chapter illustrated how long term target setting in terms of minimum energy performance requirements with a clear pathway and progressive tightening of requirements, helps to prepare the supply chain for new market conditions. This results in technological progress, innovation and market development.

On the demand side, consumer acceptance can be increased by information and awareness raising actions, demonstration projects but also preparation of market channels to deliver new products/services in appropriate way.

The EPBD CA provided some examples from **Germany, Latvia** and **Malta** where a clear indication of the NZEB level in the issued EPCs made consumers aware early on of the required level for new buildings by 2020 (or 2019 for public buildings), thus "pushing" the market.

Communicating with and educating various target groups (e.g. by providing information to the public, training builders, carrying out communication campaigns and involving energy agencies) will support rapid market introduction of NZEBs.

In **Belgium- Flemish region**[96], the NZEB level is proposed as a brand with practical guidance on how to build a NZEB. Online lists of NZEB frontrunners (architects, energy experts, construction companies, installation companies, manufacturers and banks), demonstration buildings, TV programmes and cheaper loans are available. Since the start of February 2014, a large number (300) of companies and organisations have become involved in this scheme.

Another key to success is aligning policies to support mechanisms (property tax reductions and subsidies). A software tool[97] for new buildings was developed and determines which NZEB requirements are fulfilled and which are not. When NZEB requirements are fulfilled, the label 'Ik BEN hier' ('I'm NZEB here') appears. This instrument might inspire energy experts and future homeowners to take the necessary measures to achieve the NZEB-level and receive the associated subsidy.

- *NZB2021*[98] project aimed at replicating an ongoing open-doors campaign on nearly zero-energy

[96] CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

[97] http://www.energiesparen.be/epb/prof/software

[98] http://www.nzebopendoorsdays.eu/

buildings in Flanders to 9 additional European countries (**AT, FR, GE, HU, IE, MT, PL, SE, SI**).During the project the Flemish campaign extended and teamed up with a Walloon partner in order to cover the whole of Belgium. The aim was for home owners to open their doors and explain how they have built or renovated their house in an energy efficient way. In this way, interested visitors could learn first-hand from others. Two campaigns were organised in 2013 and 2014 within the project duration.
Overall, the consortium attracted more than 25 000 visitors, 672/634 buildings and 106/134 public buildings were open for the 2013/2014 campaigns, 78%/75% of visitors voiced their intent to implement good practices by 2020 and more than 90% of the visitors were pleased with the information they received. When looking at the country breakdown, it is striking that most visitors (more than 11 000) were attracted to Belgian campaign where it has been known for many years
Many demonstration projects supported under FP7 and H2020 achieved outstanding results in terms of energy performance of buildings by applying and integrating innovative technological solutions. *DIRECTION*[99] is a four-year project that aims at demonstrating how the use of very innovative and cost-effective energy efficiency technologies can lead to the achievement of very low energy new buildings. Two new buildings are used as pilots in *DIRECTION*: NuOffice in **Germany** and CARTIF III in **Spain**. In their own climate conditions, each pilot building deploys a set of very innovative measures, constructive elements for energy optimization, high efficient equipment and advanced energy management. The NUOffice building, which was awarded the LEEDS certificate for most sustainable new office in the world, reached 30 kWh/m2/yr of primary energy consumption (with an average of 42kWh/m^2/yr in 2015). Other buildings including the Black Monolith in **Bolzano** (Italy), NuOffice2 and NuOffice3 in **Munich** (Germany) are drawing on solutions from the project *DIRECTION*.

- The *AIDA*[100] project aimed to promote and accelerate the development of NZEB in Europe by targeting two distinct groups: municipalities and building professionals. The main outcomes of the project were to raise awareness, inform and engage over 3 000 municipality representatives and building professionals by providing information on NZEB case studies and by facilitating study tours to experience these innovative buildings at first hand. Over 1 500 architects and master builders received guidance on the use of Integrated Energy Design including by accessing an IED software tool from the *AIDA* website. The project also provided technical support to municipalities to ensure the inclusion of NZEB characteristics in the public tenders for between 15-21 building projects.

  The project enabled the market uptake of NZEBs in Europe by assisting 28 municipalities in seven EU countries to develop tenders and feasibility studies for new and renovated nearly zero-energy buildings. It also supported 26 municipalities in the creation of roadmaps such as Sustainable Energy Action Plans (SEAPs) within their Covenant of Mayors membership.

- The *PassREg*[101] project found that large scale implementation of new NZEBs, in the form of policies that promote Passive House + Renewables, requires local and regional decision makers to be educated about difficult technical concepts such as NZEB and Integrated Design and proposed study tours to witness examples of best practice. The project found that political consensus, financial support, and capacity building of decision makers are all necessary and explained how the Passive House standard was adapted to fit NZEB criteria[102].

- *ENTRANZE*[103] and its follow-up project *ZEBRA2020* provide data and analysis on energy

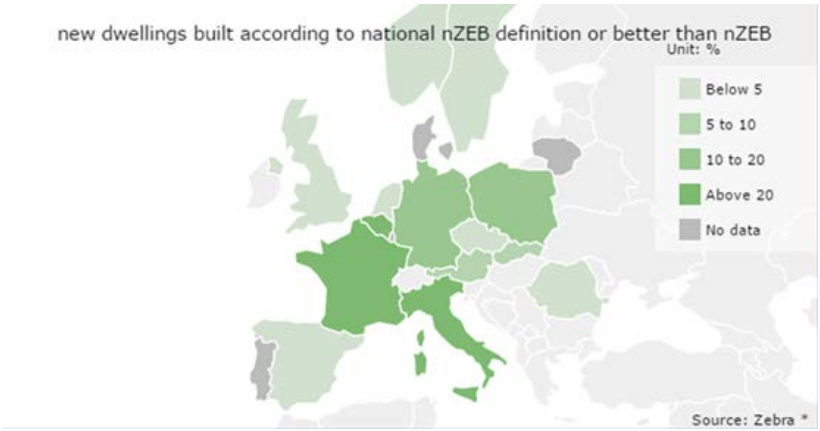
99 http://www.direction-fp7.eu/News/Most_Sustainable_Office_In_The_World.kl
100 http://www.aidaproject.eu
101 http://www.passreg.eu/
102 http://ec.europa.eu/easme/en/news/european-regions-reduce-emissions-passive-house-buildings-and-renewables
103 http://www.entranze.eu/

efficiency policies and market penetration across the EU with a particular focus on tracking NZEBs. The project developed scenarios, recommendations and strategies for the building industry and policy makers to boost the market uptake of NZEBs. To that end, it created data tools, displaying indicators on the status of building stock development in selected European countries focusing on general features of buildings, new construction, renovation activities, sales of energy efficient equipment and energy performance certificates. Another tool is in the making by *ZEBRA2020* to track the penetration of NZEBs into the European market.

- ***Checking and enforcing compliance with energy performance requirements***

Compliance rates of new buildings with national NZEBs requirements are still low across the EU.

Figure 19: Share of new dwellings built according to national NZEB definition (or better)



Source: zebra2020.eu

Compliance with energy performance requirements is checked at different stages of the building process in different MS. Some MS even check compliance several times during the building process. Compliance checks and quality control regarding airtightness, thermal bridges, summer comfort and availability of daylight in new buildings require increased attention as buildings move towards NZEB, since these topics account for an increasing share of buildings' total energy consumption[104].

As reported by the EPBD CA a special compliance check philosophy is in place in **Sweden,** based on an operational rating system applied to new houses or apartments after two years of operation. It is not necessary to measure single parameters as long as the measured value of energy consumption complies with the building code.

The **Flemish region** lays down administrative fines for infringements of the energy performance requirements. This leads to very high rates of compliance with energy performance requirements 'as-built'. The compliance rate with all requirements (including ventilation rates) has been around 97% since 2010.

[104] EPBD CA (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

- ***Minimum energy performance requirements when selling or renting a property as strong market driver***

The Energy Performance of Buildings Directive sets minimum efficiency standards only for new-builds or major renovations. Legal acts put in place in **Scotland, England and Wales**[105], have stepped up on this stance and introduced minimum standards for energy performance at point of letting.

In **Scotland**, housing associations are obliged to reach a "D class" rating when letting out apartments or to ensure that improvement work to reach this standard is carried out when a property is sold or leased to new tenants. Based on the rating of the Energy Performance Certificates (EPC), the Scottish Government has established a standard which implies that by 2020 no social property will be lower than a "D class" rating[106].

The Energy Efficiency Regulations in **England** and **Wales** have installed minimum standards for private and commercial rentals. In case a property is rated F or G class, tenants have the possibility to demand an energy refurbishment to minimum E class level from 1 April 2016 on. Almost 10% of **England** and **Wales**' 4,2 million privately rented homes currently fall below the E rating. The law obliges landlords to upgrade energy efficiency of homes currently rated F and G to a minimum of E by 1 April 2018 – or face being unable to let them until they improve the rating[107]. Unless an exemption applies, with effect from 1 April 2023, the owner of a property with an EPC rating of F or G must not continue to let out that property until works have been carried out to improve the energy efficiency to a rating of E or above[108]. The measure is expected to help around a million tenants who are paying as much as GBP 1 000 (EUR 1 292)a year more than the average annual bill of GBP 1 265 (EUR 1 637) because of poorly insulated homes[109]. The UK Department of Energy and Climate (DECC) won the Public Sector Leadership in Green Building award of the World Green Building Council for designing the Energy Efficiency Regulations[110].

Policy feedback resulting from the good practice analysis

- Minimum Energy Performance Standards (MEPS) is the strongest measure to increase the rate of renovations providing a clear signal to investors. It is also a way of solving the split incentives problem (owner/tenant dilemma).
- A clear follow-up on the standards in terms of legal enforcement and related sanctions is needed to safeguard an effective implementation.
- **The UK** examples of the inclusion of MEPS when renting houses is an interesting frontrunner which should be monitored closely and taken up in other Member States.

105 Energy efficiency and energy poverty are devolved matters in the UK.

106 This complements further energy performance targets for 2020 by the Scottish Government. Every home is to have loft and cavity wall insulation, a highly efficient boiler with appropriate controls; and for at least 100,000 homes some form of individual or community renewable heat technology. Committee on Climate Change, "Reducing emissions in Scotland: 2014 progress report", March 2015, available at: https://www.theccc.org.uk/wp-content/uploads/2014/03/1871_CCC_Scots_Report_bookmarked.pdf. Scottish Government, "Homes that don't cost the earth: A consultation on Scotland's Sustainable Housing Strategy", June 2012, available at: http://www.gov.scot/Resource/0039/00395756.pdf.

107 The Guardian, 5 February 2015. Landlords to be banned from letting draughtiest homes. http://www.theguardian.com/environment/2015/feb/05/landlords-draughty-homes-ban.

108 Shepherd & Wedderburn (2015): The new minimum energy efficiency standards: implications for real estate in England and Wales. Available at: http://www.shepwedd.co.uk/sites/default/files/MEE%20Briefing.pdf

109 The Guardian, 5 February 2015. Landlords to be banned from letting draughtiest homes. http://www.theguardian.com/environment/2015/feb/05/landlords-draughty-homes-ban.

110 World Green Building Council (2015): WorldGBC Leadership Awards. Available at: http://www.worldgbc.org/activities/govt-leadership-awards/europe.

3.3. Energy performance certificates- standardised information increases market visibility and transparency

Energy Performance Certificates (EPCs) are designed as an information-based instrument to inform prospective owners and tenants in particular about the performance of specific buildings and systems, and about ways of improving the energy performance through specific recommendations.

In implementation of the provisions related to EPCs some Member States have developed good practices to make the instrument user-friendly, reliable and, by ensuring access to EPC information to different stakeholders, to reap the full benefits of this instrument. In many countries the EPC is already being used as a document necessary to obtain financial support and subsidies or to confirm the result of supported actions.

However, as stated in the Evaluation of the EPBD, EPCs have not yet succeeded in supporting a comparable pan-European market for buildings energy efficiency investments, as they are not based on the same methodology. Indeed, the provisions for the EPCs do not require a harmonised methodology for calculating the energy performance of buildings. This was confirmed in the *STEP-2-SPORT* project[111] (see chapter 3.1.), which concluded that the differences between the calculation methodologies used in EU countries to determine the energy performance of buildings make it very difficult to compare the EPCs results of pilot sport buildings. Along this line, the Commission gave a mandate to CEN to elaborate and adopt the necessary standards for a methodology calculating the integrated energy performance of buildings, in accordance with the Directive (in particular Article 3 and Annex I of EPBD-recast). The on-going standardisation work is expected to make the CEN standards more usable as direct reference in national legislation and to give a higher transparency to national choices.

- ***Best-practices improving the quality, transparency and/or reliability of EPCs and making EPC more user-friendly for different kinds of stakeholders***

According to the EPBD CA[112] in a few MS **(Belgium - Flemish region, Portugal** and **Ireland**) guidelines were developed for the use of EPC data in advertisements, in collaboration with real estate agents, ensuring that the energy indicators could be easily identified.

In **the UK** the EPC layout was revamped in 2012 to ensure its user-friendliness:

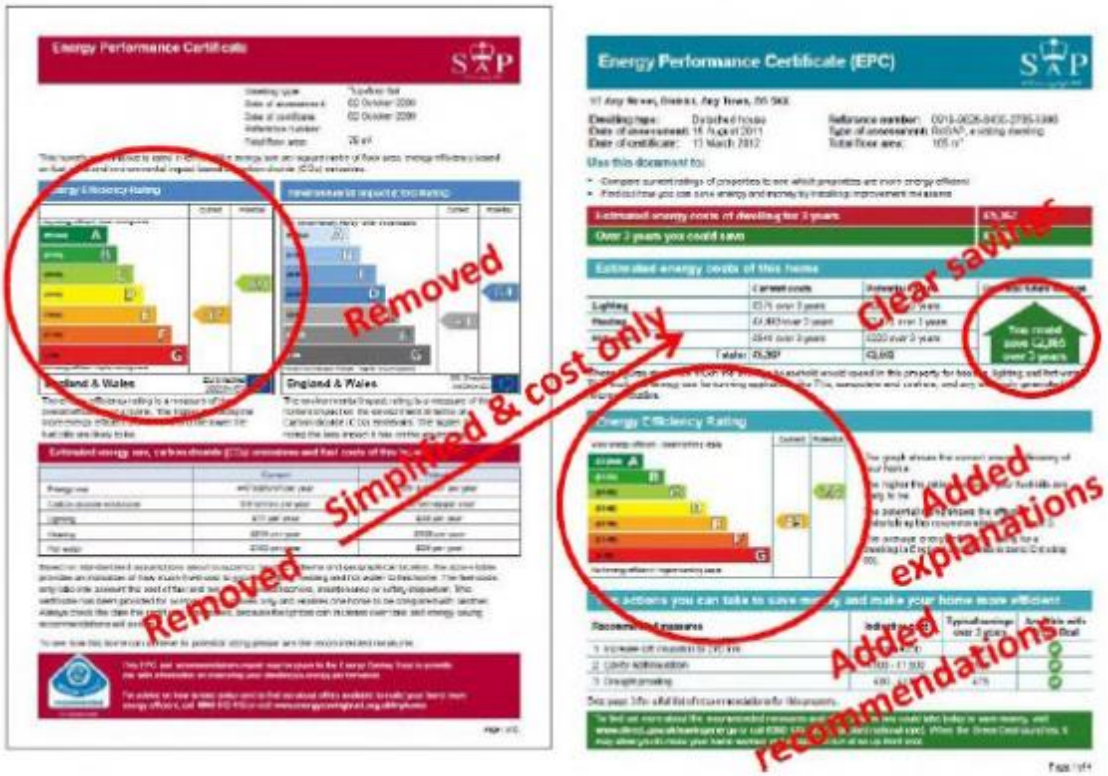
- The use of technical language has been reduced to a minimum on the first pages of the EPC and more self - explanatory icons are used.
- Technical sections, addressing experts and authorities, have been moved to the end.
- The energy rating of the current and potential energy efficiency of the building is provided. The potential rating shows the effect of undertaking the recommendations included in the EPC.
- Most EPCs recorded on the national register are freely accessible to the public through an address search (unless the building owner opts out).

All EPCs on the register are freely accessible through a unique reference number search.

111 www.step2sport.eu

112 EPBD CA (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

Figure 20: The old (before 2012) and new EPC in the UK



Source EPBD CA (2016) – Implementing the Energy Performance of Buildings Directive (EPBD)

The introduction of the new EPC in **the Netherlands** has changed the landscape of the Dutch built environment. While the previous EPC was merely technical and expensive, the new simplified EPC has empowered citizens to directly influence their energy use. The Energy Agreement of 2013 states that a **simple and affordable** EPC plays an important role in meeting the energy savings targets in the built environment. In June 2014, the House of Parliament agreed on a new EPC that should cost the Dutch citizen no more than approximately **EUR 25.**

After this decision, the new EPC for residential buildings was developed in cooperation with stakeholders. It consists of a user-friendly web-based tool where private homeowners can apply for an EPC for their house. Since 1 January 2015, all residential building owners (in total 4.5 million) received a temporary EPC (calculated on the basis of the national cadastral data) by mail. This certificate gives an indication of the energy performance of the residence. The owner can digitally change or add extra information on energy measures. Owners are also obliged to provide evidence of the measures taken, such as invoices and photos. This data is quite accurate, so the owner only needs to add limited modifications. Both existing and new data are checked by a qualified expert who is in charge of producing the definitive EPC registered in the database. The Dutch energy performance certification process for residential building owners comprises the following 4 steps shown in figure 21:

Figure 21: Infographic describing the 4 steps of the Dutch labelling process for residential building owners: 1) login, 2) uploaded proof, 3) validation by a recognised expert and 4) registration.

Source: EPBD CA (2016) Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports[113]

The results of the simplified web‑based approach from its introduction in January 2015 to December 2015 are:

- 4,5 million houses received a letter with information about the EPC and a personal pre‑setting in the EPC web tool;
- over 630 000 individual log-ins;
- over 510 000 registered definitive EPCs;
- costs were kept low because of competition, with an average of EUR 25 per EPC;

In **Czech Republic** a special tool for verification of the quality of issued EPCs was developed under the state subsidy programme EFEKT. The EPC quality verification tool is intended for non‑professional users and it allows verification of the EPC by a simple and clear calculation in case of any suspicion of intentional manipulation. The user of the verification tool enters the basic building's parameters (ideally acquired from the project documentation) and boundary condition values defined in the processed EPC. The boundary condition values are stated in the issued EPC protocol. The tool compares the boundary condition values for the assessed building and zones, against the values defined in the publicly available specifications and displays the discrepancies in a well‑structured graphic form. At the end, the verification tool compares the building parameters used by the expert who issued the EPC with the building parameters typed in and calculated by the verification tool. Depending on the size of the deviations, the colour of the fields changes from green (minor discrepancy) to red (radical differentiation). A simple and clear manual for proper verification has also been developed. The manual explains in a simple way the basic definitions (energy reference area, U value, delivered energy, etc.), shows which values are to be completed for successful verification and where these values can be found in the original EPC. The tool is accessible free of

[113] Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

charge. The website serves as a guide for building owners obliged to process an EPC. It also explains the meaning of each part of the EPC, how to read the EPC itself, and where to find the relevant legislation and links. In case the user discovers that the EPC was wrongly calculated, the State Energy Inspectorate is informed who may then carry out a deeper verification and depending on the outcomes may impose a penalty, or require corrections.

In **Hungary** the independent control system for EPCs was set up in 2013. A sample of 2.5% of the EPCs are randomly selected and checked by independent controllers every 6 months. A significant amount of useful information is obtained through this process about the experts, the controlled buildings, the typical mistakes and the general quality of the EPCs. Several recommendations have already been formulated and forwarded to the responsible Ministry of Interior including advice on improving the legislation. The system is regularly upgraded based upon the controllers' opinion. The share of incorrect EPCs is below 10%. The experts are also evaluated, particularly those who were checked more than twice. Afterwards, an evaluation list is carried out about 'good' and 'bad' experts which forms a basis for sanctions. If an EPC fails with an error of more than two energy classes, the expert loses his or her license for 3 years. Since the sanction is very strict, any suspicious EPCs have to be verified by at least two independent controllers.

The project *QUALICHeCK*[114] aims to provide a basis to better understand best practices regarding EPC input data in its report: "Towards compliant and easily accessible EPC input data"[115].

In order to arrive at correct assessment of energy performance, it is highly desirable that:

- the input data for the energy performance calculation are compliant (i.e. they have been obtained with the definitions and procedures of the applicable legislation) and evidence of this compliance exists;
- these input data can be found, seen and used by the experts in charge of the calculations by taking reasonable time, effort and money.

Possible approaches to improve compliance of EPC input data - best practices include:

1) Internet database of product performance characteristics

The "EPB product database" in **Belgium**[116] is an effective scheme to improve the compliance and easy access to product characteristics used as input data for the Energy Performance Certificate (EPC) calculation. This scheme has been successfully accepted by the market for many years.

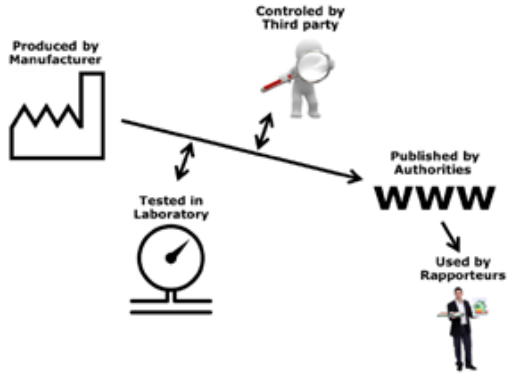
The product database provides the characteristics of hundreds of ventilation and thermal insulation products, as well as sunscreens. This scheme provides data about the energy performance of products with a recognition process (i.e. verification and publication of the data) based on third-party control.

114 http://qualicheck-platform.eu/

115 http://qualicheck-platform.eu/2016/03/report-compliant-and-easily-accessible-epc-input-data-final

116 http://www.epbd.be

Figure 22: Roles of the main parties involved in the product database in Belgium



Source: QUALICHeCK, report Towards compliant and easily accessible EPC input data

The database can provide input information for both new and existing buildings. Nevertheless, this is only useful for relatively recent renovations of existing buildings because the available data only covers products which are currently available on the market.

Although the EPB product database in Belgium is voluntary, the approach is successful and market acceptance is very high. Moreover, the manufacturers themselves are requesting this scheme as well as recognition of their products in the currently available categories. They are also interested in the development of new product categories.

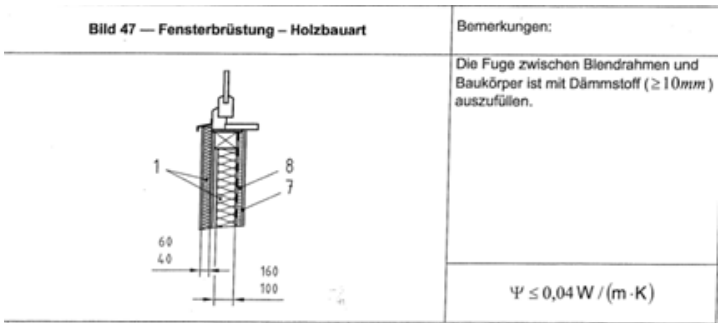
2) Easily accessible products performance data provided by the manufacturer

A voluntary scheme has been implemented in **France** by ventilation system manufacturers under the umbrella of their national association. For 19 types of different ventilation and air handling products, requirements have been defined regarding performances to be announced in the manufacturer's documentations (technical sheet, website, catalogue, and packaging).

3) Pre-calculated values for thermal bridges

In **Germany**, a set of pre-calculated values of heat transfer coefficients (or extra heat losses) for building thermal bridges has been implemented. The values are included in a dedicated DIN standard[117], which makes these values easily accessible. The German standard is regularly updated to include new construction techniques and currently very high-performance constructions are being added.

Figure 23: Example from the German standard DIN 4208, Beiblatt 2 (window parapet in a wood frame house)



Source: Qualicheck, report "Towards compliant and easily accessible EPC input data"

4) Qualification schemes for building airtightnesstesting

[117] DIN 4108, Beiblatt 2

In order to reduce variability in building airtightness test results between different experts and to improve consistency between test results and EPC input data, several countries (the **Czech Republic, Denmark, France, Germany, Ireland, Sweden, the United Kingdom**) have implemented schemes to qualify experts.

Figure 24: Number of qualified experts for buildings airtightness testing, January 2014

Source: Qualicheck, report Towards compliant and easily accessible EPC input data

The *LEAF*[118] project addresses information and trust barriers to maximise the impact of EPC recommendations. It aims to stimulate uptake and investment in retrofit by ensuring easy access to accurate, trustworthy data about EPCs, bringing together market actors – households, suppliers and policy makers - through a one-stop shop model entitled "Retrofit Action Hubs''. Good practices identified to render EPCs more end-consumer friendly include providing information on: financial savings on energy bills; potential maintenance costs; grant levels; and costs (both upfront and bill saving) of energy performance measures as compared with similar maintenance measures (e.g. external insulation as compared with simple façade painting). The langue used should also be user friendly, for example, talking about running costs rather than energy efficiency.

- ***Electronic databases for wider access and use of EPC data***

Buildings certification and technical building systems inspections, stemming from the EPBD, have the potential to yield a comprehensive data source on the energy performance of buildings. EPC schemes are a tool for policymakers that could be used for mapping and monitoring the national and European building stock and, if properly implemented, they could allow for assessment of real market needs in terms of investments and the potential for energy efficiency improvements in the building sector[119].

The EPBD CA provides the example of **Denmark** and **Ireland** where the potential of central registers of certificates and reports was exploited to determine the effectiveness of policy interventions.

Ireland in 2008 launched a pilot grant scheme for home energy efficiency upgrades which was based on 'before and after' EPC data, calibrated with EPC data modelling, assessment of energy bills from a sample of participants. It informed the final design and evaluation system of a full grant scheme.

In Denmark, an EPC database was used to calculate scenarios for potential energy savings in different

118 http://www.lowenergyapartments.eu/

119 EPCs across the EU, 2014, BPIE

building types and ages and the necessary investments, informing the government's energy saving strategy established in 2012.

The Danish database gathers a very wide range of information with respect to the building stock allowing analysis of the impact of certification scheme on the price of buildings. A study[120] made in 2013 showed that sales prices of single‐family houses increase in line with improved EPC ratings. The result is reached by statistically comparing the energy certificate and the price of all single family houses sold in 2011 and 2012. By doing the same with the sales of houses between 2006 and 2012 it became clear that, over time, the energy certificate has had a growing and strong effect on sales prices[121].

In the same field, Copenhagen Economics produced a study[122] on the relationship between house prices and energy ratings based on an econometric analysis of 365 000 sales of single-family houses in Denmark from 2006 to 2014. The input data for the study came from energy valuation of houses in Denmark since 2006, obtained from the EPC central register. The main conclusions were:

- There is a clear correlation between a high energy rating and a high sales price.
- However, the energy rating is not yet fully reflected in the sales price: the higher sales price induced by a higher energy rating is not as high as the saved future energy cost over time would justify.
- The energy label's effect varies with different buyers and houses (the effect of energy rating depends for example on heating type, it is considerably greater for houses where the source of heating is more expensive, e.g. gas more than DH).

Apart from EPC information stored in the central database, EPCs can be used in various other contexts, e.g., by adding the EPC as a supporting document to the national Green Building Council assessment scheme (e.g., in **The Netherlands, Austria**), using the EPC for specific programmes (e.g., "fresh schools" programme in The Netherlands), or as a supporting document for subsidies rewarding improved energy efficiency (e.g. **Cyprus, Austria**).

For example in **Greece**, detailed data from building energy audits are being used by an ad-hoc national steering committee for updating the national EPBD legislation to gain additional insight for the building stock. In addition, over the years EPC data have been analysed for research purposes. Recently, in the framework of the project *EPISCOP*E[123], EPC data were exploited for clustering available information in terms of the critical parameters that characterize Greek residential buildings. EPC data with actual and calculated energy consumption were also used to derive empirical adaptation factors to improve normative calculations from the EPCs for more realistic estimates.

EPISCOPE carried out monitoring activities to track the progress of housing stock energy performance and, by obtaining data for measured energy consumption via surveys, and cross-referencing these with EPC data, it was able to analyse future policy scenarios. The project found a persistent problem with availability of reliable primary data on Europe's housing stock, despite the improvements made on this with the advent of EPCs. Only **the UK** has put in place a comprehensive regime of measured data collection, via its annual National Housing Survey – an approach which the project strongly recommends to be replicated in other countries. Nevertheless, given the expense and effort, **the UK**

120 Jensen, O.M., Kragh J. & Hansen A.R., 2013. Energy label and sales price (In Danish: "Energimærke og salgspris"). Danish Building Research Institute, Aalborg University.
EPBD CA (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at:
https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

122 Copenhagen Economics *Do homes with better energy efficiency ratings have higher house prices?,* Danish Energy Agency 18 November 2015

123 See EPICOPE project www.episcope.eu

approach is unlikely to be replicated elsewhere; the project also puts forward recommendations for a reduced sample survey approach that would give the minimum acceptable level of useful data[124]. Such an approach would help to close the current gaps in building performance data.

A major output of *EPISCOPE* was its data tool for the residential building stock[125] which features on the BPIE Data Hub[126] residential building stock statistics, modernisation trends, and also national building policies and regulations including NZEB definitions. The tool also includes steps to harmonise Europe's building stock statistics, for example to account for the different ways of measuring building floor areas.

The *Request to Action* project[127] identified best-practices related to the EPC databases in **Portugal** and **Austria.**

In **Portugal**, the EPC database is used to verify the effectiveness of some EE policies and to measure the impact of new regulations and energy performance improvements including of public buildings. It helps to identify and analyse the financial cost and potential savings from the recommendation stated in the EPC. Based on around 1,1 million recommendations made so far by Qualified Experts, the average findings per building are as follows: EUR 4 500 of estimated investment costs and EUR 450 of potential yearly energy cost reduction. The information available in the EPC database is used to clearly validate the need and effective implementation of recommendations for the purpose of finance programmes (under the 2020 programme eligible measures must comply with minimum energy performance requirements from EPBD and lead to an improvement of at least 2 energy ratings) and for designing funding schemes for building refurbishment. EPC information was used to assist the redesign of the building codes in particular the new energy performance of buildings regulation by providing real values of buildings elements and technical systems. It provides credible information for Real Estate market. ADENE (Agencia Para A Energia) allows access to databases via a website. EPCs are used for a home Energy Efficiency Portal for Consumers. Consumers can obtain detailed information about the energy performance of their house and a One-Stop-Shop to receive proposals for improvements.

In **Austria**, the implementation of the Energy Performance of Buildings Directive offered the opportunity to start an EPC harmonisation process within Austria, aiming to develop a common calculation methodology, and to implement further elements like HVAC systems, as well as to enhance regular inspections.

In 2007 a database for collecting EPCs and inspection protocols was established in the **Austrian provinces of Salzburg, Styria and Carinthia**. Automatic plausibility checks and random checks took place for the uploaded data. The database is internet based and is used for registering EPCs, as well as for analysing the available data for different monitoring activities. The database is also used by research institutions and it was successfully used in European and national projects (e.g. *EPISCOPE, TABULA, Request2Action, R-Bau*) to enable national pilot actions: developing building typologies, adapting energy strategies in the building sector, calculating energy savings.

An EPC register was established in 2008 in **England and Wales**[128]. It is a legal requirement to enter the EPC on the register before giving it to the person who requested it. All documents recorded on

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124 See EPICOPE report "Tracking of Energy Performance Indicators in Residential Building Stocks" available at: http://episcope.eu/fileadmin/episcope/public/docs/reports/EPISCOPE_SR4_Monitoring.pdf

125 Available at: http://www.buildingsdata.eu/data-sources/episcope-data

126 Available at: http://www.buildingsdata.eu/

127 Request to Action project IEE/13/789, European Best Practice meeting on EPC Databases, 04.11.14, Brussels

128 CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

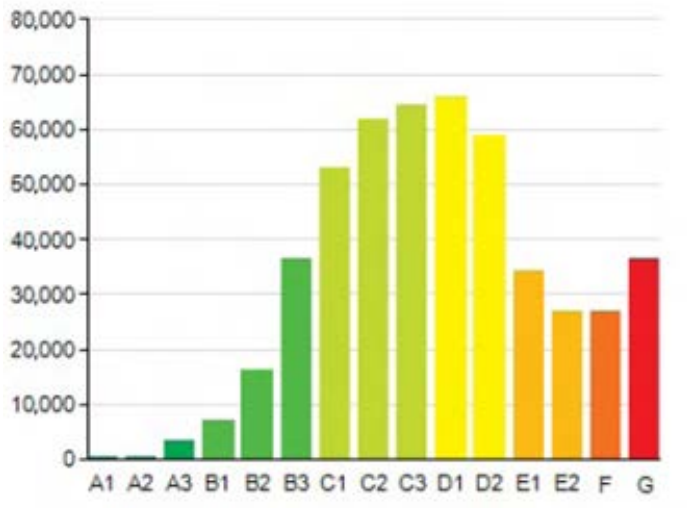
the register are retained for at least 20 years. The register also supports enforcement activities, reduces fraudulent issue of certificates/reports, and allows statistical analysis to inform policy making and improve understanding of the building stock.

An effective use of the EPC database lies in combination with other databases. For example, in **Scotland** the local authorities need effective data on the housing stock to plan their energy saving programmes. They focus on areas with high levels of fuel poverty. Reliable information on buildings' energy performance, in combination with the data from other relevant databases in these areas, enables them to negotiate with energy suppliers accordingly[129].

Ireland provides a good practice example in terms of harmonised IT environment for the EPC (BER) scheme with a number of distinct but integrated IT systems to facilitate its regulatory role. These systems are interconnected with internal systems including an internal finance system, the BER quality assurance management system, and the Better Energy Homes grant management system. They are also used for derived publications by the Central Statistics Office.

To give researchers access to statistical data from the scheme, a BER Research Tool was developed. This tool provides access to information on all aspects of construction that affect the energy performance of residential units. This research tool has already been widely used by local authorities, Non-Governmental Organisations and researchers[130]. It provides key input data to the building energy model for the calculation of technical energy savings potential, informing the content of Ireland's national strategy for mobilising energy renovation of the building stock pursuant to Article 4 of the EED. The profiles of EPCs published from the initiation of the scheme up to the end of September 2014 are shown below[131].

Figure 25: Profile of residential EPCs in Ireland

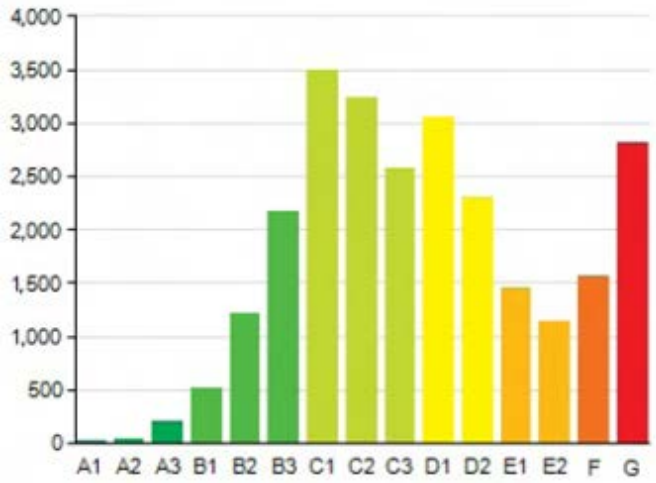


129 EPBD CA (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports. Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

130 For example the *EPISCOPE* project

131 EPBD CA (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports.

Figure 26: Profile of non-residential EPCs in Ireland



Source: CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports[132].

Policy feedback resulting from the good practice analysis

- **EPCs** and their underlying data have become the **key information source** to inform the general public about the energy quality of a building. Many good practices show that this instrument is performing better once it is simplified and **customized to local needs.** The present off-line information can trigger **further benefits** once an **online-provision of data** allows for comparisons **and online-support**.

3.4. Cross cutting issues

- ***Single energy performance calculation methodology for multiple users***

Today there are 35 different national and regional methodologies to calculate the energy performance of buildings. Such a variety prevents comparisons of potential building investments and their efficiency throughout the EU. This is also costly because it increases market fragmentation and creates barriers to the ability of technologies to be applied in similar conditions across the EU. A harmonised energy performance calculation method would have a positive effect on market readability providing appropriate market information for property valuation for the investors.

As reported by the CA EPBD[133] the **German** transposition of the EPBD resulted in an exemplary all-in-one calculation method DIN V 18 599 for energy performance of buildings.

The German government instigated the development of a holistic calculation method covering all the aspects mentioned in Annex I of this directive. The method is presumed to be suitable for differentiating between the different uses and combination of uses identified in typical German non-residential buildings. It combines knowledge from the areas of building physics, heating and hot-water systems, AC and ventilation systems and lighting.

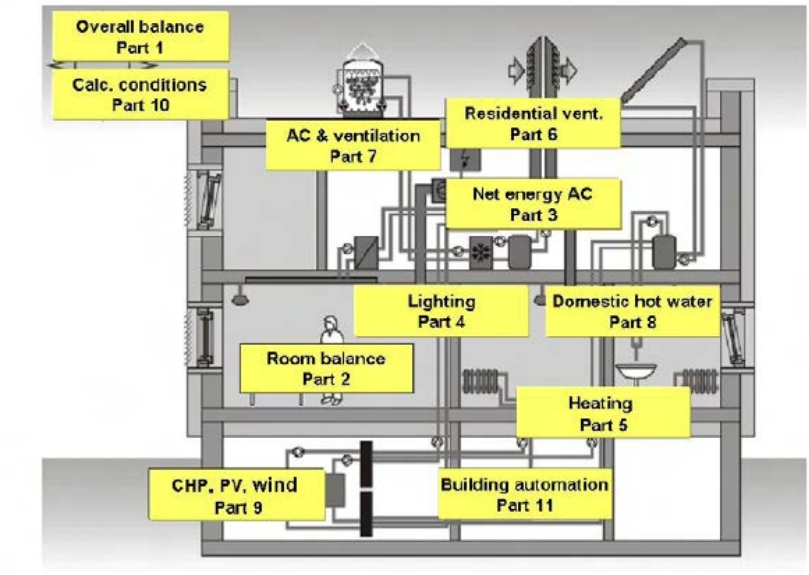
132 Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

133 CA EPBD (2016) – Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports Available at: https://www.dropbox.com/s/vaq0h8if64ypmlh/CA3-BOOK-2016-web.pdf?dl=0

The standardisation process led to a fruitful and exemplary cooperation of experts from very different backgrounds together with a common goal, i.e., to achieve energy performance calculation.

The technical basis for DIN V 18599 comprises several approved international standards (e.g., EN ISO 13 789, EN ISO 13 790). The calculation procedure is in principle in line with other CEN standards from the mandate 343, however they are much more consistent, unambiguous and clear to the users because of the 'all in one place' approach. Moreover, the 'common language' and consequent use of indicators and indices throughout this unique standard facilitates its use for legal purposes.

Figure 27: Structure of German calculation standard DIN V 18599



Source: CA EPBD (2016)

- ***Making energy efficiency a win-win game (best practices in addressing split incentives)***

Many potentially cost-effective investments in energy efficiency in buildings do not take place due to well-documented market failures, of which one of the most important is the so-called split incentive or owner/tenant dilemma. In the context of building-related energy, it refers to a situation where the building owner pays for retrofitted energy efficiency upgrades but is unable to recover savings from reduced energy use that accrue to the tenant[134].

The EPBD evaluation informs that split incentives play an important role. 30% of the EU population lives as tenants, according to Eurostat. Landlords may have little incentive to invest in housing stock improvements as return on capital employed can be limited.

In 2009, **France** passed a law ('loi MOLLE') which allows social housing companies to recoup energy savings from tenants when they invest in the energy retrofit of the building, thus overcoming the split incentive. Through this mechanism, 50% of the energy cost savings generated by the investments are invoiced to the tenant through what is called a 'third line of invoice' (on top of the rent and usual rental charges). This third line can be charged for 15 years but remains a fixed amount even if energy cost savings tend to increase over time.

134 JRC report (2014) Overcoming the split incentive barrier in the building sector; available at: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC90407/2014_jrc_sci_pol_rep_cov_template_online_final.pdf
See also the presentations of the JRC workshop on "Unlocking the energy efficiency potential in the rental & multifamily sectors" available at: http://iet.jrc.ec.europa.eu/energyefficiency/node/9115

This mechanism was used by ICF Habitat, one of the biggest French housing companies with 100 000 dwellings, in the implementation of the first energy performance contract (EnPC) in social housing in France, funded through the project *FRESH* (Financing energy Refurbishment for Social Housing)[135].

In a 64-dwelling estate in **Schiltigheim** (**Alsace** region), the EPC signed in 2011 with SPIE[136] reduced energy consumptions by 47% and provides a guaranteed level of energy consumption for 19 years. In Schiltigheim, tenants agreed to return 50% of the energy savings. However, due to the long payback time of the project, this represents only 27% of total expected savings and around 8% of investment costs.

The 'third line of invoice' thus allows owners to recoup part of the energy savings from tenants, however the amounts are limited to 50% over 15 years, whereas most investments have an energy payback time around 25 years in social housing. Additionally, tenants need to give their agreement through a vote, which complicates the use of this mechanism, and in consequence it is not used as much as it could be. In private housing, the amounts that can be recouped are a lump sum between EUR 10 and 20, which represents an even lower contribution for the landlord[137].

In **Reggio Emilia (Italy)**, the social housing company ACER Reggio Emilia implemented an energy performance contract with 50% energy savings, guaranteed over 12 years. 60% of the energy savings were allocated to the ESCO whereas tenants received the remaining 40%, representing a 20% lower bill every month. This pilot project was possible because 100% of tenants gave their agreement.

As a result of the project *FRESH*[138], the regional legislation (law 24/2001) was modified in 2013 in order to make it easier to recoup energy savings from tenants when implementing energy performance contracts. In 2016, several social housing companies in **Emilia Romagna** are preparing a large-scale programme to retrofit their buildings through energy performance contracts, through the project *LEMON*[139].

Public authorities are often confronted with a challenge when it comes to using energy more efficiently in their buildings: they may own the buildings, but often do not occupy the buildings themselves. There is a split incentive between the day-to-day users of the buildings and the owners, usually local municipalities, which pay for the energy bills.

- The project *EURONET 50/50 MAX*[140] is an example of how this challenge can be successfully addressed thanks to an innovative concept that helps change the behaviour of public building users and enables sharing of the savings achieved on the energy bills between the municipalities and the building users. Thus, employees, and in the case of schools, the pupils have a direct incentive to save energy.
  EURONET 50/50 MAX is the strategic roll-out in 13 countries of the 50/50 concept: municipalities and schools collaborate to share the benefits of energy savings achieved by buildings users (via a financial pay-out of 50% of the energy savings to the schools/ the other 50% is a net saving for municipalities who pay the energy bills).
  The project has so far been implemented in 516 schools and 45 other public buildings. It has involved more than 88 430 pupils, 6 450 teachers and 100 city councils working together to save energy. Preliminary figures show that in 2014 most of the participating schools managed

135 https://ec.europa.eu/energy/intelligent/projects/en/projects/fresh

136 SPIE SAS operates as a multi-technical services company in France and internationally. It offers electrical, mechanical, and HVAC engineering services; and ICT services, www.spie.com

137 For more information: www.buildup.eu/en/practices/publications/energy-performance-contract-64-social-dwellings-schiltigheim-france

138 https://ec.europa.eu/energy/intelligent/projects/en/projects/fresh

139 http://cordis.europa.eu/project/rcn/200000_en.html

140 http://www.euronet50-50max.eu/en/

to reduce electricity consumption, heat consumption or both. The 50/50 methodology has been integrated into 148 local strategies (most of them are SEAPs of the Covenant of Mayors); into 11 regional strategies, most of them energy strategies; and finally in 4 national strategies.

- A key part of the *RentalCal*[141]project is on regulatory barriers, especially split incentives between landlord and tenant. Initial results prove that only three participating countries (**Czech Republic, Germany, Spain**)[142] offer a formal regulatory regime that allows for legal rent increases for improved energy efficiency. While one key concern of RentalCal is to render these regulatory deficits transparent so that national law makers can address the issues, another is to open up the discussion within the industry regarding green value drivers beyond rent premiums. Based on these guidelines a modular calculation tool will be developed, together with a web based information platform. Thus*, RentalCal* aims to contribute to a harmonization of the methodologies and calculation standards in the field of profitability assessments for energy retrofitting investments in the private rental housing sector.
  The eleven partners of the *RentalCal* consortium represent housing markets from eight EU member states (**Czech Republic, Denmark, France, Germany, Great Britain, Poland, Spain and the Netherlands**), each with a distinct regulatory and socioeconomic framework for housing provision, *RentalCal's* consortium members cover a majority share of the EUs largest rental housing markets with a total of about 33 million dwellings in the private rental sector, with about 46 % of it dating from 1980 or earlier. With an estimated increase in refurbishment rates of about 10 % directly or indirectly induced by *RentalCal,* this will lead to an estimated impact of about EUR 190 million in additional investment in deep refurbishment with a total of 474,25 GWh in saved energy over a five year period.

- ### *Tackling fuel/energy poverty e.g. in residential accommodation such as social housing*

Among the first programmes to tackle energy poverty was the "Warm Front" programme in **the UK**, introducing *inter alia* energy efficiency measures in dwellings to reduce the common adverse effects of energy poverty. Even though the programme ceased to exist after 2013, its review suggests that every single GBP invested into Warm Front produced as much as GBP 1 to GBP 36,3 in benefits over a 20-year period in terms of monetary savings and excluding indirect benefits such as improved health and living conditions[143]. A total of 2,3 million households received assistance from the Warm Front scheme since it was launched in 2000. Grants were available for improvements such as: loft insulation, cavity wall insulation, hot water tank insulation, heating system improvements.

141 http://www.rentalcal.eu

142 Czech Republic: http://www.rentalcal.eu/The%20Czech%20rental%20market; Germany: http://www.rentalcal.eu/The%20German%20rental%20market ; Spain: http://www.rentalcal.eu/The%20Spanish%20Rental%20market

143 Sovacool B (2015): Fuel poverty, affordability, and energy justice in England: Policy insights from the Warm Front Program. Energy 93, pp. 361-371

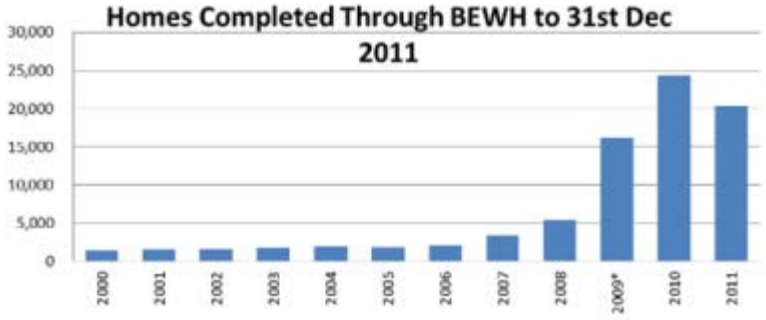
Table 2: Coping strategies undertaken by fuel poor households in the United Kingdom

	% households surveyed
Turned heating off, even though would have preferred to have it on	35%
Turned the heating down, even though would have preferred it to be warmer	33%
Turned out lights in my home, even though would have preferred to have them on	22%
Turned the heating down or off in some rooms but not others, even though would have preferred not to	20%
Only heated and used one room in the house for periods of the day	14%
Used less hot water than would have preferred	15%
Had fewer hot meals or hot drinks that would have liked	4%
None	37%

Source: Sovacool B (2015)

Other examples from **the UK** and **Ireland** combine the energy efficiency obligations under article 7 of the EED obliging utilities to undertake energy efficiency improvements with actions targeting vulnerable consumers (see chapter 2.1.). Following the Irish government's Energy White Paper of 2007 and several in-depth studies of energy poverty in the country , the programme 'Better Energy Warmer Homes' has been established in Ireland and lead to a significant number of refurbishments to date (Figure 28).

Figure 28: Homes completed through the BEWH scheme



Source: SEAI[144]

The **Irish** pilot action of the project *EPISCOPE*[145] has produced an interactive map of north **Dublin** that combines data from Energy Performance Certificates with other data from the population census. In this way it is possible to map areas of fuel poverty, by identifying districts that overlap poor energy performance with low income households. Additionally, **the UK** partner BRE supports the annual UK housing surveys, which track both energy performance and fuel poverty. Presentations on both these pilot actions were presented in the EPISCOPE Workshop 'Towards an energy efficient European housing stock –mapping, modelling and monitoring refurbishment processes'[146].

Romania has implemented an 'Improving Energy Efficiency in Low-Income Households and Communities programme' in recent years to address fuel poverty effectively. The programme, originally designed to support 110 000 people and to reduce emissions in the amount of 660 000 t CO_2e, has overachieved its original targets and helped some 160 000 people in Romania to live in more energy efficient apartment blocks and reduce their heating bills.

144 Available at: http://www.seai.ie/Grants/Warmer_Homes_Scheme/WHS_Statistics/

145 http://episcope.eu

146 http://internal.episcope.eu/fileadmin/episcope/internal/meeting/pm5/workshop/EPISCOPE_ExpertsWorkshop_Presentations.pdf pages 88-122

A number of EU-funded projects, such as *POWER HOUSE*, *POWER HOUSE NZC* [147]and the new *TRANSITION ZERO* project (see chapter 3.1.) focus on working with (social) housing associations to boost the energy efficiency of housing of this vulnerable group of consumers. The *POWER HOUSE NZC (nearly-Zero Energy Challenge)* project provided a platform for a pan-EU knowledge exchange among public, cooperative and social housing practitioners to learn from each other. The project was coordinated by Housing Europe, the European Federation of Public, Cooperative and Social Housing, working with its network of 42 national and regional federations which together gather about 43 000 public, social and cooperative housing providers in 22 countries. Altogether they manage over 26 million homes, about 11% of existing dwellings in the EU. More than 30 case studies of Nearly-Zero Energy Buildings across the EU are documented and energy consumption before and after the nearly-zero energy refurbishment monitored[148].

- ***Best practices on skills improvements of buildings professionals***

Development of skills in the construction sector is crucial to meet NZEB targets and secure performance in the long term, since negative experiences have an impact on the whole market uptake. Consumers should be able to rely on the skills of the building professional and get value for money, which means state-of-the-art information and advice, achieving the expected (energy) performance, a maximum operational lifetime and a safe and healthy building. Schemes to upgrade the quality of the works have been developed through initiatives like *BUILD UP Skills*.

The training of energy experts is also essential in ensuring the transfer of knowledge on issues related to the EPBD. Within the framework of Article 17, Member States must ensure that the energy performance certification of buildings and the inspection of heating and air-conditioning systems are carried out in an independent manner by qualified and/or accredited experts. The EPBD CA identified the following good practices in ensuring high qualifications of accredited experts:

- **Germany:** the national list of energy efficiency experts for the support programmes of the Federal Government in the field of energy efficiency aims to improve the quality of local energy consulting services by means of uniform qualification criteria, proof of regular advanced training and random checks of the results.
- **Slovenia**: a common training/certification article in its legislation for all three Directives EED, EPBD and RES and is achieving synergies by implementing a co-ordinated modular training approach.
- **Croatia:** training programmes on energy efficiency for professionals (architecture, construction and building services) have been implemented since 2009. The objective is to enhance knowledge of engineers that, with their competencies, are able to consider construction works and buildings as a whole in terms of energy. Since the beginning of programme implementation, more than 2 200 engineers have completed these training programmes, of which the majority are authorised to carry out energy audits, energy certification of buildings and regular inspections of heating and cooling or AC systems in buildings. This Croatian model of creating professional and competent staff for carrying out energy audits and energy certifications of buildings has also been implemented by other countries in the Balkan region.

BUILD UP Skills is an initiative implemented under the framework of the IEE programme[149] to unite forces and to increase the number of qualified workers in the building workforce in Europe.

The project focuses on the continuing education and training of craftsmen and other on-site workers

147 http://www.powerhouseeurope.eu/home/power_house_nearly_zero_energy_challenge_partners/the_project/

148 Power house and Power house Nearly-Zero Challenge financed under Intelligent Energy Europe: http://www.powerhouseeurope.eu.

149 IEE Calls for proposals 2011, 2012 and 2013

in the field of energy efficiency and renewable energy in buildings and has three main components:

1. **Establishment of national qualification platforms and qualification roadmaps to 2020 (Pillar I: 2011-2013)**

   The aim was to gather all relevant stakeholders in a country in order to develop and agree on a strategy and roadmap, after having identified and quantified needs and priority measures. The national reports include information on current characteristics of the building workforce, skill needs and gaps, barriers to training, existing strategies and policies. Thirty national projects have been supported in the 28 EU Member States as well as in Norway and the Former Yugoslav Republic of Macedonia which are now all completed.

2. **Development and upgrade of qualification and training schemes (Pillar II: from 2013)**

   This funding component invited proposals to introduce new or upgrading existing qualification schemes. These should be based on the *BUILD UP Skills* national roadmaps developed under Pillar I.

   Ten national projects (first batch) started in October 2013 in Austria, Cyprus, Estonia, Finland, Germany, Ireland, Latvia, the Netherlands, Romania and Spain. Twelve additional projects (second batch) were recommended for funding in March 2014. These projects have started in September 2014. They cover the following countries: Bulgaria, Croatia, Greece, Former Yugoslav Republic of Macedonia, Hungary, Italy (two projects), Lithuania, Luxembourg, Portugal, Slovakia and Sweden.

3. **Europe-wide coordinated support activities (EU exchanges)**

   The objective is to support the exchange of best practices through meetings of all participating *BUILD UP Skills* projects. Six EU exchange meetings were organised by the EASME between 2011 and 2014. In addition projects were gathered in peer review teams and also set up separate peer review meetings and activities.
   The achievements of the project are the accreditation of 17 training centres, the mobilisation of more than EUR 40 million for the implementation of the training schemes; the training of >120 trainers, the triggering of +/- 2 000 trainings reaching around 10 000 persons.
   The evaluation[150] of the initiative concluded that *BUILD UP Skills* has been a success in the way that the initiative has managed to create national platforms gathering various construction sector actors and stakeholders throughout Europe including representatives of the construction industry, the training sector, the energy sector, politicians and decision makers.

The evaluation recommended maintaining the momentum of the *BUILD UP Skills* Initiative and to continue the platform work and the launch of more Pillar II projects.

Additionally, the World Economic Forum[151], has highlighted *BUILD UP Skills* as an example of best practice in construction.

Other *BUILD UP* success stories include:

- *BUILD UP Skills Construye2020* **(Spain):** The project developed an app for mobile devices[152] which can be used as a training tool on good practices for the renovation of buildings related to different activities covering notably aluminium carpentry, insulation, renewable energy systems, energy efficiency and efficient installations. Moreover the project is working with the

150 COWI, Evaluation of the BUILD UP Skills initiative under the Intelligent Energy Europe Programme

151 http://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_full_report__.pdf, p. 46

152 https://play.google.com/store/apps/details?id=com.esampedro.simuladorApp

national qualification institute in the development of a new qualification for the installer of ground source heat pumps.

Figure 29: *BUILD UP Skills Construye2020* infographic

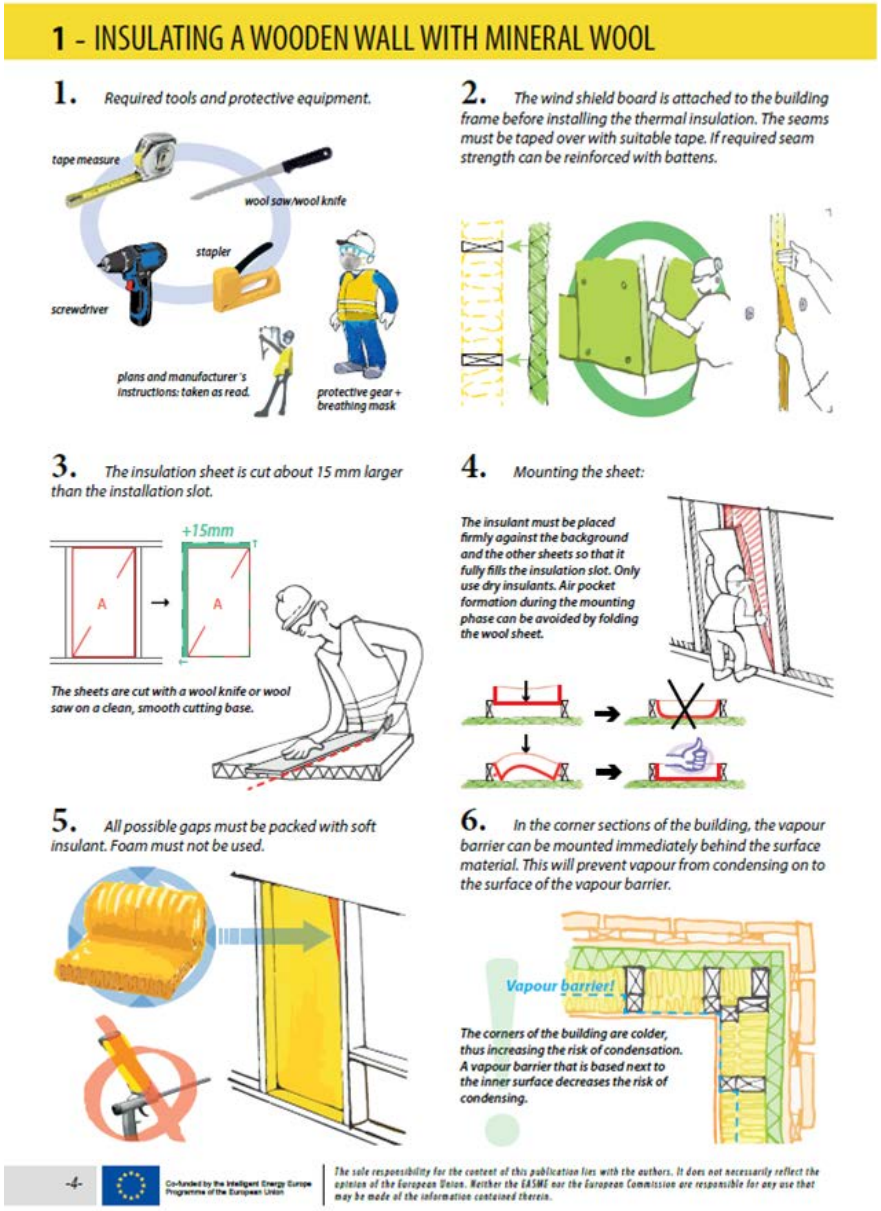
Source: *BUILD UP Skills Construye2020*

- *BUILD UP Skills Netherlands@Work* **(Netherlands):** Eight profiles of blue collar professional competences have been created constituting competence profiles for an occupation including the skills required when building energy-neutral buildings. The project developed an app[153] for mobile devices which enables blue collar workers to choose the adequate course based on their previous knowledge.

- *BUILD UP Skills BEEP* **(Finland):** the BEEP partners have developed an innovative training concept (both for trainers & workers) based on best-practice of energy-efficient construction, based on a comprehensive toolbox including: sets of slides and didactic videos in 5 languages, material dedicated to workers self-learning, a pilot training for 'change agents' (experienced workers/mentors who can help to set an example and explain how to improve the quality of the work) and an on-site training ambassador who plays a critical role in attracting workers' to the pilot trainings.

153 https://play.google.com/store/apps/details?id=bus.app.apk

Figure 30: Training material BEEP



Source: BUILD UP Skills BEEP

- *BUILD UP Skills Qualishell* **(Romania):** The project supported the implementation of national qualification schemes for installers of thermal insulating systems and high efficiency windows systems to ensure high performance building envelopes and support the move towards the implementation of NZEBs.
  The project also developed effective mechanisms to ensure a large-scale and long lasting implementation of the two developed qualification schemes, by use of existing networks, evaluation of competences acquired, and promotion of effective partnerships between education system and construction sector[154].

An open training and qualification platform for professionals (architects, engineers, building

[154] The results of the project have been included in the QUALICHeCK's report (p.40) on "good practices for improving quality of the works".

managers) has been developed within the Horizon 2020 project *PROF-TRAC*[155] to focus on multi-disciplinary skills cutting across traditional professional disciplines. It has carried out a skills mapping exercise, which is an equivalent of a BUILD UP Skills Pillar I status quo report, but for professionals instead of blue collar workers. In addition, PROF-TRAC has created a free online repository of training materials, enabling potential trainers to design their own course.

The **Alsace** region in France is setting up an integrated service for energy renovation of private homes, including the provision of tailored financing, in the frame of the project *MLEI PSEE Alsace*. On the supply side, it is developing a training programme on deep renovation of detached homes, which aims to encourage craftsmen to create consortia that are able to deliver a holistic offer for deep renovation rather than individual contracts. This approach, called DOREMI, allows each craftsman to better estimate the cost of his own lots and thus reduce the risk of over-pricing when craftsmen make a quote, while increasing the delivered energy performance. The DOREMI approach has been successfully implemented in the South of France and has proved to keep deep renovation costs under EUR 400/m2, instead of EUR 500-600 without coordination of the craftsmen.

Technically, craftsmen are taught to use a so-called 'Universal Technical Solution' which has been modelled specifically for the detached housing stock of Alsace. It consists of a standard package of solutions which allow reaching the low energy renovation standard with a relatively good accuracy, without using a thermal engineer for each project which represents excessive costs.

Training of craftsmen consists of 2 training modules: module 1 is 3 days of training for all professionals, after which the expectation is that some of the craftsmen will create consortia. These consortia can then follow module 2, during which they are accompanied for 30 hours on actual renovation projects.

- ***Smart homes& buildings – not a distant future (IT solutions for better buildings energy performance, multiple benefits for occupants and better integration of the building in the energy system)***

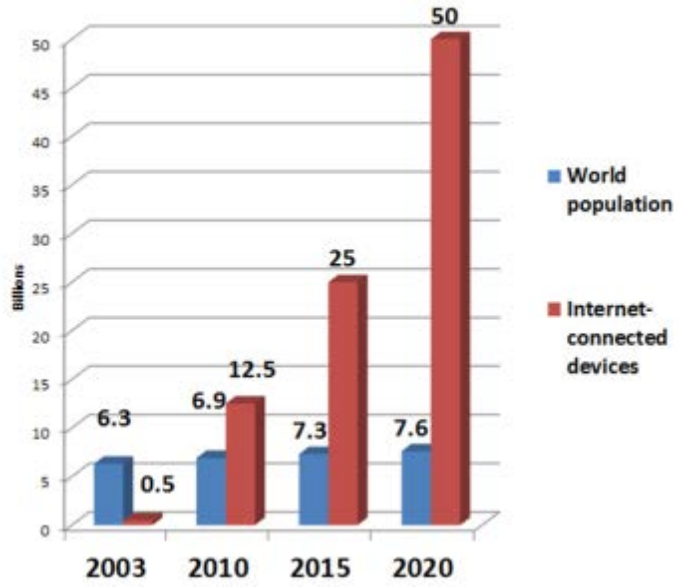
Information and telecommunication technologies have an increasingly important role in the transition towards a more sustainable future: dematerialisation, saving of resources by disrupting existing business models towards shared economy with higher efficiency. ICT also has the potential to change behaviour, reduce travel, improve the efficiency of products, systems and processes, and specifically to accelerate energy market transformation enabling demand-response, real time energy management and integration of intermittent renewable energy sources. The implementation of appropriate ICT solutions will enhance network efficiency and improve overall system operation by better matching local supply and demand.

At building level ICT ensures an optimised **energy management** supporting design, **monitoring and control** with smartness and self- learning capacities; **user information, enhancing comfort** and ensuring optimal indoor conditions for building occupants; real time communication and **interactions with the grid** allowing active demand-side services to energy system (demand response and integration of renewable energy sources).

The underlying challenge is to keep the energy consumption of the growing amount of internet-connected devices under control as a large share of the electricity is consumed in network-enabled "standby".

155 http://proftrac.eu/open-training-platform-for-nzeb-professionals.html

Figure 31: Number of internet-connected devices comparing to the world's population



Source: "The Internet of Things – How the Next Evolution of the Internet is Changing Everything", Dave Evans, Cisco, April 2011, p3

Development of standard communication protocols is also crucial as well as the challenge related to data protection and security.

Building Information Modelling (BIM) appears as an instrument to help structure, manage and integrate building project information, facilitating the design, simulation, analysis and operation of energy efficient solutions. This effectively contributes to increased collaboration, efficiency in terms of materials, costs and time as well as enhanced project quality. BIM is a digital representation of the characteristics of a building and its systems. It is intended to be used to save and share information before and during construction. The true benefits of BIM are obtained when the technology is applied throughout the project life cycle, from design to demolition. Many projects funded under H2020 EeB PPP address the energy efficiency of buildings and infrastructures through the use of ICT and novel BIM approaches[156].

One of the principal innovations being developed in the project *MORE-CONNECT*[157] is to link data from existing buildings with manufacturing tools for an automated construction process: data on building characteristics, potential for energy efficiencies, and end-users demands are linked using **BIM systems** to steer industrial process and to enhance quality control. The benefits include:

- tailor-made solutions for individuals in a mass production way to optimize costs, environmental aspects and quality
- a nearly zero energy performance of the total modular renovation
- a maximum return on investment less than 8 years and with a limitation of the total renovation time of 5 days
- plug & play connection of modular components communicating by integrated (wireless) sensors and control components for performance diagnostics and control ensuring performances guaranty but also healthy indoor environment, safety and accessibility.

156 EeB PPP Projects Review 2016 : http://www.ectp.org/cws/params/ectp/download_files/36D3750v1_EeB_PPP_Project_Review.pdf

157 http://www.more-connect.eu

ZERO-PLUS[158] aims to develop entire districts of new high energy performance buildings, with interactive RES production and consumption. To this end the project is developing design, decision and support IT tools. ICT for smart energy management and demand-side services at district level (peak shaving for the DSO) is also developed under the *Rennovates*[159] project. The project develops a holistic systemic deep renovation concept developing smart energy-based communities resulting in energy-neutral housing maximizing the use of renewable energy. The procedure comprises several steps:

- A physical renovation installing a new façade, new roof. The roof contains PV panels (5-6 kW).
- All consumption is electrified (reduce dependency on gas), to this end, a pre-fabricated energy module is attached to the building, containing hot water storage, heat pump etc.
- The equipment in the energy module is foreseen with a gateway allowing for smart control of the equipment[160].

Figure 32: holistic systemic deep renovation concept- *Rennovates*

Source: http://rennovates.eu/

As stated in the EPBD CA report[161], IEE projects show that electronic monitoring and control has the potential to find energy saving opportunities more cheaply and effectively than regular inspection alone. A large number of buildings can be monitored continuously, with reports generated automatically when certain conditions are detected. The increasingly wide use of BMS may be the key to further progress, though standard data formats and transmission protocols will have to be agreed to ensure interoperability between devices and equipment from different manufacturers and the networks infrastructure.

- The *HARMONAC*[162] project had found that the average energy savings potential for individual AC systems was 35-40% of their measured consumption and indicated that monitoring was more likely to be cost-effective than universal inspection.
- The *iSERV*[163] project was designed to look at the prospects for automatic monitoring of buildings on a larger scale (data from 733 systems in 16 countries).

These projects concluded that automatic monitoring revealed many installations had much greater potential for savings than the inspections had suggested. The combination of inspections and monitoring helps to find measures that an inspection on its own would not be able to identify.

158 http://www.zeroplus.org/

159 http://rennovates.eu/

160 https://www.eebus.org/en/about-us/

161 *Concerted Action EPBD Report www.epbdca.eu/outcomes/Report_Automatic_Monitoring.pdf*

162 *HARMONAC* – Energy Consumption in European Air Conditioning Systems and the Air Conditioning System Inspection Process http://ec.europa.eu/energy/intelligent/projects/en/projects/harmonac
iSERV – Inspection of HVAC Systems through continuous monitoring and benchmarking http://www.iservcmb.info/

Monitoring as a partial substitute for inspections was assessed in the CA EPBD report[164] which concluded *Even if not always feasible at present, it is important that national legislation does not block the opportunity for automatic monitoring in future*.

The Province of Torino provides a good practice[165] by developing an IT tool (ENERCLOUD) to better support local authorities in monitoring and reducing their energy consumption. The analysis carried out by ENERCLOUD produces an understandable report, based on benchmarking data, useful for monitoring real improvements obtained by actions implemented by the local authority. Key success factor of this initiative was the presence of dedicated technical resources and an effective partnership between municipalities and energy providers. ENERCLOUD is a web-based cloud-computing software that enables monitoring and evaluation of the thermal/electric energy consumption of public buildings and of the electricity consumption of public lighting systems, using the data from energy bills. The software enables comparison of energy consumption with target values, identifying abnormal values and potential improvement areas[166].

The Energy Efficiency part of H2020 addresses the challenge of end-user behavioural change to achieve greater energy efficiency taking advantage of ICT:

- the *PeakApp*[167] project aims to develop and validate innovative ICT based system connecting energy markets and end-users. Although the focus will be on achieving energy savings through behavioural change, the solution will also enable increased consumption of renewable and low-priced electricity from the spot market using a dynamic electricity tariff. Validation under real life conditions in social housing will be carried out in Austria, Estonia, Sweden and Finland, involving 2 500 households, connecting them to social networks, motivating them through serious gaming, and boosting the efficacy of Smart Home building energy management systems.
- the *ORBEET*[168] project aims to develop an IT ecosystem for real-time energy performance monitoring and displaying. Users will be engaged with IT tools through intrinsic/extrinsic human motivators. The validation is foreseen in 4 public buildings in 4 countries. The action aims at triggering a 20% energy demand reduction per building, a 30% CO_2 emission reduction with a 2 years pay-back period.

Policy feedback resulting from the good practice analysis

- Addressing energy efficiency in buildings can have a positive impact not only in economic terms (in terms of the energy bills), but also improve public health and safety, by reduced mortality and morbidity due to poor indoor climate.
- With enhanced efficiency, there is a corresponding need for significantly increased technical skills. **Dedicated training and qualification schemes** need to make sure that worker qualifications keep pace with the technical complexity of buildings and building components.
- The **very dispersed nature of building performance calculation methodologies** is a **clear barrier** to ongoing uptake of best practices.

164 Concerted Action EPBD Report www.epbdca.eu/outcomes/Report_Automatic_Monitoring.pdf

165 identified by the *COOPENERGY* project http://www.coopenergy.eu/

166 For more information:
http://www.coopenergy.eu/sites/default/files/good_practice_files/39_Province%20of%20Torino%2C%20IT%20-%20ENERCLOUD%20software.pdf
http://www.cittametropolitana.torino.it/cms/ambiente/risorse-energetiche/progetti-energia-sostenibile/enercloud/enercloud

167 http://www.peakapp.eu/

168 http://orbeet.eu/