European Commission

European Construction Sector Observatory

Improving energy and resource efficiency

Analytical Report

November 2018

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1.
Introduction

"The energy efficiency is not a slogan, it is one of the most cost effective ways to support the transition to a low carbon economy and a key policy to implement the Paris Agreement. Besides, it is also an effective way to create investment opportunities, growth and employment domestically".

Climate Action and Energy Commissioner Miguel Arias Cañete at the EU Sustainable Energy Week, Brussels, 20 June 2017

The European Union has set out ambitions targets for energy efficiency and climate change over the coming decades. These targets have major implications for the construction sector, in terms of its overall resource efficiency and specifically the energy performance of buildings in accordance with the Energy Performance of Buildings Directive (2018/844/EU). Currently, buildings account for approximately **40% of the EU's energy consumption and 36% of its CO2 emissions**. The building stock is relatively old, with a large proportion of buildings built before the 1980s. The current replacement and renovation rates are not high enough to ensure that the full potential energy savings is achieved. For example, **64.9% of residential buildings in the EU were built before 1980**[1]. In parallel, the construction sector also requires high levels of resource inputs and accounts for 38% of the waste generated in the EU.

The Roadmap for moving to a competitive **low carbon economy in 2050** estimated that emissions from the built environment could be reduced by around 90% by 2050, through the introduction of **passive housing technology** in new buildings, the **refurbishment of old buildings** to improve their energy performance and the **substitution of fossil fuels** by electricity and renewables in heating, cooling & cooking[2].

↓ -90%

Reduction of emissions in EU
from the built environment by 2050

The **Roadmap to a Resource Efficient Europe**, published in September 2011, sets out the practical steps to reach the objectives of increasing energy and resource efficiency, in particular within the context of the building sector and construction more broadly[3]. The roadmap stressed that efforts on promoting high energy performance and renewable energy use in buildings need to be complemented with policies that promote resource efficiency, and to cover a broader range of impacts, taking into account the full lifecycle of buildings, from initial planning and manufacturing of construction products to final demolition and waste treatment and disposal. The more recent initiative of **Resource Efficiency Opportunities in the Building Sector**, published in 2014, further urges a more efficient use of resources consumed by new and renovated commercial, residential and public buildings and reduction of their overall

1 EU Building Stock Observatory https://ec.europa.eu/energy/en/eubuildings

2 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A Roadmap for moving to a competitive low carbon economy in 2050, Brussels, 8.3.2011, COM(2011) 112 final.

3 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Roadmap to a Resource Efficient Europe, Brussels, 20.9.2011, COM(2011) 571 final.

environmental impacts throughout the full life cycle. As the studies demonstrate, construction and demolition waste (CDW) makes up a third of total waste generated in the EU, however the average recovery for EU-27 is still below 50%[4].

Improving the resource efficiency along the lifecycle of buildings and recycling CDW will make the construction sector more competitive as well as reduce material use and environmental impacts associated with our built environment.

It is within the context of these long-term goals that the European Commission introduced **Construction 2020**[5] – its strategy for the sustainable competitiveness of the construction sector and its enterprises. This strategic policy agenda for the construction sector in Europe focuses on energy and resource efficiency under Thematic Objective **3 "Improving resource efficiency, environmental performance and business opportunities"**[6]. The related policy measures, foreseen in the Construction 2020 Action Plan, include the development of measures providing incentives for energy and resource efficiency within the framework of Cohesion Policy Funds and Horizon 2020, support through green public procurement guidelines, guidelines for the recycling and valorisation of construction and demolition waste, the provision of trainings, data collection and monitoring. The issues of energy and resource efficiency are high on the agenda at Member State (MS) level as well. A variety of policy responses have been introduced, taking the form of initiatives and government programmes aimed at supporting investment in energy and resource efficiency improvements, innovation and skills development.

Within this context, the purpose of the present Analytical Report is to draw a snapshot of the current energy and resource efficiency situation in the construction sector in the EU-28. Namely, **Chapter 2 provides a high level analysis of the state of energy efficiency and resource in the sector**, focusing on the quantitative analysis of the characteristics of the building stock and the waste and emissions generated through construction activity. **Chapter 3 provides an analysis of the main drivers of energy and resource efficiency**, namely regulatory measures and economic factors. **Chapter 4 provides an overview of the obstacles for increased energy and resource efficiency of the construction sector**, zooming in on the issues of insufficient investment incentives, lack of access to finance, low awareness and knowledge and finally skills shortage, which is a supply side obstacle. Finally, **Chapter 5 focuses on the main policy responses**, highlighting best practices and lessons learned from various national and regional programmes.

[4] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Resource Efficiency Opportunities in the Building Sector, Brussels, 1.7.2014, COM(2014) 445 final.

[5] European Commission, Construction sector competitiveness, https://ec.europa.eu/growth/sectors/construction_en.

[6] Communication from the Commission to the European Parliament and the Council, Strategy for the sustainable competitiveness of the construction sector and its enterprises, Brussels, 31.7.2012, COM(2012) 433 final.

2.
State of energy and resource efficiency

This chapter describes the current state of **energy performance of the building stock** as well as the **resource efficiency of the construction sector in the EU**. Based on the analysis of key performance indicators related to characteristics of the building stock, such as the number of insulated homes or the number of nearly zero-energy buildings (NZEB)[7], to renovation spending or to waste management, this section sets the scene in understanding key trends and figures.

State of energy performance of the building stock

This first section focuses of the energy performance of the building stock. Currently, **buildings account for approximately 40% of the final energy consumption in the EU**[8] and while many efforts and policy initiatives have been implemented to improve their energy efficiency, this issue remains central in reducing energy consumption across many EU MS.

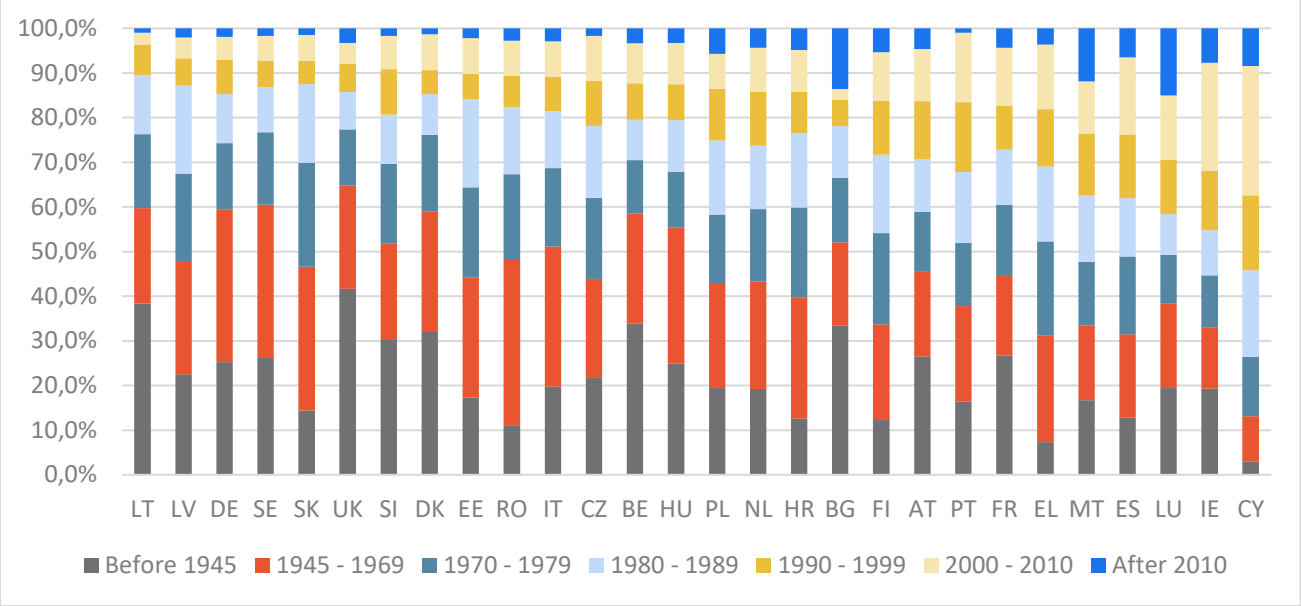
Age of the residential building stock

The residential building stock in the EU MS is relatively old. On average, 21.6% of the building stock in MS is built before 1945, 45.4% before 1969 and 75.4% before 1990. As can be seen in the graph below, in all MS with the exception of Cyprus, Ireland, Luxembourg, the proportion of the residential building stock which was built after 2000 is below 25%. A relatively old building stock means that without significant investments to improve the energy performance of old building stock, **the average level of energy performance of the national stock will remain low**.

[7] According to Energy Performance of Buildings Directive (EPBD) 2010/31/EU, the definition of Nearly Zero-Energy Buildings (NZEBs) is described in two different articles: Article 2 and Article 9 as well as in Annex I. Generic definition is as follows: "nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby", European Commission, National nearly zero buildings definitions, 2016, https://ec.europa.eu/energy/en/content/national-nearly-zero-energy-buildings-nzebs-definitions.

[8] Buildings Performance Institute Europe (BPIE), Europe's Buildings Under the Microscope. http://bpie.eu/wp-content/uploads/2015/10/HR_EU_B_under_microscope_study.pdf.

Figure 1 Age of the residential building stock – share of dwellings by year of construction, EU-28, 1945-2014, (%)



Source: EU Building Stock Observatory

Construction of new buildings and NZEB

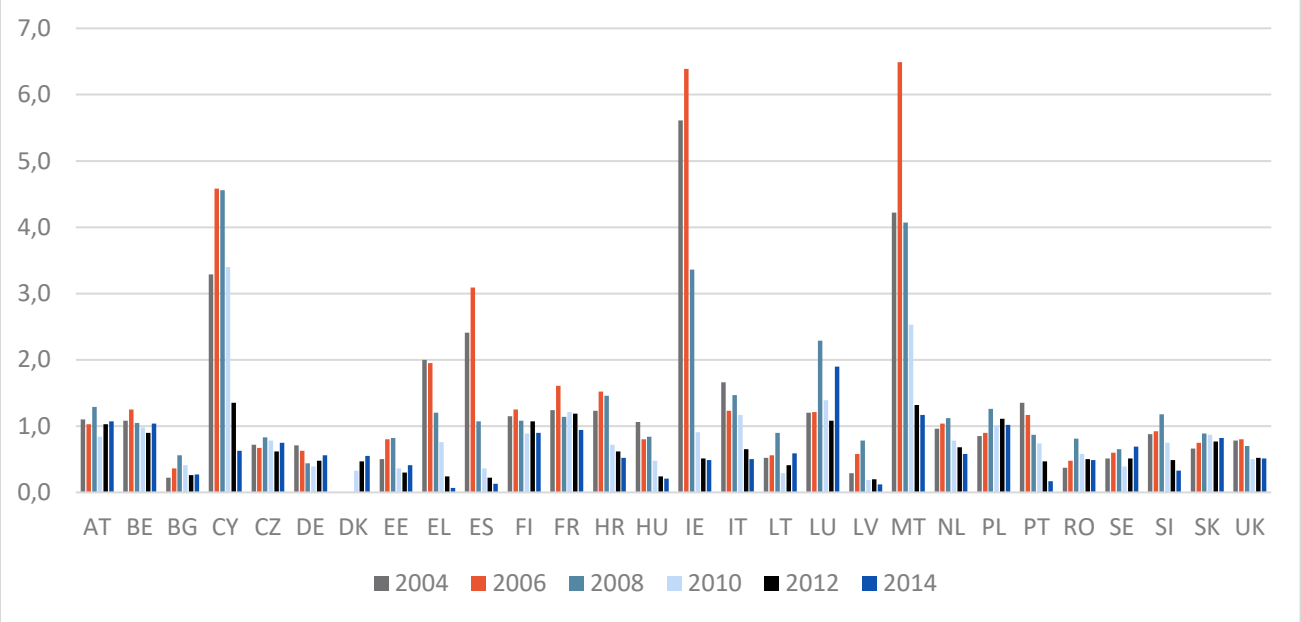
The rate at which new buildings replace the old stock or expand the total stock is low (about 1% a year depending on each MS). With construction rate significantly higher than the demolition rates, the building stock is naturally extending in size. This means that the increasing size will lead to increasing energy consumption and consequently increasing CO2 emissions.

However, when all new buildings will be nearly-zero energy buildings, i.e. by 2021, the cost-effective saving possibilities remain for new construction will be limited. Buildings are assets with a long lifetime and with a natural trend for low replacement and refurbishment rates. Given current construction and demolition rates, around 70% of the buildings, which are already built, will be occupied by 2050. At current renovation rates, it will take over 100 years to renovate the EU building stock[9].

Looking further into the recent construction of new dwellings, Figure 2 shows more detail on the differences between the MS and the volatility experienced in some markets. While most MS have maintained an annual share of new dwellings added to the residential stock of less than 1%, **smaller, island economies like Cyprus, Ireland and Malta experienced a construction boom in the early 2000s**, which was, however, brought to a halt with the onset of the 2007-2008 financial crisis. There was a substantial contraction of the Spanish market as well, the consequences of which are still felt today.

[9] European Commission, Proposal for a Directive of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings, Impact Assessment, Commission Staff Working Document. https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1490877353361&uri=CELEX:52016SC0414

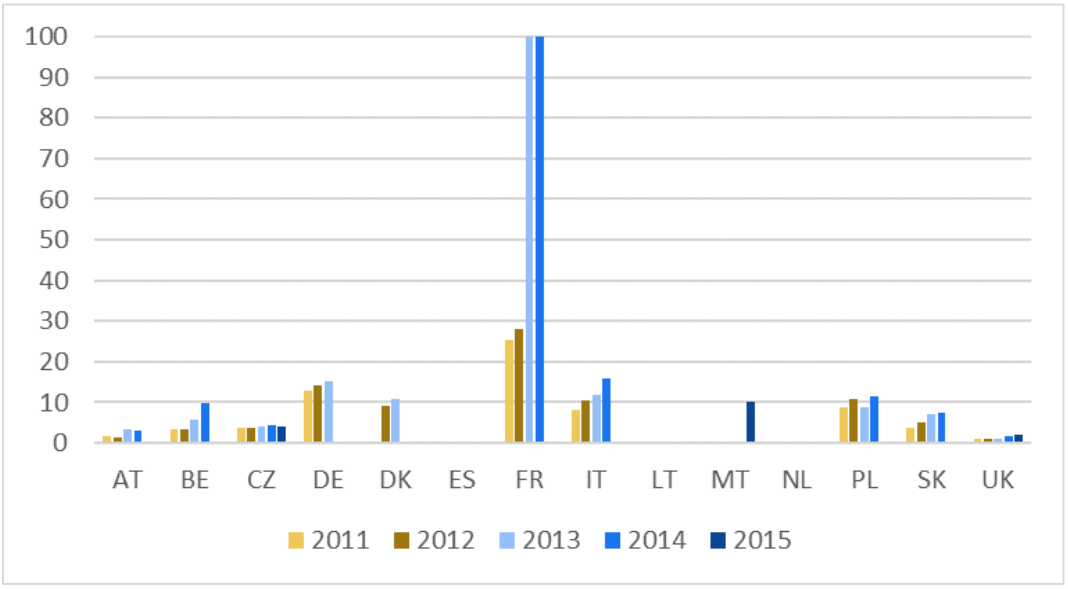
Figure 2 Annual share of new dwellings in total residential stock, EU-28, 2004, 2006, 2008, 2010, 2012 and 2014, (%)



Source: Eurostat

Furthermore, the share of NZEB in new construction for residential buildings has increased between 2011 and 2015[10] in all MS for which data is available, except Lithuania, the Netherlands and Spain. Notably, since 2014 all new residential dwellings in France have been NZEB dwellings.

Figure 3 Share of NZEB in new construction for residential buildings, by country, 2011-2015, (%)



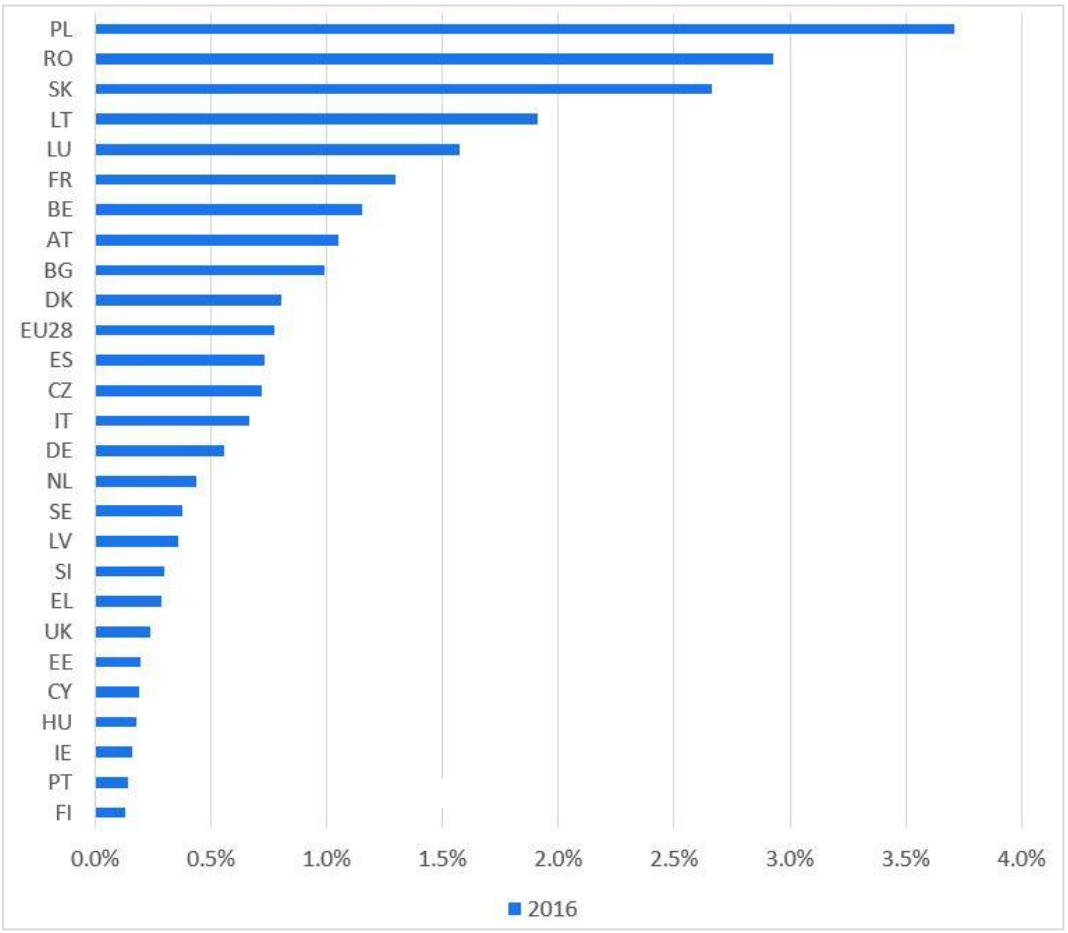
Source: EU Building Stock Observatory

[10] In accordance with Directive 2010/31/EU on the energy performance of buildings, Article 9. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN.

Renovation spending

The low levels of construction of new dwellings highlight the importance of renovation of existing buildings for increasing the energy performance of the building stock. As can be seen from Figure 4, the average share of renovation spending (including non-energy efficiency related innovations) out of households' disposable income varies. The highest shares are recorded in **Poland, Romania and Slovakia**, which spend more than 2.5% of their disposable income on renovation. The potential push factors for high renovation spending in these countries are likely to be found in the relatively **high age of the building stock** as well as the presence of **policy measures** that incentivise renovation (see Section 5).

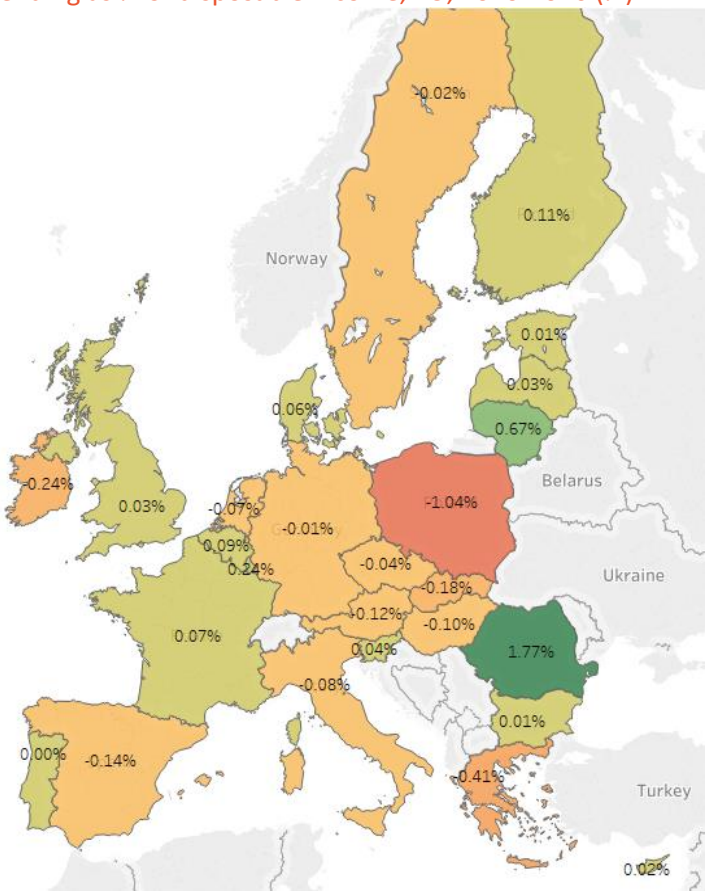
Figure 4 Renovation spending as % of disposable income, EU-28, 2016 (%)



Source: Eurostat

As shown in Figure 5, renovation spending has been increasing between 2010 and 2016 in only about half of the EU MS. In fact, the graph depicts the percentage point change across MS in renovation spending. Strikingly, **Poland**, which ranks highest in Figure 5, has seen the most significant decrease over the 2010-2016 period. This shows the continued need to support renovation spending across EU MS through targeted policies. With regards to countries which have experienced a major increase, **Romania** and **Lithuania** have respectively seen a 1.8 %and 0.7% rise in renovation spending (as a share of disposable income).

Figure 5 Trend in renovation spending as % of disposable income, EU, 2010-2016 (%)



Source: Eurostat

Energy performance of building stock

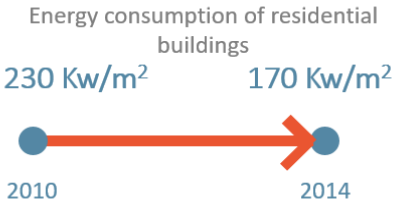
Assessing the energy performance of the building stock requires the analysis of several indicators, which together give a broad picture of the current situation. Overall, the analysis shows an improvement in energy performance, which is fostered through a comprehensive regulatory framework and various policy schemes in place across EU MS.

With regards to the legislation, the 2018/844/EU Energy Performance of Buildings Directive (EPBD) and the 2012/27/EU Energy Efficiency Directive (EED)[11] are the EU's main regulatory instruments promoting the improvement of energy performance of buildings and providing a stable driver for stakeholders and investment decisions.

Since the introduction of the EPBD, the Directive has made it possible for consumers to make informed choices that help them save energy and money, and has resulted in a positive change of trends in the energy performance of buildings. Following the introduction of energy efficiency requirements in national building codes in line with the Directive, new buildings today consume only half as much as typical buildings from the 1980s.

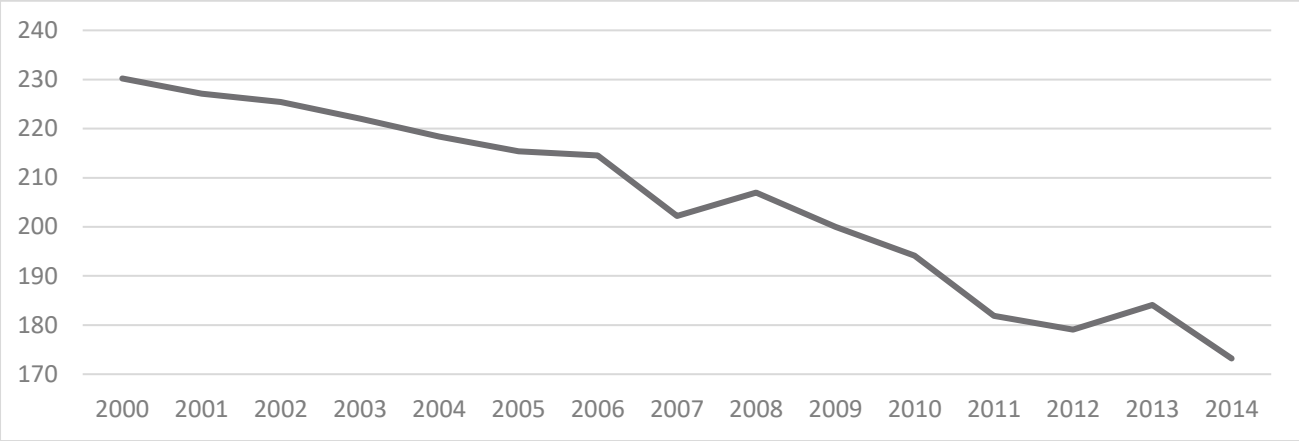
A proxy indicator to assess this point is represented in the graph below, which shows reduction in the **energy consumption of residential buildings** across the EU from 2000.

[11] After a political agreement, the revised version of the 2012/27/EU Energy Efficiency Directive was adopted in December 2018. To date, the official publication is still pending.



Data from the Odyssee-Mure project shows that even when climate-corrected, energy consumption per square metre between 2005 and 2014 decreased in all MS, with an average annual change of 2.3% per year for the EU-28 as a whole[12].

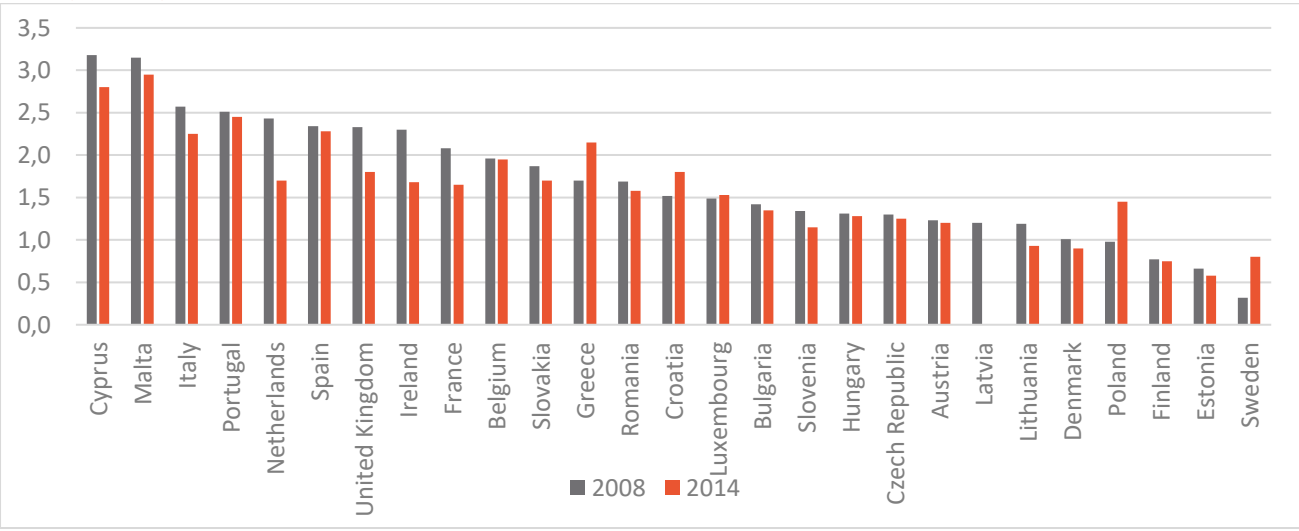
Figure 6 Energy consumption of residential buildings, normal climate, 2000-2014, (kW/m²)



Source: EU Building Stock Observatory

Still, when analysing the average heat loss per square metre across countries, there is a clear decreasing trend across a significant majority of EU MS. However, there are some important exceptions including **Greece, Croatia, Luxembourg, Poland and Sweden**.

Figure 7 Energy efficiency value of building shell in residential buildings – Average heat loss, EU-28, 2008 and 2014 (kW/m²)



Source: EU Building Stock Observatory

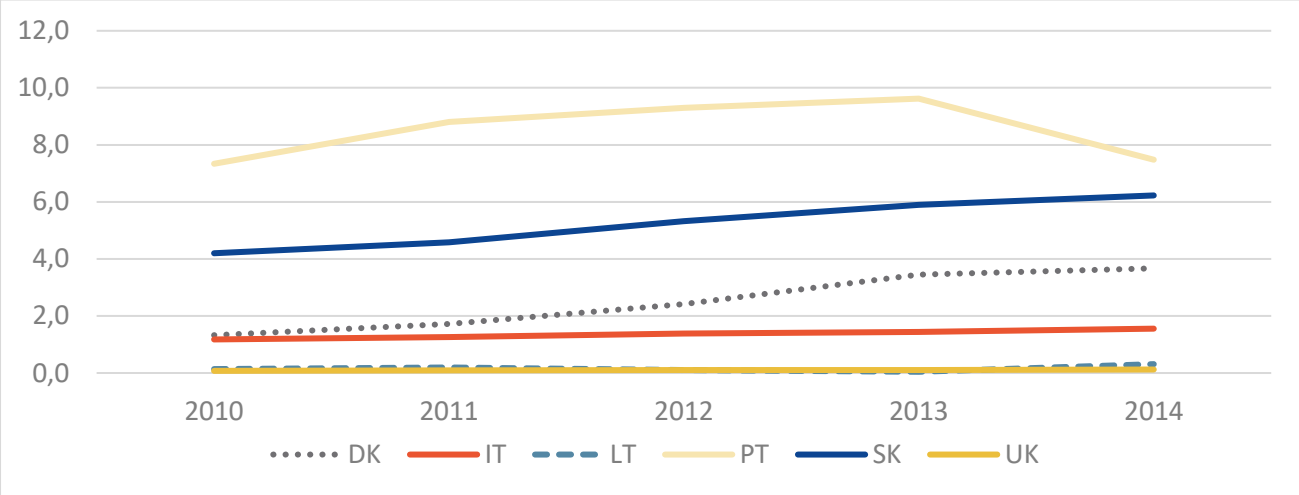
Note: Data for Germany not available

[12] European Commission, 2017, Second Report on the State of the Energy Union https://ec.europa.eu/commission/sites/beta-political/files/swd-energy-union-key-indicators_en.pdf.

EPCs are an fundamental part of **Directive 2010/31/EU** on the **Energy Performance of Buildings (EPBD),** seeking to inform building owners, occupiers and property actors on (i) energy performance of buildings with the goal that they can compare and evaluate different buildings and make informed decisions; and (ii) practical ways to enhance the energy efficiency of buildings and their performance class (e.g. from A to G).

Looking more specifically at the energy efficiency characteristic of the building stock, the chart below shows the improvement in the number of dwellings registered in EPC label A as a share of the total building stock for most of the countries for which data is available. This shows that despite the relatively old age of the building stock, there is a trend towards the construction of more energy efficient housing across the EU. Despite the fact that there is more awareness of energy efficiency among consumers thanks to EPCs, much improvement is still indispensable in order to reap the full potential of the EPCs. There is a need to reinforce the role of EPCs in the context of national legislation, particularly **for renovation policies and programmes as well as to further promote the EPC schemes as a tool for mapping and monitoring the national and European building stock.**

Figure 8 Distribution of residential building stock registered in EPC label A, by country, 2010-2014 (%)



Source: Eurostat

More recent data on this topic can be found in the reports submitted by MS in the context of their **National Energy Efficiency Action Plans** (NEEAs)[13] and **National Building Renovation Strategies**[14], which show that the final energy consumption of the residential sector in the EU dropped by 11% from 309 Mtoe in 2005 to 275 Mtoe in 2015. The improvements in efficiency (-67 Mtoe) significantly contributed to it and were linked to the greater energy efficiency of appliances and energy performance improvements in the building stock following the gradual implementation of the Energy Performance of Buildings Directive (EPBD) and eco-design minimum standards. However, these results should also be interpreted in light of the effect of warmer winter seasons which reduced heating needs within this period and partially offset the positive activity effect, driven by an increase in floor area for heating and gross disposable income[15].

[13] European Commission, National Energy Efficiency Action Plans and Annual Reports, https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans.

[14] https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/buildings-under-eed

[15] Report from the Commission to the European Parliament and the Council, 2017 assessment of the progress made by MS towards the national energy efficiency targets for 2020 and towards the implementation of the Energy Efficiency Directive as required by Article 24(3) of the Energy Efficiency Directive 2012/27/EU Brussels, 23.11.2017, COM(2017) 687 final.

A deteriorating performance was reported by 11 countries, with the biggest **increases in consumption** being in **Bulgaria** (+19%), **Lithuania** (+10%) and **Romania** (+6%), which reflects the catching-up effect in these countries. In contrast, the **United Kingdom** (-25%), **Belgium** and **Ireland** (-23%) were the top performing countries in **reducing energy consumption of the residential sector**.

The residential sector intensity in terms of energy consumption per population decreased in the EU by 9% in 2005-2015, but the performance of MS varied.

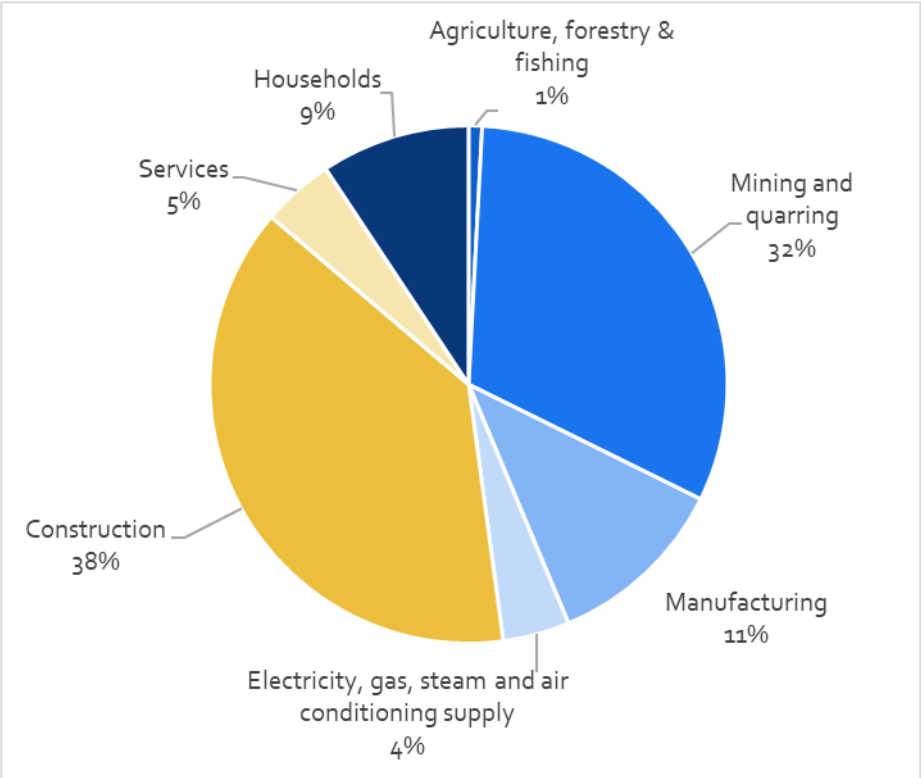
State of resource efficiency of the construction sector

In the context of this report, the resource efficiency of the construction sector will be discussed mainly in terms of the material extraction and use in construction, demolition activities and the sector's impact on the environment through emissions. The state of resource efficiency of the constructions sector will thus be analysed through a set of available data indicators on the generation and treatment of construction sector waste and the potential for resource efficiency improvement provided by innovative construction sector companies.

Waste generation and treatment

In 2014, the construction sector accounted for 38% of the waste generated in the EU, more than any other sector of the economy (Figure 9).

Figure 9 Waste generation by NACE Rev. 2 activity, by sector, 2014 (%)



Source: Eurostat

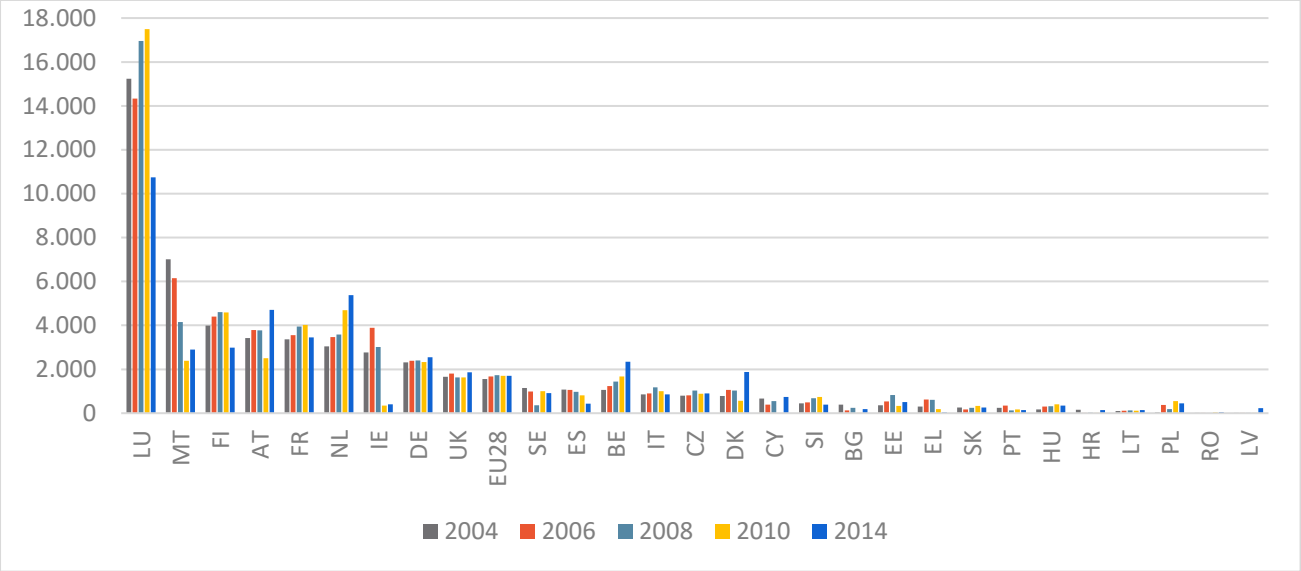
Note: Excludes waste generated by the waste-related activities

As can be seen from the following figure showing the generation of waste by the construction sector, the volumes of waste per capita vary significantly, reflecting the population size and the volume of activity in the construction sector since 2014.

> Countries with small populations but noted high levels of construction activity like Luxembourg and Malta register high levels of waste per capita.

About half of the MS have seen a decrease in the amounts of waste generated, e.g. Spain saw a decrease of 59.3% in 2014 compared to 2010, but while that may be due to increased resource efficiency of the construction processes, it is more likely to reflect the downturn in activity in the construction sector since the financial crisis.

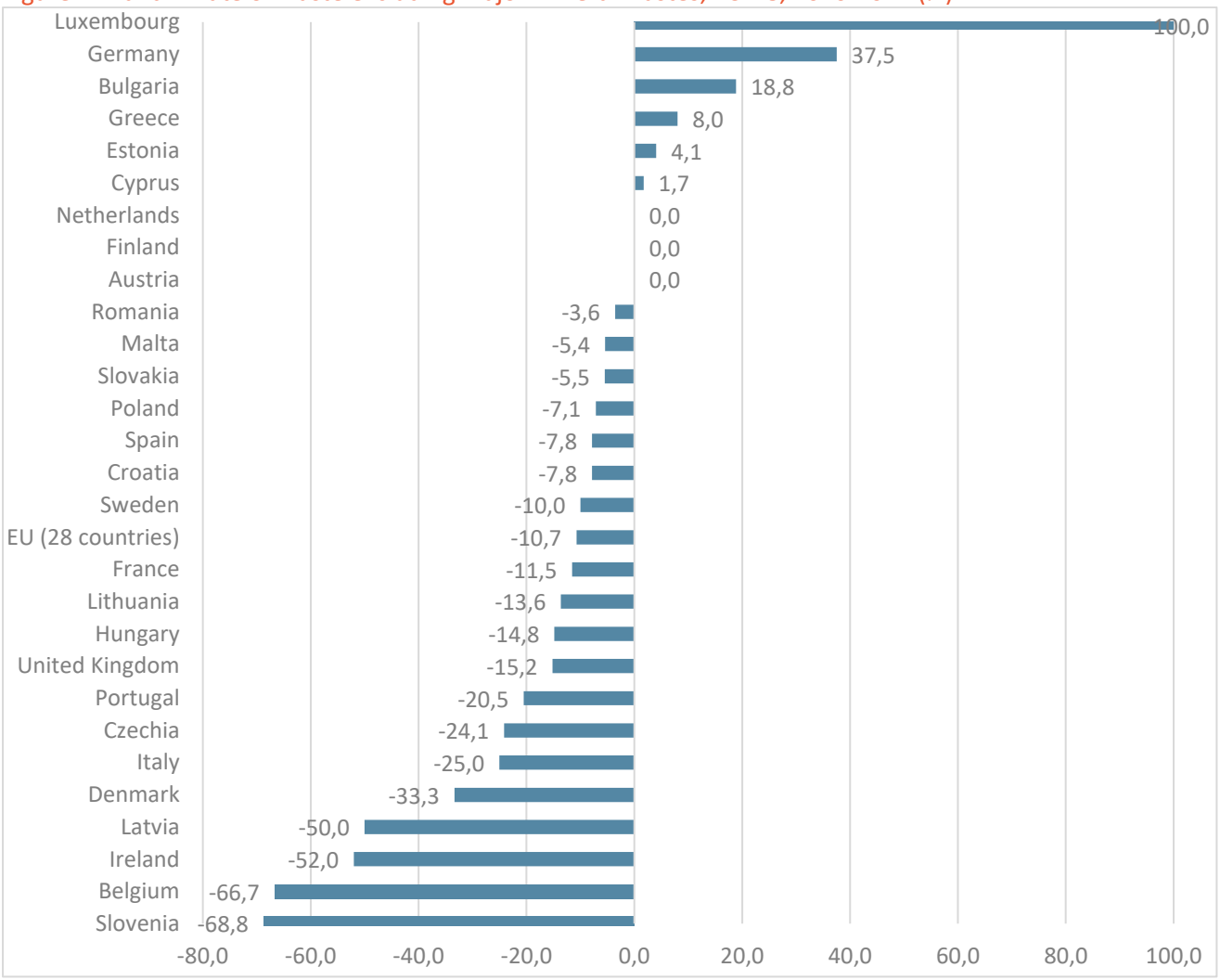
Figure 10 Generation of waste by the construction sector: non-hazardous and hazardous, EU-28, 2004, 2006, 2008, 2010 and 2014 (kg per capita per year)



Source: Eurostat

Despite the heterogeneous trend in waste generation by the construction sector, the change between 2010 and 2014 in landfilling rate shows a clear reduction for most countries in the EU. Notable exceptions are **Luxembourg, Germany and Bulgaria**, where the landfilling rate has increased (Figure 11). However, it is important to note that the high percentage change in these countries, albeit describing a trend, is not informative when it comes to volumes of waste. Although increasing, the ratio of the landfilled waste volume against the treated waste volume in Luxembourg for instance is still among the lowest in the EU, whilst in Bulgaria, it is the highest. Overall in the EU the landfill rate has reduced by 10.7% for that period. This can be partly accounted for by the increasing efforts to recycle waste but also on the increasing cost of landfilling for construction waste.

Figure 11 Landfill rate of waste excluding major mineral wastes, EU-28, 2010-2014 (%)



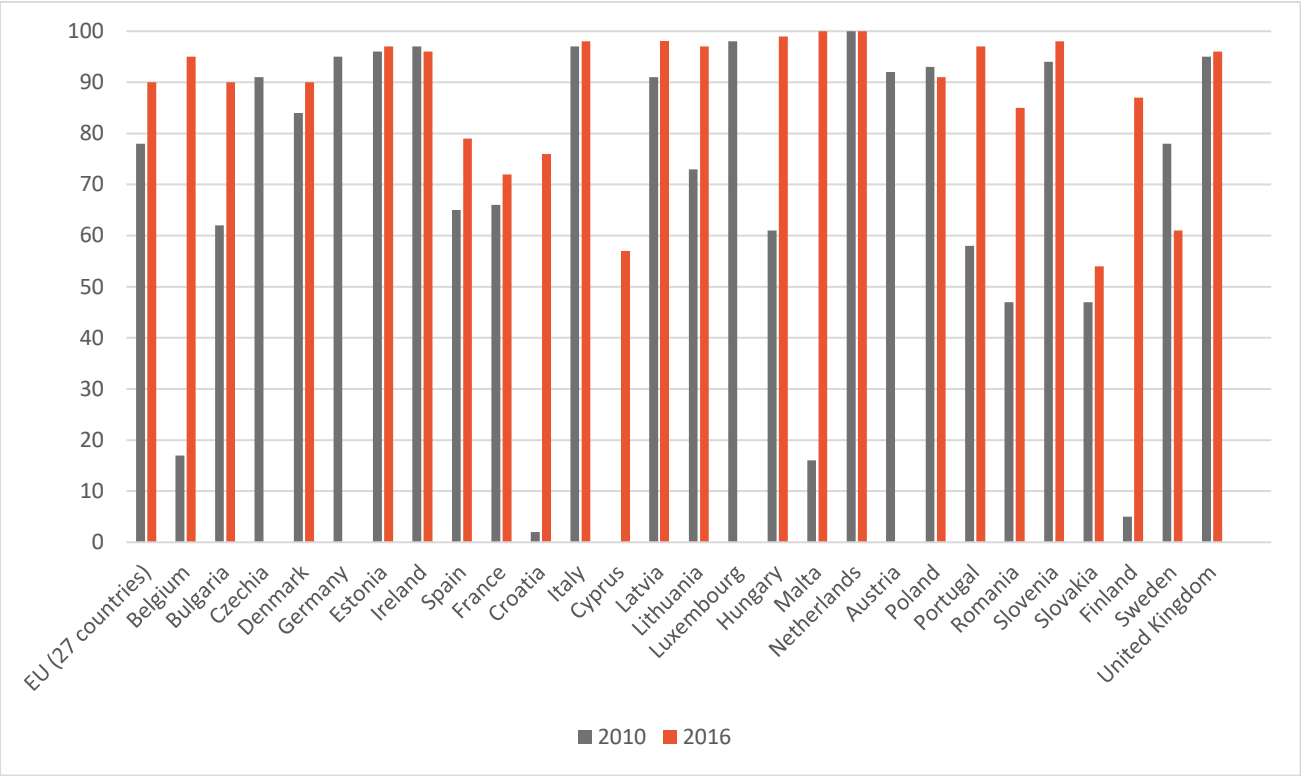
Source: Environmental Data Centre on Waste

Note: There was no change in data between 2010 and 2016 for Finland, Austria and Netherlands

Reducing the amount of waste generated goes hand in hand with the recovery, reuse or recycling of waste. Below, Figure 10 and 11 depict respectively the recovery rate of construction and demolition mineral waste and the landfill rate of waste. The former shows that most countries have done significant efforts between 2010 and 2016in increasing the recovery rate. In fact, only five countries, namely Belgium, Sweden, Czech Republic, Germany and the Netherlands have not seen their rate increase.

Significant improvements have occurred, particularly in **Malta, Finland and Croatia**, where the recovery rate has increased by more than 67%. On average the situation in the EU has improved with the recovery rate rising 15.4% over the 2010-2016 period.

Figure 12 Recovery rate of construction and demolition mineral waste, EU-28, 2010 and 2016 (%)



Source: Environmental Data Centre on Waste

Note: Data is for EU 27 – excluding Greece, as no statistics are available

It is worth mentioning that in the adoption of the Waste Framework Directive 2008/98/EC (WFD)[16] recovery encompasses recycling, reuses and recovery through backfilling. The revision of the WFD[17] would require specific recorded data for recovery by backfilling, which is still a cheap and easy way to avoid recycling and getting out the "close the loop" objective of circular economy.

Eco-innovation

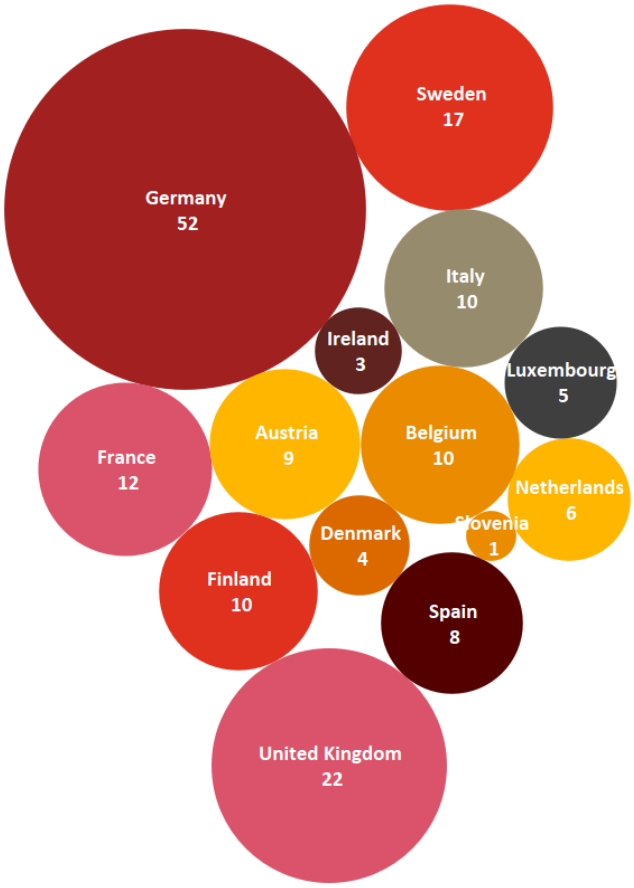
Technological advances play a key role in fostering the energy performance improvement of the building stock. In fact, smart technological approaches such as **Building Information Modelling (BIM)** can contribute to simplify and support the construction of higher energy performing buildings.

In the same vein, research and development is playing an important role in finding new ways to recycle or reuse construction and demolition waste. Figure 13 depicts the number of firms by EU MS present in the ranking of EU top 1000 companies by R&D spending. Germany, with 52 companies featuring in this ranking, stands at the forefront of research and development in the construction sector, followed by the United Kingdom with 22 companies and by Sweden with 17.

[16] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098

[17] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste

Figure 13 Presence of firms ranked in EU top 1000 companies by R&D spending in the construction sector, by country



Source: European Commission

3.
Drivers of energy and resource efficiency

Regulatory developments and the economic considerations of firms and households are the main drivers for improvements in the energy performance of buildings and the resource efficiency of the construction sector overall. Regulatory initiatives at international, EU and national level have provided and will continue to provide a strong incentive for the optimisation of energy and resource consumption by all types of economic actors. In parallel, the volatility of energy and resource costs provides an economic incentive to reduce their use to generate savings/gain competitiveness. The remainder of this chapter looks further into the main trends and drivers for energy and resource efficiency in the European construction sector of 2020 and beyond.

Regulations and resource constraints have emerged as two of the most influential drivers

Regulatory drivers

International regulatory framework

Recent developments in the international regulatory framework on sustainability and climate change in particular have given a strong impetus for more progress in increasing the energy and resource efficiency of the construction sector.

SDG Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
7.2 By 2030, increase substantially the share of renewable energy in the global energy mix.
7.3 By 2030, double the global rate of improvement in energy efficiency.

SDG Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.

SDG Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
11.1 By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
11.3 By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.

"Transforming our World: the 2030 Agenda for Sustainable Development" including its 17 Sustainable Development Goals (SDGs) and 169 targets was adopted in 2015 at a special UN summit.

The Agenda is a commitment to eradicate poverty and achieve sustainable development world-wide by 2030, ensuring that no one is left behind and integrating in a balanced manner the three dimensions of sustainable development: economic, social and environmental.

Several of the SDG goals, presented in the box above, are of particular relevance for the construction sector, with their emphasis on access to housing and infrastructure and improvements in energy efficiency.

Further impetus to improving the resource efficiency of the construction sector comes from the **Paris Climate Accord,** which is an agreement within the United Nations Framework Convention on Climate Change (UNFCCC) dealing with greenhouse gas emissions mitigation, adaptation and finance starting in the year 2020[18]. Improving the energy performance of buildings and the resource efficiency of the construction sector overall can contribute to meeting the targets set by the accord.

European regulatory framework

At the European level, the Roadmap to a Resource Efficient Europe, published in September 2011 sets out the practical steps to reach the objectives of increasing energy and resource efficiency, in particular within the context of the building sector and construction more broadly.

> According to the Roadmap, better construction and use of buildings could help making significant resource savings: it could save **42% of the EU's final energy consumption** and about **35% of the total GHG emissions**, **50% of the extracted materials**, and it could **save up to 30% of water** in some regions.

The EED requires energy distributors or retail energy sales companies to achieve **1.5% energy savings per year** through the implementation of energy efficiency measures, Article 7 of the EED allows MS to establish either energy efficiency obligation schemes (EEOS) or alternative policy measures, to achieve their energy savings targets. In addition to ensuring that there are no regulatory and non-regulatory barriers to energy performance improvements in buildings, including in relation to property and tenancy law, and in relation to public purchasing, MS are expected to arrange for public bodies' buildings playing an exemplary role – 3% of the total floor area of buildings owned and occupied by the central government is to be renovated each year, starting in 2014.

20% energy savings target to be achieved by 2020 (EED)

The framework builds on the targets set by the **EED** (2012/27/EU), which planned for a 20% energy savings target to be achieved by 2020 and included a number of provisions and targets focusing specifically on energy efficiency in buildings. The Directive requires MS to submit **National Energy Efficiency Action Plans (NEEAPs**) every three years starting from 2014, as well as establish a long-term **National Renovation Strategy** for mobilising investment in the renovation of residential and commercial buildings.

The latest report on the implementation of the EED estimates that MS across the EU have reported 28.5 Mtoe energy savings in cumulative terms for 2015[19]. This is **15% more overall than the estimated amount of savings for 2015**, assuming a linear delivery of the savings requirements to be achieved by the end of 2020. Notably, Energy Efficiency Obligation Schemes have been introduced in 15 MS and are responsible for the **highest share of energy savings** (35%). The report highlights that progress towards the estimated savings for 2015 differs significantly among the MS:

[18] United Nations / Framework Convention on Climate Change (2015) Adoption of the Paris Agreement, 21st Conference of the Parties, Paris: United Nations.

[19] European Commission, Report from the Commission to the European Parliament and the Council - 2017 assessment of the progress made by MS towards the national energy efficiency targets for 2020 and towards the implementation of the Energy Efficiency Directive as required by Article 24(3) of the Energy Efficiency Directive 2012/27/EU, Brussels, 23.11.2017, COM(2017) 687 final.

- 15 MS achieved more savings than the annual amount needed (Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Malta, the Netherlands, Romania, Slovakia, Slovenia, Sweden, and the United Kingdom);
- 5 MS (Hungary, Italy, Lithuania, Poland, and Spain) came close to achieving the amount needed;
- 8 MS achieved much less than the amount needed (Bulgaria, Croatia, Cyprus, the Czech Republic, Greece, Latvia, Luxembourg and Portugal).

The Energy Performance of Building Directive (EPBD) (2010/31/EU) introduces the concept of Nearly Zero Energy Buildings (NZEBs). It requires the definition of new minimum energy performance requirements (for new buildings and major renovations), applying a cost-optimal calculation. Moreover, it introduces the concept of Nearly Zero Energy Buildings (NZEBs) and establishes the requirement for all new buildings to be NZEBs by 2020.

In addition, energy performance certificates (EPCs) have to be issued when a building is sold or rent, while inspection schemes for heating and air conditioning systems should also be established.

On 30 November 2016 the Commission proposed an update to the Energy Performance of Buildings Directive (EPBD)[20] as part of the 'Clean Energy for All Europeans' package[21].

In 2018 political agreements between the Commission, the Parliament and the Council were reached for the adoption of four out of the eight legislative proposals of the "Clean Energy for All Europeans" package. The revised EPBD (2018/844/EU) was formally adopted on 14 May 2018. The new directive contains additional measures aimed at accelerating the **cost-effective renovation of existing buildings** with a solid financial component. The agreement also supports **electro mobility infrastructure** deployment in buildings' car parks and introduces new provisions to enhance smart technologies and technical building systems, including automation.

Following the revision of the EPBD, in December 2018 further revisions were adopted also to the Energy Efficiency Directive, the Renewable Energy Directive and the Governance Regulation[22].

The revision of The Renewable Energy Sources (RES) Directive (2009/28) establishes a common framework for the promotion of energy from renewable sources. It recognises information and training gaps, especially in the heating and cooling sector, which are addressed through provisions regarding the information and training of all relevant actors, including builders and installers. Thus, under the Directive, MS are responsible for ensuring the introduction of certification schemes for installers of small-scale biomass boilers and stoves, solar photovoltaic and solar thermal systems, shallow geothermal systems and heat pumps.

Another strand of EU regulation covers the resource efficiency of the construction sector in relation waste management. The **Waste Framework Directive (WFD)** (2008/98/EC) aims to provide a framework for moving towards a

[20] Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, https://eur-lex.europa.eu/legal-content/EN/TXT/?toc=OJ%3AL%3A2018%3A156%3ATOC&uri=uriserv%3AOJ.L_.2018.156.01.0075.01.ENG

[21] European Commission, Proposal for a Directive of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings, COM(2016) 765 final.

[22] European Commission, Press release, Commission welcomes Council adoption of new rules on Renewable Energy, Energy Efficiency and Governance, https://ec.europa.eu/info/news/commission-welcomes-council-adoption-new-rules-renewable-energy-energy-efficiency-and-governance-2018-dec-04_en

European recycling society with a high level of resource efficiency. It contains measures addressing different streams of waste generation.

> Article 11.2 of WFD specifically requires MS to take measures to ensure that by 2020, a minimum of 70% (by weight) of non-hazardous construction and demolition waste shall be prepared for re-use, recycled or undergo other material recovery.

On 19 June 2018, the European Parliament and the Council – the European co-legislators – reached a provisional political agreement on **the Energy Efficiency Directive**. The agreement includes a headline target of **at least 32.5% for energy efficiency to be achieved collectively by the EU in 2030**, with a possible upwards revision clause by 2023 and aims to facilitate energy savings through **renovations** and other actions undertaken through a set of national measures, facilitating the energy savings market.

Moreover, the agreement increases awareness among consumers of space heating, cooling or domestic hot water supplied from collective sources through useful billing and consumption information.

Having identified the lack of confidence in the quality of Construction and Demolition (C&D) recycled materials, as one of the common hurdles to recycling and re-using Construction and Demolition waste in the EU, in 2016, the EU adopted the **Construction & Demolition Waste Management Protocol.**

> The Protocol is a voluntary measure that aims to increase confidence in the C&D waste management process and the trust in the quality of C&D recycled materials through improved waste identification, source separation and collection, waste logistics, waste processing, quality management and the provision of appropriate policy and framework conditions[23].

Moreover in 2017, the EC achieved a study on Pre-demolition & Renovation Waste Audits. The outcomes have been released as Guidelines for Assessment of Construction and Demolition Waste Streams prior to Demolition or Renovation of Buildings and Infrastructures (known as Waste Audit Guidelines). Their implementation is important to a **better demolition waste management** through **assessment of the viable recovery routes** for materials (including reuse and the potential reuse value, recycling on- and off-site and the associated cost savings and energy recovery)[24].

> This target is expected to result in the creation of 400,000 additional jobs in the general economy by 2030, particularly in the construction sector, by increasing the demand for skilled manual labour[21].

This new proposal should also improve the interconnectedness among different Directives related to energy efficiency performance.

> The national/regional regulatory framework is to a large extent driven by the implementation of international and European regulation, notably the transposition and implementation of the EPBD and EED.

[23] European Union Construction & Demolition Waste Management Protocol. September 2016. https://ec.europa.eu/docsroom/documents/20509/attachments/1/translations/en/renditions/native.

[24] Technical and Economic Study with regard to the Development of Specific Tools and/or Guidelines for Assessment of Construction and Demolition Waste Streams prior to Demolition or Renovation of Buildings and Infrastructures, Specific Contract 30-CE-0751644/00-00 – SI2.720069, VTT, Tecnalia, RPA, December 2016.

National regulatory framework

The impact assessment for the proposed revision of the EED found that the transposition and implementation of the Directive has been incomplete and slow, partly due to lack of political commitment for energy efficiency policies in some MS, particularly in the case of Article 7 (on the energy savings to be achieved by energy distributors or retail energy sales companies). On the transposition deadline in 2014, only four MS had declared full transposition of the Directive, with the final cases on infringements due to non-communication of transposition measures being closed only in 2017 and one case of non-conformity still ongoing[25].

> For both new and existing buildings, the choice of a cost-optimal methodology to steer existing national energy performance requirements towards cost-efficient levels has proved to be an efficient approach, while energy performance certificates are delivering a demand-driven market signal for energy efficient buildings.

The 2016 evaluation of the EPBD reported that the overall architecture of the Directive is working, combining minimum requirements and certification in particular for new buildings. Targets for all new buildings to be nearly **zero-energy** by 2020 have proved to set a 'future-proof' vision for the sector and mobilise stakeholders accordingly. However, the progress in developing and fixing the national application of the **NZEB definition** in most countries has been particularly sluggish[26].

Additional regulatory initiatives have been introduced in some MS to give further impetus to improvements in the area of **energy performance of buildings**. For example, in 2018, a law will come into force in **Lithuania** requiring all new buildings to be built as A+ class, and from 2021 the highest - A++ class. Such buildings are called energy-free, because they will have to produce half of their energy consumption from renewable energy sources (solar, wind, geothermal, etc.). Similarly, the Minimum Energy Efficiency Standard (MEES) which came into effect in **England** and Wales in April 2018, applies only to private rented residential and non-domestic property. The new regulation aims at encouraging landlords and property owners to improve the energy efficiency of their properties by a restriction on the granting tenancies where the property has an Energy Certificate below E[27].

> In France, the 2012 Thermal Regulations *(Réglementation Thermique 2012 - RT)* encourages the construction of low energy buildings, the reduction of the energy use of existing buildings by 38% by 2020 (by 40% in public buildings) and the energy efficient renovation of social housing.

The regulation also seeks to develop technological and industrial innovation in the global construction supply chain and improve the energy quality of buildings, regardless of the type of energy used[28].

In the area of **resource efficiency** within construction, regulatory measures can be found in the introduction of sustainable construction certification schemes. For example, in **Germany** the Guidelines for Sustainable Construction *(Leitfaden für Nachhaltiges Bauen)* were made compulsory for federal buildings in 2013 by the Federal Ministry of Transport, Building and Urban Affairs. They specify a number of criteria for sustainable building construction, including ecological quality, economic quality, socio-cultural and functional quality, technical quality and process quality, which i.a. address matters of energy efficiency, resource efficiency and waste prevention. The Assessment System for Sustainable Building complements the guidelines and can result in the award of a Sustainable Building Certificate.

There are also regulatory measures to decrease C&D waste through higher recycling.

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25 European Commission, Infringement decisions. Accessed 26 February 2018. http://ec.europa.eu/atwork/applying-eu-law/infringements-proceedings/infringement_decisions/index.cfm?lang_code=EN&typeOfSearch=true&active_only=0&noncom=1&r_dossier=&decision_date_from=&decision_date_to=&DG=ENER&title=Energy+Efficiency+Directive&submit=Search.

26 Erhorn, Hans & Erhorn-Kluttig, Heike, Overview of national applications of the Nearly Zero Energy Building (NZEB) definition. April 2015.

27 RICS, Minimum Energy Efficiency Standard, April 2018, http://www.rics.org/uk/knowledge/glossary/minimum-energy-efficiency-standard-/

28 RT Batiment, Présentation, 2012, http://www.rt-batiment.fr/batiments-neufs/reglementation-thermique-2012/presentation.html

For example, in France, the Energy Transition Law *(Loi de transition énergétique)* sets a recycling target of 70% for C&D waste by 2020 in line with the Waste Framework Directive and further stipulates that, as of January 2017, distributors of construction materials, products and equipment shall take back the waste arising from the same type of materials, products and equipment they sell.

In **Austria**, the Recycled Construction Materials Ordinance has an objective to ensure the **high quality of the waste generated during construction** and demolition activities in order to promote its recycling. It sets specific requirements during the construction and demolition of structures, such as the implementation of a pollutant investigation, an organised and recycling-oriented demolition of structures and a duty to separate the waste generated. Quality requirements for the manufacture and use of recycled construction materials are also defined.

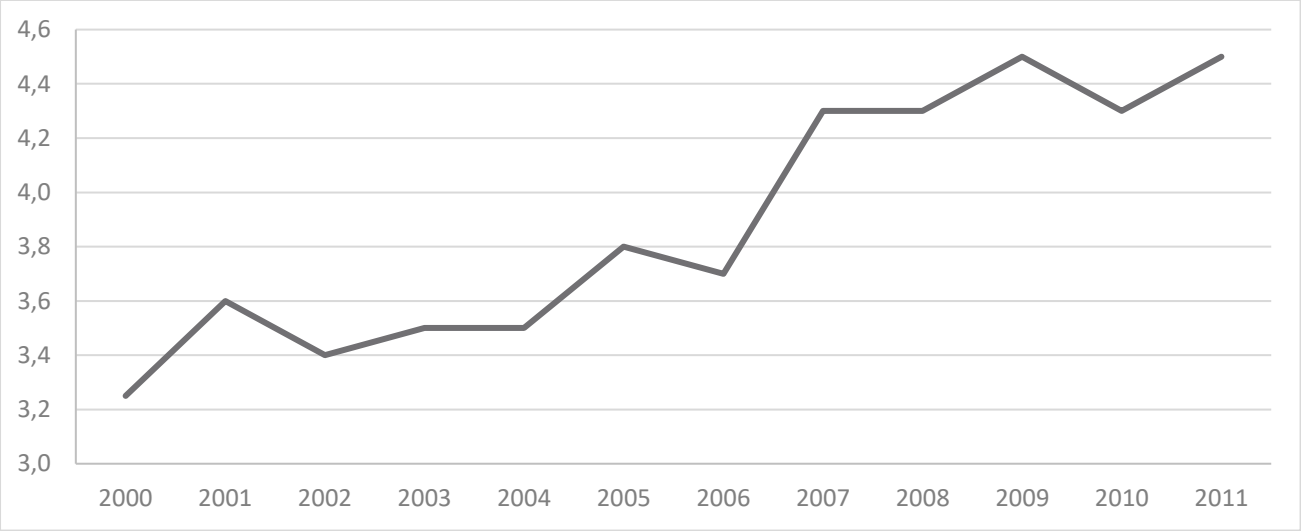
Economic drivers

Energy costs

Research by the EEFIG carried out in 2015 found that the drivers for **investment in residential, public and commercial buildings** are quite different, with economic factors such as individual payment capacity, ease of undertaking investments, the availability of tailored financial products and fiscal support being particularly important for **investments in the energy efficiency of residential property**[29]. The same study did not find energy prices to be a strong direct driver for individual investment decisions, but the overall economic case for investment in the energy efficiency in buildings can be made when the energy efficiency savings outweigh the investment costs for the implemented improvements. As such, determinants for energy efficiency savings such as energy expenditure and its main inputs – consumption and prices – will be analysed in the following figures.

As can be seen from Figure 14, **household expenditure on energy consumption** has been on the upswing since 2000, with its share of overall household expenditure standing at 4.5% in 2012, and the highest shares of expenditure on energy can be found in **Slovakia** (11.3%), **Poland** (9.0%) and the **Czech Republic** (8.6%). The overall increase in expenditure is likely linked to the changes in energy consumption over the same period (Figure 19), but also increasing electricity prices (+30.5% for 2007-2017) and gas prices for household consumers (+14.1% for 2007-2017).

Figure 14 Share of households' expenditures on energy consumption - electricity, gas and other housing fuels, EU, 2000-2011 (%)

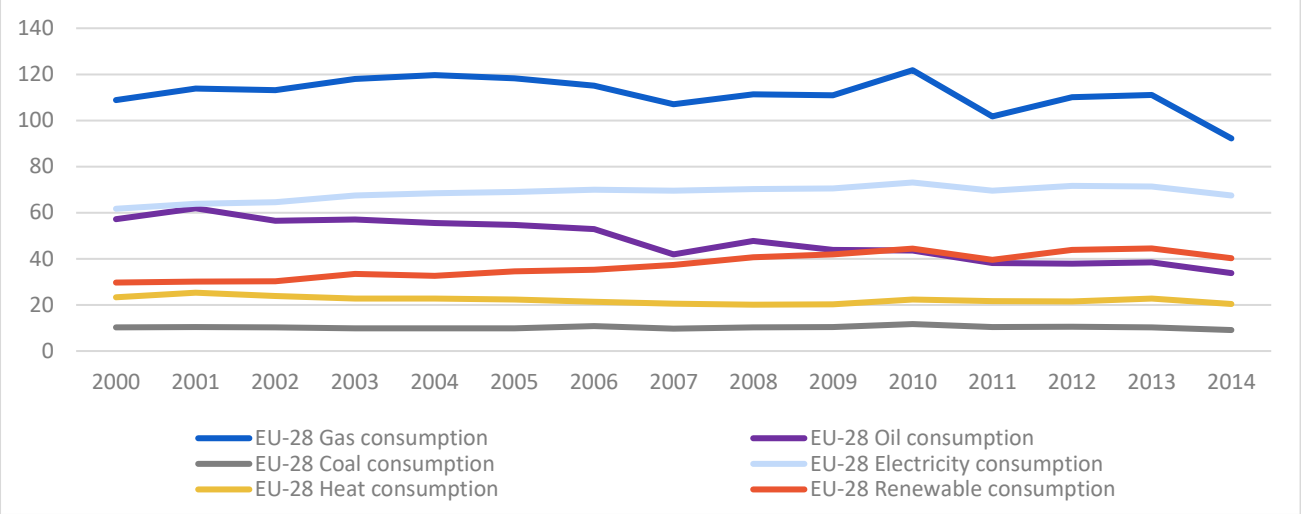


Source: EU Building Stock Observatory

Note: No data for Croatia

[29] Energy Efficiency Financial Institutions Group (EEFIG), Energy Efficiency – the first fuel for the EU Economy: How to drive new finance for energy efficiency investments, Final Report, February 2015, https://ec.europa.eu/energy/sites/ener/files/documents/Final%20Report%20EEFIG%20v%209.1%2024022015%20clean%20FINAL%20sent.pdf

Figure 15 Energy consumption of households by energy type in Mtoe, EU-28, 2000-2014, kW/m2



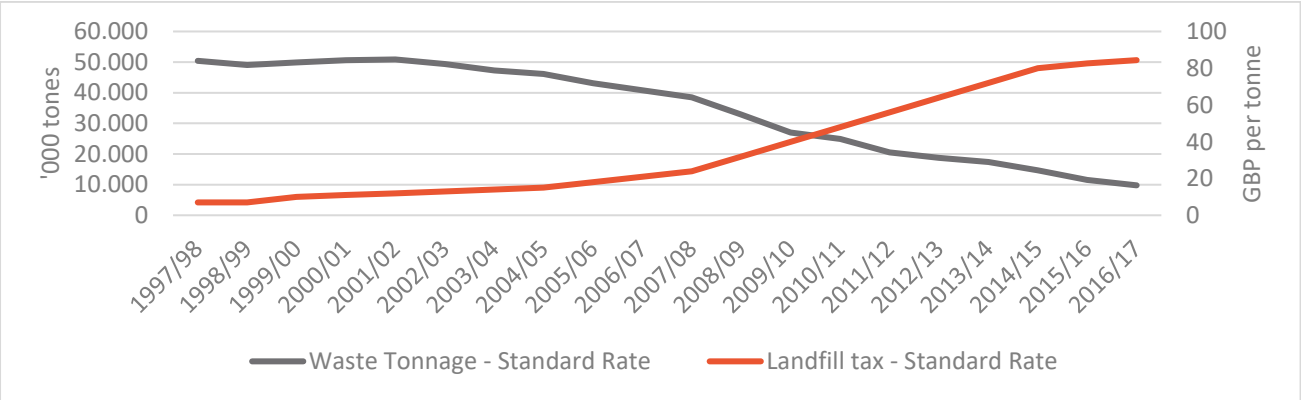
Source: EU Building Stock Observatory

Looking at the factors influencing the energy efficiency investment decisions for commercial property, the EEIFG study found that regulatory requirements take precedence, but the strength of the business case for the investment is also important. As such energy prices are indeed likely to be relevant and price fluctuations, such as the sustained drop in oil prices since 2014 may cause some economic actors to defer their investments in energy efficiency[30]. On the other hand, low energy costs may be used as an opportunity to find resources for investment and increase resilience to energy price fluctuations and anticipate regulatory measures.

Resource efficiency

Another economic driver is the potential for reduced waste management costs by decreased reliance on landfill disposal/higher resource efficiency. The targets set by the **WFD** (see section on regulatory drivers) have led to increasing restrictions and prices of landfill use. For example, in **the UK** landfill tax rates have grown more than ten-fold between 1997 and 2016 (see Figure 16), which, together with the increased investment in treatment facilities enabled an 80% drop in the amount of waste landfilled each year.

Figure 16 Landfilling tax and amount of landfilled waste in the UK – standard rates, UK, 1997-2016 (tonnes and GBP)



Source: HMRC[31]

[30] International Energy Agency, 2016, Lower oil prices are driving down investment and energy efficiency as Middle East producers gain market share. https://www.iea.org/newsroom/news/2016/july/lower-oil-prices-are-driving-down-investment-and-energy-efficiency.html.
Grenoble Ecole de Management, 2016, Energy Market Barometer report Winter 2015 https://en.grenoble-em.com/news-low-oil-prices-cause-investment-renewables-biofuels-and-energy-efficiency-technologies-decrease.

[31] UK Government, User consultation: HMRC Indirect Tax receipts statistics, August 2016, https://www.gov.uk/government/publications/user-consultation-hmrc-indirect-tax-receipts-statistics.

As a result, there are economic gains and competitive advantages to be found in innovative construction designs and processes that reduce the amount of C&D waste, especially through the **deconstruction of buildings and the reuse of resources**.

The Construction & Demolition Waste Management Protocol described in the section on European policy developments prompts industry stakeholders to address comprehensively the different steps needed to increase confidence in the C&D waste management process and the trust in the quality of C&D recycled materials and thus promote their use. The increasing take up of **Building Information Modelling (BIM)** technology makes it possible to maintain information on the materials and material connections of a building, including in subsequent renovations, which will be essential for assessing the potential for deconstruction as opposed to classic demolition. While a number of obstacles remain, the shift towards a circular economy in the buildings sector will necessitate further developments[32].

At a recent EU-level discussion, construction sector stakeholders highlighted the importance of **raising awareness of sustainable building principles** among citizens, owners, and investors, developing methods to demonstrate the benefits of it as well as regulatory tools to promote its use (e.g. Green public procurement rules for the public sector).

It should be noted that the use of construction materials with improved environmental performance is also seen as a source of **competitiveness.**

An increasing number of companies are interested in making their resource-efficiency efforts visible to the outer world by using environmental performance certification schemes such as the EU Eco-Management and Audit Scheme (EMAS)[33] in order to achieve a competitive advantage.

This holds true especially for environmental product declarations that are also often used within building certification systems[34]. Examples of relevant optional schemes include LEED[35], BREAM[36], and the Level(s) scheme of the European Commission[37].

[32] European Commission, Workshop "Design for Deconstruction and Durability of Buildings", November 2017.
[33] http://ec.europa.eu/environment/emas/index_en.htm
[34] Passer et al, 2015, Environmental product declarations entering the building sector: critical reflections based on 5 to 10 years' experience in different European countries.
[35] https://new.usgbc.org/leed
[36] https://www.breeam.com/
[37] http://ec.europa.eu/environment/eussd/buildings.htm

4.
Obstacles to energy and resource efficiency

While regulation and economic factors are driving the demand for energy and resource efficiency improvements, a number of obstacles remain and contribute to the presence of the "**energy efficiency gap**" - the difference between the optimal and actual level of energy efficiency in the sector[38]. The following table presents an overview of the most common barriers to the development of high energy performing buildings, as presented in a recent report of the Global Environmental Facility (GEF).

Table 1 Most common barriers to the development of high energy performing buildings

Policy Barriers	**The benefits of high energy performing buildings are not assessed and taken into account for energy policy making and resource planning.**
Institutional, Legal, Regulatory Barriers	• Regulations to promote energy performance in buildings are un-adapted or missing. • Insufficient enforcement and control of regulations on waste which enable unfair competition of below standards waste discarding operations. • Lack of awareness or will from national, regional and local authorities in their leading by example role through (Green) public procurement. • Strong impediments against operating or environmental permit for construction and demolition waste sorting and recycling facilities. • Harmonisation in End-of-Waste criteria is required by some MS which have not developed their own ones while existing criteria as developed by MS would hardly be reconcilable.
Economic and Financial Barriers	• Some projects cannot be profitable without fiscal or/and economic incentives that are not in place. • Financing is limited; projects are seen as too small and too risky by financiers who lack awareness and expertise on energy efficiency. • Fossil energy benefits from favourable conditions and/or subsidies. • The agents making the energy performance investment decisions are not those paying the energy bills and benefiting from the energy savings (split-incentive dilemma). • Upfront costs are given more attention than running costs. Public organisations may not benefit financially from the energy savings they achieve.
Information and Technology Barriers	• There is a lack of information on and awareness of energy efficiency and its benefits among policymakers and building officials as well as the general public, including: - Lack of data on energy consumption and building performance - Lack of local expertise for audits - Lack of knowledge about measurement and evaluation protocols - Lack of local capacity to design, build, and maintain energy-efficient buildings (especially among individual or small company builders) - Lack of understanding of energy efficiency solutions and how to implement them

[38] Gerarden, Todd D., R.G. Newell, and R. Stavins. "Assessing the Energy-Efficiency Gap." Journal of Economic Literature 55, no. 4 (2017): 1486–1525.

	- Lack of availability of energy-efficient materials and equipment and limited national expertise to design and manufacture them • Energy consumers are scattered and the building sector is fragmented amongst multiple trades and companies. For multi-apartment buildings residents, in order to reach an agreement, participation of all owners and residents is necessary. • Traceability and confidence along the treatment and recycling chain for construction and demolition waste could still be improved with the help of adequate and recognised ICT tools.

Source: GEF[39]

Some of these challenges are particularly common in the EU context - the costliness of improvements and the long-term nature of returns on investment, as well as the low awareness of the benefits especially among households can be barriers to the demand for improvement measures.

An additional challenge for the EU is the skills shortage in the construction sector in general and specifically within the energy performance improvements sub-sector, which can be a supply-side bottleneck.

Return on investment

Article 19 of the EED recognised that one of the main obstacles when assessing the economic returns from **energy efficiency** investment is the issue of **split incentives** between the tenant and owner of a building, which can be explained through the agency theory**.**

In landlord-tenant relationships, the landlord lacks the incentive to invest in improving the energy performance of a property unless the investment costs can be recovered through premium rents.

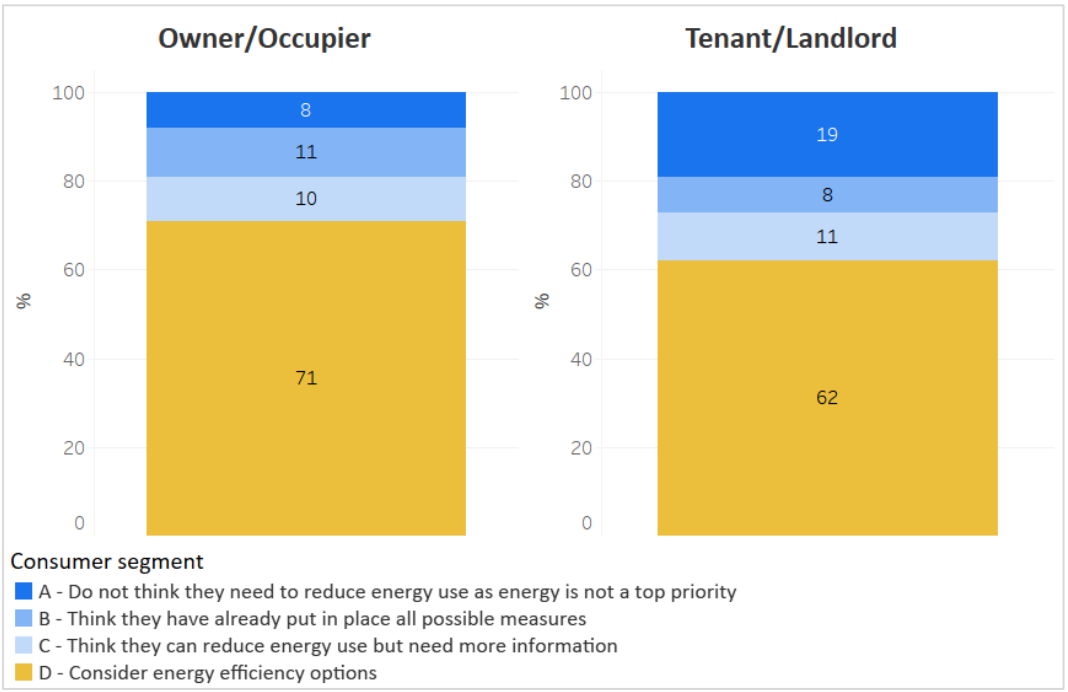
However, charging premium rents is not possible when it is costly to resolve the information asymmetry regarding a building's energy performance (i.e. the tenant's certainty that a higher rent is offset by low energy bills or regulation prevents the extra costs from being passed on to the tenant.

On the other hand, the tenant's incentive to invest in energy performance improvements to the property is compromised by the potential mismatch between the longevity of the tenancy in relation to the payback time involved in the investment[40]. As such, it is important to ensure that there is sufficient **regulatory certainty on the rights and obligations of each party** in the case of investment in energy efficiency, as well as working models that facilitate the investment. An illustration of the consequences of split incentives can be found in the results of a recent survey of owners and tenants of residential buildings in Ireland (Figure 17).

[39] United Nations Development Programme (UNDP), Promoting Energy efficiency in buildings: Lessons Learned from International Experience, March 2009, https://www.thegef.org/sites/default/files/publications/EEBuilding_WEB_2.pdf.

[40] Olsthoorn, Mark & Schleich, Joachim & Hirzel, Simon, 2017. "Adoption of Energy Efficiency Measures for Non-residential Buildings: Technological and Organizational Heterogeneity in the Trade, Commerce and Services Sector," Ecological Economics, Elsevier, vol. 136(C), pages 240-254.

Figure 17 Interest in energy efficiency improvements for consumer segments in the residential sector in Ireland, 2016 (%)



Source: SEAI[41]

In parallel, the potential savings generated from investments in energy and resource use optimisations can be a powerful driver, but also an obstacle in the event that they are too low or spread over a time horizon that does not match investors' preferences. Deep renovations, which include overhauling heating and cooling systems, insulation and windows or installing intelligent monitoring systems, require major investments and disruptions and usually a **long payback horizon**. The higher the initial cost and the longer the period over which the investment will pay for itself through lower energy bills, the less attractive the investment project becomes for investors with preference for short-term returns[42].

An additional obstacle comes from the uncertainty of the actual energy savings compared to the projected ones. The so-called "**energy performance gap**" occurs when supposedly high energy performing buildings register higher energy consumption than expected[43] . The characteristics and behaviour of the building residents have been found to have a strong impact on the amounts of energy consumed in a building.

> One such behavioural element is the so-called "rebound effect"[44], the increase of energy consumption in services for which improvements in energy efficiency reduce the costs[45].

Furthermore, tenants are found to have a higher rebound effect than homeowners[46]. In terms of **resource efficiency**, when talking about design for deconstruction and re-use, one of the main challenges is to make the business case for recycling materials that are not valuable or for construction materials produced via more sustainable (e.g. low

41 SEAI, Behavioural insights on energy efficiency in the residential sector, 2017. Accessed on https://www.seai.ie/resources/publications/Behavioural-insights-on-energy-efficiency-in-the-residential-sector.pdf.

42 International Energy Agency, Promoting energy efficiency investments - Case studies in the residential sector, 2008. https://www.iea.org/publications/freepublications/publication/PromotingEE2008.pdf.

43 BuildUP, Closing the Building Energy Performance Gap: combining automation with analytics, June 2017. http://www.buildup.eu/en/practices/publications/closing-building-energy-performance-gap-combining-automation-analytics.

44 Herring, H., & Sorrell, S. (2009). Energy efficiency and sustainable consumption. The rebound effect. Basingstoke: Palgrave Macmillan.

45 An example of the rebound effect is when a home is retrofitted with insulation or a more efficient boiler. The expected efficiency gain is negated if people increase the hours of space heating and/or raise the internal (winter) temperature. This results in a higher energy use.

46 Van den Boom, Paula, 2017, Performance gaps in energy consumption: household groups and building characteristics, Building Research & Information, Volume 46, 2018. http://www.tandfonline.com/doi/full/10.1080/09613218.2017.1312897.

emission), but costly methods. It is also important to ensure that **life-cycle cost models** demonstrate the value of reusable materials or buildings that can be adapted to future needs rather than being demolished[47].

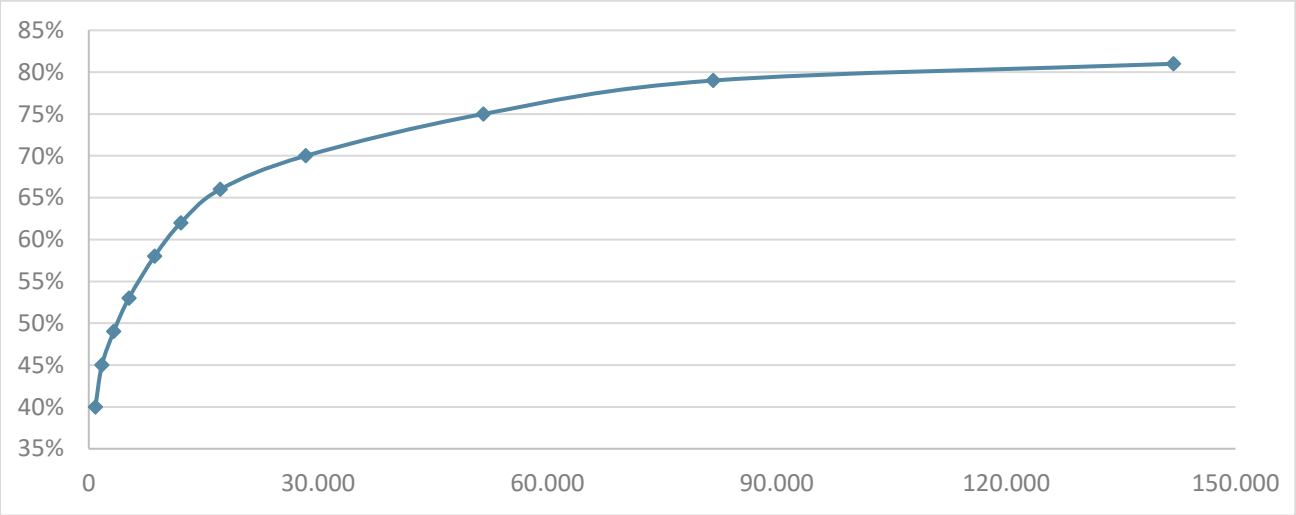
Access to finance

Access to finance for households, the public and private sector is subject to different factors and trends.

Residential sector

As noted in Section 3, economic factors such as individual payment capacity, ease of undertaking investments, the availability of tailored financial products and fiscal support are particularly important for investments in the energy efficiency of **residential** property[48]. As can be seen from the model representing investment behaviour in households in OECD countries, people living in wealthier households are more likely to invest in energy efficiency[49].

Figure 18 Predicted probability of investing in energy efficiency at different income levels, 2015 (%)



Source: Amelie, N. & Brandt. N. (2015)

> As investments in energy efficiency such as home renovation and energy saving technologies are costly, a high income household has a greater financial capacity to afford them and to benefit from reductions in their energy bill.

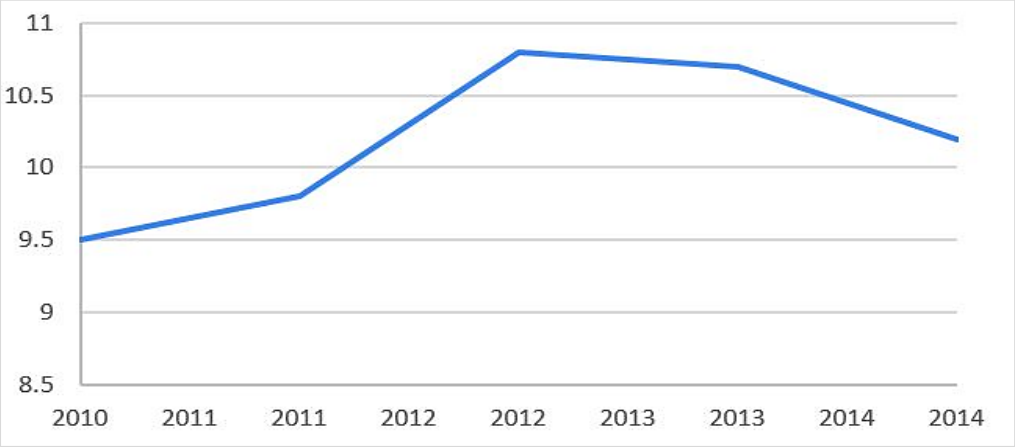
So, people living in poorer households may end up using a large share of their income to pay for energy, which is referred to as energy poverty. As can be seen from Figure 19, energy poverty levels in Europe have increased - country-level data shows that as many as 40.5% of **the Bulgarian population** in 2014 lived in households which were unable to keep their home adequately warm, followed by **Greece** (32.9)% and **Portugal** (28.3%).

[47] European Commission, Workshop "Design for Deconstruction and Durability of Buildings", November 2017.

[48] Energy Efficiency Financial Institutions Group E (EIFG), Energy Efficiency – the first fuel for the EU Economy. How to drive new finance for energy efficiency investments, February 2015. https://ec.europa.eu/energy/sites/ener/files/documents/Final%20Report%20EEFIG%20v%209.1%2024022015%20clean%20FINAL%20sent.pdf.

[49] Amelie, N. & Brandt. N. (2015) Determinants of households' investment in energy efficiency and renewables: evidence from the OECD survey on household environmental behaviour and attitudes http://iopscience.iop.org/article/10.1088/1748-9326/10/4/044015/meta.

Figure 19 Energy poverty - proportion of inhabitants unable to keep home adequately warm, EU-28, 2010-2014 (%)



Source: EU Building Stock Observatory

> Energy poverty is a result of a combination of low income, high energy expenditure and poor energy efficiency of dwellings.

Energy poverty is a result of a combination of low income, high energy expenditure and poor energy efficiency of dwellings, which is why effective action to alleviate energy poverty has to include energy efficiency measures alongside social policy measures. Low-income households and particularly households in a situation of energy poverty are much more likely to lack both savings to cover the initial investment costs for clean energy technologies and access to credit[50]. Although economic theory states that the market should provide capital for all investment needs at a risk-adjusted price, in practice, low-income borrowers can have extreme difficulties in accessing capital[51]. If the costs and difficulty in obtaining the initial capital needed for energy efficiency improvements are insurmountable, consumers will not make the investment.

> Evidence from a recent survey of Irish consumers showed that of the respondents who have investigated the ways to reduce energy use through energy efficiency purchases but had not acted upon these yet, over 70% identified "not having sufficient funds" as the most relevant barrier to action[49].

One of objectives of the "**Clean Energy for all Europeans**" package is to ensure that energy poor and vulnerable consumers can benefit from modern energy services and become more engaged with the energy market. The proposal to revise the Directive strengthens the existing provisions on energy poverty by requiring MS to take energy poverty into account also when designing alternative policy measures. The agreement reached for the revised **Energy Performance of Buildings Directive** calls for Member State action to address energy poverty issues, as part of the long-term building renovation strategies that MS have to establish to decarbonise EU buildings by 2050. The agreement, which is in line with the principle of subsidiarity, could contribute to taking out from energy poverty between **515 thousand to 3.2 million households** in the EU.

The Energy Poverty Observatory which was launched on 29 January 2018 by the Commission has developed a number of indicators to measure energy poverty that can be used by MS.

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50 Institute of Physics Science (IOP Science), Determinants of households' investment in energy efficiency and renewables: evidence from the OECD survey on household environmental behaviour and attitudes, April 2015, http://iopscience.iop.org/article/10.1088/1748-9326/10/4/044015/meta.

51 International Energy Agency (IEA), Promoting energy efficiency investments, case studies in the residential sector, 2008, https://www.iea.org/publications/freepublications/publication/PromotingEE2008.pdf.

52 Sustainable Energy Authority of Ireland (SEAI), Behavioural insights on energy efficiency in the residential sector, August 2017, https://www.seai.ie/resources/publications/Behavioural-insights-on-energy-efficiency-in-the-residential-sector.pdf.

Non-residential public sector

The aftermath of the worldwide economic crisis left a lot of governments in Europe struggling to balance public budgets. Public sector expenditure in the EU relative to GDP was 3.5% lower in 2016 compared to 2010 (46.3% in 2017, 49.8% in 2010). As such, many countries maintained low levels of investment in energy performance improvements of the public sector building stock. For example, in **Germany**, municipalities recorded a very high level of investment backlog, related to a large extent to school and education infrastructure, public administration buildings and to a smaller degree to social housing, which only started to decrease following increased federal government spending since 2016 which will i.e. improve the energy performance of the existing stock and finance new high energy-performing construction.

The results of the Horizon 2020 EmBuild project show that **access to finance** is considered to be a main barrier to investment in energy efficiency, with local authorities sometimes lacking the technical skills necessary to apply for available funding (e.g. ESIF, EFSI).

> Limited borrowing capacity of the public sector, complex financial schemes favouring large investments and unfavourable accounting rules are also reported as key barriers for municipalities[53].

Non-residential private sector

Access to finance for energy performance improvements in non-residential private buildings is generally subject to the overall trends in lending to non-financial companies. Following the low levels of lending activity after the financial crisis, there has been a recovery across the EU, but nevertheless, there is a barrier to be found for energy performance improvements when considering that private actors have competing, and often better understood, priorities for investing the capital that they are able to access.

> Specifically, uncertainty about the robustness of methods to estimate savings from energy efficiency, along with a resultant under-appreciation of some of the wider financial benefits (such as reduced exposure to fuel price volatility), leads to the application of a high discount rate to returns, which increases the perceived risk.

High **risk premiums** of the offered financing can make it unattractive for investors, thus effectively reducing their access to financing[54].

Awareness and knowledge

> The lack of information and awareness stand amongst the most important barriers to the deployment of energy efficient technologies[55].

Consumer's knowledge of the costs and wider benefits (e.g. health, indoor air quality, increased property value, etc.) of different energy solutions, how much energy they use in their homes, or what rates of return to expect from energy efficiency measures is likely to affect the adoption of such measures[56]. However, it is the responsibility of each Member State to set minimum requirements for the energy performance of buildings and building elements with the possibility

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53 EmBuild, Barriers that hinder deep renovation in the building sector, June 2017. http://embuild.eu/site/assets/files/1316/d4_1_embuild_final_report-1.pdf.

54 Association for the Conservation of Energy, 2013, Financing Energy Efficiency in Buildings. https://wec-policies.enerdata.net/Documents/cases-studies/Financing_energy_efficiency_buildings.pdf.

55 International Energy Agency (IEA), Promoting energy efficiency investments, case studies in the residential sector, 2008, https://www.iea.org/publications/freepublications/publication/PromotingEE2008.pdf.

56 Mills B. and Schleich J., 2014, Household transitions to energy efficient lighting Energy Economics, 46, 151–60.

to review regularly their minimum energy performance requirements for buildings in regards to technical progress as outlined in Directive 2010/31/EU[57].

In the first instance, consumers need to be aware of the possibility for energy performance improvements. Once a general level of awareness has been reached, consumers need **more detailed information** and often **individual technical assistance** or 'coaching', in order to commit and plan for the introduction of energy performance improvements – e.g. sufficient information to take a decision on the specific technical solution, product, brand, technical specifications, contractors, financial assistance, etc.[58]. Furthermore, specialised technical assistance may be needed to carry out a proper analysis of the costs and benefits, such as a **life-cycle assessment model**. There may also be a lack of clearly synthesised information on the financial options available to individuals investing in energy efficiency[59].

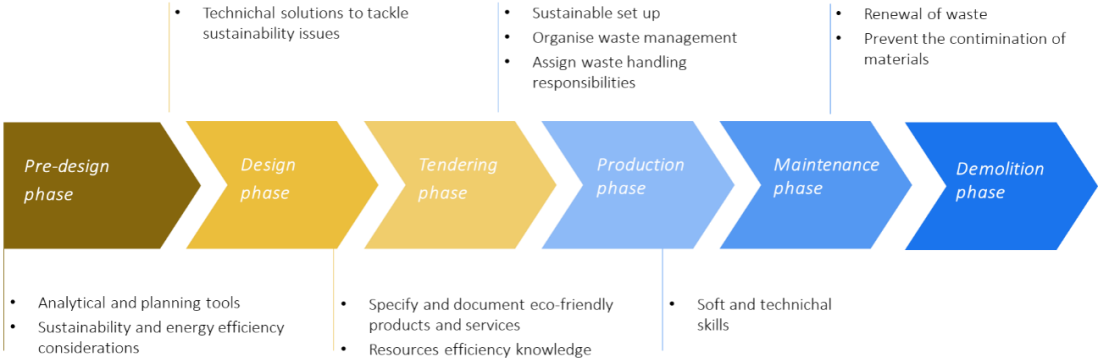
> The results of a recent survey of consumers in **Ireland** offer confirmation of the impact of information failure – the survey carried out by the SEAI found that increasing the awareness of homeowners was to the benefit of completing **retrofits**, and highlighting local opportunities and initiatives to complete retrofits are important to **stimulate the interest of households**.

Furthermore, households' engagement is improved where information / initial contact regarding the potential for an energy efficiency measure comes from a **trusted source** that is perceived as likely to act in the household's best interests and to provide impartial advice[60].

Skills shortage

As described in detail in the ECSO analytical report on TO2 – Improving the human capital basis, the stringent energy efficiency targets and increasing demand for sustainable construction solutions are expected to necessitate a transformation of the skills required during all stages of the building process, from planning to design, production, maintenance and renovation and finally demolition (Figure 20)[61].

Figure 20: Skill needs across the construction process



Source: PwC / ECSO Analytical report TO2

[57] Article 10 of Directive 2010/31/EU on the energy performance of buildings, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN.

[58] The GEF, 2010, Promoting Energy efficiency in buildings: Lessons Learned from International Experience. https://www.thegef.org/sites/default/files/publications/EEBuilding_WEB_2.pdf.

[59] United Nations Economic Commission for Europe, Overcoming barriers to investing in energy efficiency, 2017 https://www.unece.org/fileadmin/DAM/energy/se/pdfs/geee/pub/Overcoming_barriers-energy_efficiency-FINAL.pdf.

[60] Sustainable Energy Authority of Ireland (SEAI), Behavioural insights on energy efficiency in the residential sector, August 2017, https://www.seai.ie/resources/publications/Behavioural-insights-on-energy-efficiency-in-the-residential-sector.pdf.

[61] PricewaterhouseCoopers (PwC), European Construction Sector Observatory – Analytical report on TO2 - Improving the human capital basis, April 2017.

It has been estimated that **retrofitting of existing homes** could create around **280,000-450,000 new jobs** for energy auditors, certifiers, inspectors of heating systems and renewable technology installers, with potential strong impact in **Central and Eastern European economies**, where the least energy-efficient buildings are located.

According to the national Status Quo Analyses[62] conducted under the BUILD UP Skills initiative, over **3 million construction workers** in Europe will need to increase their skills in the building sector in relation to energy efficiency (EE) and renewable energy systems (RES) by 2020, stressing the pivotal role of **dedicated training**[63].

Specifically, looking at the demand by type of occupations, the trend at the EU level indicates that the highest numbers of workers needing to be trained on energy efficiency and renewable energy are found in the following professions:

- ✓ Electricians;
- ✓ Plumbers (including installers of heat pumps boilers, biogas systems, central heating, sanitary and thermic equipment);
- ✓ Carpenters and joiners;
- ✓ Bricklayers;
- ✓ Technicians (including Heating, Ventilation, and Air Conditioning - HVAC).

A similar trend is observed at Member State level, although training needs can vary between countries, both in terms of the occupations for which additional training is required to meet **2020 energy targets**, and in terms of the share of the total workforce requiring additional training.

In countries such as Bulgaria, the currently low level of introduction of energy-efficiency buildings implies that the entire construction workforce should be trained on the basic principles of energy efficiency by 2020, without particular differences between occupations. Similarly, in Spain, up to 100% of the workforce is estimated to require extra skills in EE and RES until 2020.

62 BUILD UP Skills, National BUILD UP Skills Projects. http://www.buildup.eu/en/skills/bus-projects.

63 European Commission, BUILD UP Skills - An initiative to boost the energy skills of Europe's building workforce. February 2014. http://ec.europa.eu/energy/intelligent/files/build_up_skills_publication.pdf.

5.
Policy initiatives

Trends in policy initiatives

Given the multiple drivers and obstacles to the energy and resource efficiency of the construction sector, MS are taking action in addressing these through various policy instruments and initiatives. Indeed, there is a variety of schemes implemented either by the government or by industry associations, training providers or other similar bodies, which aim at addressing the insufficient demand and supply for energy performance improvements through **incentive schemes**, **information and awareness raising measures**, **research support** and **skills development initiatives**. Training in energy efficiency stands out as a major area of policy activity, also spurred by EU funds.

Looking across the EU-28, the following **key trends** can be observed:

- Policy activity is concentrated in measures that target the direct improvement of the **energy performance of the residential building stock**, in particular through financing measures;
- Most MS have in place policies targeting skills shortages for energy and resource efficiency, which are a combination of formal **Vocational Education and Training (VET) training** and non-formal training initiatives;
- Several Member State have measures aiming to improve **awareness** of and **knowledge** about energy and resource efficiency;
- The majority of MS have introduced financing or other types of measures to support research in the area of energy and resource efficiency.

Table 2 provides an overview of the extent of coverage of policy areas through dedicated initiatives in every Member State. Each policy area will be discussed in greater detail in the following sections, outlining some of the key initiatives that MS are taking to address the specific challenges affecting energy and resource efficiency in the construction sector.

Table 2: Overview of energy efficiency policy initiatives by country, EU-28

Country	Energy eff. improvements & renovation	Information & Awareness	Research initiatives	Skills & training initiatives	Resource efficiency improvements
Austria					
Belgium					
Bulgaria					
Croatia					
Cyprus					
Czech Republic					
Denmark					
Estonia					
Finland					
France					
Germany					
Greece					
Hungary					
Ireland					
Italy					
Latvia					
Lithuania					
Luxembourg					
Malta					
Netherlands					
Poland					
Portugal					
Romania					
Slovakia					
Slovenia					
Spain					
Sweden					
United Kingdom					

Fiscal Measures | Financing Measures | Non Regulatory | Training | Strategy

Note: This overview is based on the data collected by ECSO

Energy performance improvements & renovation/rehabilitation initiatives

Financing measures

In light of the identified issues with the need for financial incentives and increased access to finance for energy performance improvements and renovations, all EU-28 MS have introduced financing measures to support the increased investment in building up and improving the energy performance of the existing building stock. Usually focused on residential buildings rather than non-residential ones, the measures usually take one of the following forms:

- ✓ Grants;
- ✓ Loans;
- ✓ Guarantees.

Grants are the most common financial incentive offered, followed by **loans** and **guarantees**. Overall, in most cases combinations of these instruments are offered under different schemes.

Grants

Grant funding is available in 24 of the EU MS. Usually, the grant schemes cover only part of the needed investment, ranging in most cases between 30% - 50% of the total amount.

An example of such a scheme is the "Better Energy Homes" programme offered in **Ireland** by the Sustainable Energy Authority. Since 2006, homeowners can receive a grant, covering up to 30% of the cost of improving the energy efficiency of their homes. Depending on the type of work undertaken, a ceiling applies. For instance, for external wall insulation, a grant of up to EUR 4,599 for detached houses can be received. The Thermal Rehabilitation Programme launched in 2009 by **the Romanian government** also aims to support energy efficient residential buildings. Specifically, for dwellings built between 1950 and 1990 a particularly high grant of up to 80% of the cost can be offered to reduce the annual energy consumption for heating to below 100 kWh/m^2.

Bulgaria is the only country to offer a scheme covering 100% of the cost of renovations improving energy efficiency. The National Programme for Energy Efficiency of Residential Buildings launched in early 2015 by the Ministry of Finance aims to support the renovation of private multi-family apartment blocks through a budget of BGN 1.0 billion (EUR 511.3 million).

The following box presents the outline, results and assessment of a grant scheme from **Spain**.

Financing for renovation and regeneration of urban residential buildings in Spain

In Spain, 54% of the housing stock (approximately 25.2 million buildings) were constructed before 1980 and, of those older buildings, 16.21% (about 2.2 million) are in a poor condition that requires renovation or the demolition and replacement of the building. The Urban Regeneration and Renovation Programme (*Ayudas a la Regeneración y Reurbanización Urbanas (ARRU)*) provides part-funding to support the renovation of buildings and homes, the urbanisation or redevelopment of public spaces and, where appropriate, new building construction to replace demolished buildings.

To be eligible for ARRU grant funding, applicants must demonstrate compliance with certain prerequisite criteria. To apply for a building renovation grant, a building owner must demonstrate that the building was constructed before 1981, and that at least 60% of the surface area of the building is above ground and is intended for residential use. Single and multi-household buildings are eligible for funding.7 To apply for a partial demolition and construction grant, applicants must show that the new building will be in compliance with the requirements of the Technical Building Code and will achieve a minimum energy rating B (on the energy rating scale that goes from F to A, where F is the least efficient and A is the most efficient).

By the end of 2016, approximately EUR 280 million in ARRU funding have been awarded to support over 117,000 renovation projects.

The ARRU programme is assessed positively by industry stakeholders, who highlight its value to local communities and its positive impact on activity in the construction sector in Spain.

Loans

Loan schemes in support of energy efficiency renovations were identified in 18 MS. Despite being less prevalent than grants, loans remain widespread and offer an important support for the financing of renovation works across the EU. In some cases, development banks, such as the KfW, the EIB and the EBRD support the financing of these programmes.

For instance, the **Residential Energy Efficiency Credit Line** (REECL) introduced by the European Commission, the European Bank of Reconstruction and Development (EBRD), and the **Bulgarian Energy Efficiency Agency** helps reduce energy consumption and bills in Bulgarian households. With a budget of EUR 50 million, the REECL allows partnering banks to provide loans to households or associations of homeowners for implementing energy performance improvements such as double-glazing, thermal insulation or other energy efficient installations. In Austria, through the support of the EIB with a EUR 150 million framework loan, the *Bausparkasse der Österreichischen Sparkassen AG* funds energy efficient renovation and the sustainable construction of buildings. Funds are available for both private and public sector projects resulting in documented energy savings and increased use of renewable energies, thus improving the quality of housing in the country.

Beyond granting loans, some schemes also offer reduced interest rates. This is the case, for instance, **in France**, whereby the Zero Interest Eco loan *(Eco-prêt à taux zero)* allows to finance at least two energy efficiency measures with a ceiling of EUR 30,000. These can include improvements such as the insulation of roofs, outside walls, windows and doors or the installation of renewable energy-based hearing. The maximum repayment period has been set at 15 years.

The Energy Efficiency Fund launched in 2014 in **Ireland** also offers financing at preferential interest rates. In fact, it finances innovative projects focused on energy efficiency across Irish public and private sector buildings and urban infrastructure on a commercial basis, through a total funding of EUR 75 million. EUR 35 million was invested by the government and the rest was matched via private sector funding investment via the Sustainable Development Capital LLP fund Management Company. The fund invests in building retrofit projects, such as the replacement and upgrading of energy systems in old buildings with new equipment (e.g. LED lighting, heating and ventilation systems, boilers, etc.), as well as urban infrastructure projects (e.g. new outdoor lighting and smart metering systems for local authorities, district heating for social housing, etc.).

Guarantees

Guarantees are the least common type of financial incentives for energy performance improvements and renovation. Still, such programmes are important in increasing access to finance for households which would not have the necessary financial backing to take out a loan. Five of the 28 EU MS are implementing such schemes, including two schemes which are complemented with loans and/or subsidies.

For instance, **the Luxembourgish government** put in place a guarantee scheme managed by the Ministry of Housing, which guarantees up to EUR 131,630 to eligible individuals wishing to take out loans for the renovation of their dwellings. Another similar guarantee scheme exists in **Sweden**. While before 2017, the guarantees offered focused on new building and conversion, the Swedish National Board of Housing and the Swedish Energy Agency have proposed to further extend its use to also include specific renovation measures.

The Latvian government offers a scheme providing a **mix of loans, grants and guarantees** in order to improve the financing of renovation works for energy efficiency purposes of multi-apartment buildings. Altum, a development finance institution in Latvia, manages this scheme which had started in the 2007-2013 programming period with support from the European Regional Development Fund (ERDF) and has been extended. Financial support is provided in the form of grants, guarantees and loans. Grant amounts vary between 36-50% of the value of the loan taken out from a commercial bank (or between 25-35% in case of a loan provided by Altum), depending on the final heating energy consumption achieved after the works.

Guarantees can cover up to 80% of a loan taken out from a financial institution, with the maximum guaranteed amount being set at EUR 3 million.

Loans can be provided by Altum in case no loans are available from other credit institutions, with their amount not exceeding the cost of the eligible energy efficiency measures. Activities supported by the scheme include renovation, reconstruction works, purchase and installation of high efficiency RE-based heat/hot water production equipment, etc. Upon completion of the renovation works, the annual heat energy consumption for heating must not exceed 90 kWh/m^2.

The total budget of the programme is EUR 166.5 million over 2016-2023, of which EUR 141.5 million are from the ERDF and EUR 25 million from the state budget.

Another financial instrument called "The Smart Finance for Smart Buildings" was approved by the Board of the European Investment Bank (EIB) in February 2018 with the aim to make investments in energy efficiency projects in residential buildings more attractive to private investors, through the smart use of EU grants as a guarantee.

This new instrument, together with other EU policy initiatives for smart buildings, seeks to unlock a total of EUR 10 billion in public and private funds between 2018 and 2020 for energy efficiency projects. It is foreseen to support **up to 220,000 jobs** and help establish a renovation market for small businesses worth up to EUR 120 billion, including up to EUR 3.2 million European families could be taken out of energy poverty. Although the financial instrument is under development, several MS have already expressed their interest in applying for it[64].

Fiscal measures

Fiscal measures supporting energy efficiency renovation work and improvements are much less widespread than financing schemes. However, these can play a significant and effective measure in order to incentivise renovation works, as is seen in the countries implementing them.

Across EU MS only four countries implement fiscal measures, namely France, Ireland, Italy and Sweden. France and Ireland offer tax credits, while Italy and Sweden offer tax deduction.

In **France**, the government offers a 30% **tax credit** *(Crédit d'impôt pour la transition énergétique – CITE)*, up to a maximum of EUR 8,000 (EUR 16,000 for couples) over a five-year period on the expenditures incurred for energy efficiency renovation works. This tax credit has been renewed by the new government until December 2018. Thereafter, the tax credit will become an in-cash benefit, so that beneficiaries can recoup some of their renovation expenses as soon as the renovation works are completed. The CITE can be combined with other financial measures, such as the Zero Interest Eco-loan.

In **Ireland**, the Home Renovation Incentive, offered by the Sustainable Energy Authority of Ireland, provides a tax relief for homeowners and landlords in the form of a tax credit at 13.5% of qualifying expenditure incurred on repair, renovation or improvement work carried out on a principal private residence. The value of works carried out must be at least EUR 4,405 excluding VAT to benefit from the incentive.

Other policy measures

In addition to the regulatory measures described in Section 3 and the financing schemes introduced so far, the MS have also introduced other measures that contribute to the uptake of energy performance improvements.

[64] European Commission, Smart finance for smart buildings: investing in energy efficiency in buildings, February 2018, https://ec.europa.eu/info/news/smart-finance-smart-buildings-investing-energy-efficiency-buildings-2018-feb-07_en

With regards to **tax deductions**, **the Italian government** allows to deduct up to 65% of the costs incurred for energy efficiency upgrades off the taxable income. Depending on the renovation work done, the maximum amount deducted can reach EUR 100,000. For energy performance improvements on communal spaces in apartment blocks, the tax deduction can be increased to 75%, through the "Eco Bonus" scheme. Similarly, **the Swedish Government** has introduced the Repairs, Maintenance or Conversion and Extension Work deduction programme back in 2008. It offers a 50% tax deduction up to a maximum of SEK 50,000 (EUR 5,300) per person per annum. However, it can only be claimed for the costs of labour, not for materials. It applies to construction works on a residential property older than five years, as well as repair and maintenance interventions to restore a dwelling to its former condition, regardless of its age.

These measures include the set-up of public bodies to monitor the implementation of energy efficiency policy. For example, in **France**, the Environment and Energy Management Agency *(Agence de l'Environnement et de la Maîtrise de l'Energie – ADEME)*, through its Permanent Observatory for the Improvement of Energy Efficiency in Housing *(Observatoire Permanent de l'Amélioration ENergétique du logement – OPEN)* gathers data on the results of these public policies since 2006. Another example from France - of a measure combining financing support with technical assistance - is presented in the following box.

Technical assistance and work supervision for energy efficiency renovation

"Picardie Pass Rénovation **(PPR)" is an innovative technical and third-party financing instrument that aims to encourage and support building renovation work across the region. The Regional Council of Picardy created a dedicated body, the Public Service for Energy Efficiency (PSEE), to play a central role in programme implementation. The PSEE supports** private renovation projects **by** providing technical assistance and long-term loans to homeowners**, whose payback is offset by significant** energy savings **and hence** lower energy bills**. The PSEE also supervises the works on behalf of property owners throughout the renovation process.**

PSEE has a budget of EUR 65.9 million for the pilot phase (2014-2018), of which EUR 57 million is allocated to renovation works and EUR 9 million to Picardie Pass Rénovation (PPR) management costs. By 15th September 2016, 1,250 PPR renovation contracts had been signed, of which 458 renovation projects were still ongoing or finalised. PPR has been successful in terms of outreach. Around 1,900 energy audits have been carried out by PPR technicians and around 3,900 households got into contact with the PSEE. Although this does not mean that all households that showed interest will eventually join PPR, it demonstrates that the programme benefits from a significant untapped potential and a strong interest from the public. Therefore, the programme seems highly likely to meet its objective of 2,000 renovation contracts signed by the end of the pilot phase.

Although it is still at the pilot phase, the PPR programme has the support of all relevant stakeholders. One of the programme's greatest strengths lies in the central role played by the PSEE, which provides financing and technical support to property owners, supervises works on their behalf and acts as the unique contact person for building companies. However, there is still room for improvement and some adjustments are needed prior to any roll-out, in particular with a view to achieving a balanced budget over time.

Information and awareness raising initiatives

In order to increase the awareness on policy measures fostering energy efficiency, various initiatives across EU MS have been devised and implemented.

For example, **the Latvian government**, through its "Let's live warmer" information campaign, encourages apartment owners to get involved in the management of the common property and improvement of its energy performance, as well as encouraging construction companies, building materials producers and traders to take initiatives regarding

renovation of multi-apartment buildings. To this end, it includes **education seminars** and **conferences** on energy efficiency in both multi-apartment buildings and public sector buildings. Special guidance materials are provided on project preparation and implementation, as well as the operation of buildings after the completion of the energy efficiency project.

The first edition of the campaign proved to be successful in raising awareness about the funds available for apartment renovation, having contributed to the completion of 740 projects over its implementation (2009-2013). Between 2010 and 2017, 11 cycles of workshops were held throughout Latvia, as well as about 235 information events, including discussions, seminars, conferences and exhibitions.

A more detailed example of an information and awareness raising initiative is presented in the following box.

Energy advisory network in Slovenia

The Energy Advisory Network for households (ENSVET) is part of a series of measures that were introduced as part of Slovenia's National Energy Efficiency Action Plan 2014-2020, even though it was first set up in 1991 as a part of a pilot project that brought together Slovenian-Styrian energy initiatives in the context of a programme for bilateral cooperation with Austria.
The main goal of ENSVET remains the same – to increase interest and private investment in renewable energy sources (RES) and the rational use of energy (RUE) through a network of regional advisory offices. The main barriers that the network is working to overcome are:

- Low interest in the implementation of energy efficient (EE) measures;
- Low public awareness of EE and environmental issues;
- Lack of investment funds to implement EE measures.

ENSVET provides the public with free counselling and is engaged in a wide range of awareness raising activities across the country. Recently, ENSVET has also added a new scheme for low-income households called AERO, which is a service that is provided in cooperation with social work centres.
ENSVET runs an average of 6,000 advisory sessions per year and aims to increase this figure to 10,000 per year by 2020.

Table 3: Impact of ENSVET for the period 2011-2016

	2011	2012	2013	2014	2015	2016
No. of advisory sessions	5,797	5,867	5,483	4,344	4,321	5,746
End use energy savings (MWh/year)	16,303	20,164	18,540	18,540	17,326	13,727
Reduction in Co2 emissions (kt/year)	4,250	5,257	4,776	4,834	4,517	3,579

Source: Ecofund

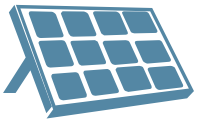
Based on the results of Eco Fund's latest survey of beneficiaries, which was conducted in 2013, 75% of respondents said they were 'very satisfied' with ENSVET services, and 25% said they were 'satisfied'. The most common reason for not implementing the solution suggested by advisors was reported to be the lack of financial resources.

Research initiatives

A number of MS have introduced research initiatives in order to support **innovation in the construction sector**. For example, in **Belgium**, the Framework Convention for the Development of Green Building and Sustainable Architecture initiative was signed between Québec and Wallonia in October 2017, and the partnership in the eco-construction sector

in the same year. The so-called Framework Convention for the Development of Green Building and Sustainable Architecture intends to stimulate scientific exchanges within the eco-construction cluster between the two regions and to implement coordinated trainings and research programmes in eco-construction and sustainable development.

The Danish Eco-innovation Programme (*Miljøteknologisk Udviklings- og Demonstrationsprojekt* - MUDP), launched in 2015, is a subsidy scheme that supports Danish companies in developing and demonstrating **new eco-efficient solutions** focusing on **sustainable construction, water, climate change adaptation, the circular economy and recycling of waste**, among others. For 2017, a total of almost DKK 100 million (EUR 13.4 million) is available under the scheme[65]. Innovation networks in construction play an important role in Denmark – the Innovation Network for Energy efficient and Sustainable construction (*InnoBYG*) focuses on developing projects, knowledge sharing as well as linking relevant stakeholders such as research institutes, industry players and universities[66]. The network comprising over 250 members among industry, architects, engineering firms and research institutes was launched in 2010 and its financing was renewed for another 4-year term in 2014.



Support for research is also provided in Germany, where the federal government implements an Energy Research Programme, including research initiatives like the "Solar-powered Buildings/Energy-efficient Cities" initiative, which will provide EUR 150 million of funding for projects for a period of up to five years, with the first call for proposals launched in 2016.

In addition, the "EnEff.Gebäude.2050 – Innovative projects for achieving nearly climate-neutral building stock by 2050" funding initiative, also launched in 2016, is available for exemplary innovation and transformation projects in the building sector that can contribute to the removal of barriers on the path towards a virtually climate-neutral building stock[67].

Skills and training initiatives

The move towards an energy efficient and sustainable building sector constitutes one of the primary drivers for future skill needs. Energy efficiency and sustainable construction carry significant market potential, being expected to attract extensive investments and providing major opportunities for businesses in the general economy.

The renewable energy industry alone is predicted to employ up to 2 million people by 2020, with the majority of new jobs being created in the construction sector.

In light of the challenges faced by the construction sector, MS are dedicating considerable efforts to the development of initiatives aiming to address the **training and skill needs** brought about by the stringent energy efficiency targets and required to embrace the opportunities that come with **the shift towards a sustainable and highly energy performing building sector**. The conducted research identified skills-oriented measures focusing on energy efficiency in 20 MS.

Most of the identified projects in the EU MS aim to develop energy-efficiency skills through **continuous education and training programmes** that build on the current expertise of onsite workers and other construction professionals. A number of measures take place under the umbrella of the **EU BUILD UP Skills initiative**.

For instance, in **Cyprus**, WE-Qualify "Improving Skills and Qualifications in the Building Workforce", co-founded by the EU projects Intelligent Energy Europe and BUILD UP Skills, is a key initiative to address the skills gaps related to the implementation of energy efficiency in buildings through VET programmes in the area of thermal insulation, and pilot

65 Miljøstyrelsen, Søger du tilskud under MUDP?, http://ecoinnovation.dk/tilskud/soeger-du-tilskud-under-mudp/.

66 Innovationsnetværk for bæredygtigt byggeri (InnoBYG), http://www.innobyg.dk/om-innobyg.aspx.

67 Federal Ministry for Economic Affairs and Energy .Neue Forschungsinitiative stärkt Energiewende in Gebäuden und Städten, April 2016. https://www.bmwi.de/Redaktion/DE/Pressemitteilungen/2016/20160411-neue-forschungsinitiative-staerkt-energiewende-in-gebaeuden-und-staedten.html.

trainings for the installation of thermos panels as well as for the installation and maintenance of biomass heating systems.

> BUILD UP Skills also supported trainings in Bulgaria, Greece, Lithuania and Slovakia on skills needed by the construction sector for the transition to constructing nearly zero-energy buildings.

There are several examples of national initiatives.

In **Luxembourg**, the Professional Association of Architects and Consulting Engineers (OAI) and the Luxembourg Chamber of Crafts are active in delivering trainings on energy renovation, passive houses, ventilation systems and other related topics.

Similarly, in **Malta**, the Building Regulation Office (BRO) offers courses to educate and qualify assessors of energy performance in buildings. Over the past years, it has qualified 160 officers for the residential segment and 30 officers for the non-residential segment. In the future, the BRO also intends to qualify assessors to determine the efficiency of air-conditioning and ventilation systems, as well as space heating systems.

In **Denmark**, the Bedre Bolig initiative, which aims to improve energy performance in housing, contains a training module on offering professional advice on energy renovation.

Another type of initiatives are **'Train the trainers' schemes**, which are provided in the framework of the EU-wide BUILD UP Skills initiative or as national initiatives. In Bulgaria, the BUILD UP Skills EnerPro project resulted in the training of 319 certified workers and 114 certified trainers. Additionally, the project contributed to reducing the gap in continuing professional training of trainers in the construction sector.

Similarly, as part of the BEEP project in **Finland**, a dedicated train-the-trainer scheme was developed and piloted with 40 trainers. An example of a national "train the trainers" scheme can be found in **Romania**, where such training is provided by The Builder Vocational Training School *(Casa de Meserii a Constructorilor),* which is responsible for the development of the human capital base in the construction sector and the promotion of continuous professional training.

Aside from classroom-style VET courses, **other types of initiatives** are being introduced to improve the energy-efficiency skill base in the construction sector. These encompass **web-based trainings/e-learning**, as well as **seminars, summits and knowledge-sharing events** found across several MS including **Denmark, Portugal, Austria, the Netherlands, Sweden and Italy**.

Train the trainers initiatives are mostly developed in the framework of the BUILD UP Skills initiative

For instance, the Future Leaders Programme in **the Netherlands** is organised annually by the Dutch Green Building Council to connect young ambitious professionals active in the field of sustainability of the built environment. The programme allows **knowledge-sharing, coaching and networking** with leaders and peers, thus shaping the next generation of sustainability leaders.

As part of the Swedish **BUILD UP Skills** project SWEBUILD, the Swedish Construction Federation launched Energy Builders (*Energibyggare*)[68], a four-hour **interactive web-based training** in the field of energy-efficient construction and renewable energy tailored to all parties active on a construction site, including **builders, installers, supervisors and managers**.

The programme includes areas such as thermal insulation, air-tightness, moisture control and installations. Upon successful completion of the training, the acquired qualification can be registered in the ID06 Skills Database. Some countries also organise awareness-raising summits for stakeholders to discuss the need for energy-efficiency skills.

In **Italy**, Formedil, the national body for professional construction training, organises the **National Days of Construction Training** (*Giornate nazionali della formazione edile*). For 2015, these focused specifically on the need to impart better and new technical skills to construction workers to meet the increasingly stringent energy efficiency standards. The

[68] Energibyggare, http://energibyggare.se/

latest 2016 edition of the event focused on the need aligned the skills of the workforce with innovation in an evolving market. Finally, some countries are promoting the participation of the workforce in energy efficiency-related trainings through financial incentives.

In Belgium the Brussels regional government introduced a Support for Vocational training to entrepreneurs *(Steun voor opleiding - Gewestelijke steunmaatregelen voor Brusselse ondernemingen)*. It consists of financial support for SMEs operating in the construction sector, whereby employees are eligible for a financial refund up to 50% for the courses related to sustainable and energy saving construction. The workers that have acquired the knowledge are also encouraged to share the best practices related to sustainable living with their clients.

Key takeaways

✓ The majority of initiatives to adapt the skill base of the industry to energy efficiency requirements and sustainable construction target the current construction workforce (onsite workers) and other construction stakeholders (clients, developers, property owners, etc.).

✓ 'Train the trainers' schemes are equally crucial. Currently not as targeted by national initiatives, they are mostly developed within the framework of the EU-wide BUILD UP Skills project (e.g. Bulgaria, Finland, Estonia and Slovenia);

✓ Other types of initiatives (web-based trainings/e-learning, seminars, summits, knowledge-sharing events and financial incentives) are also being introduced to raise awareness and strengthen the energy efficiency skill base in the sector (e.g. the Netherlands, Italy and Belgium).

Resource efficiency improvements

Within the context of implementing the Waste Framework Directive, the EU MS have included targets for reducing C&D waste. A number of MS have also introduced additional policies to support resource efficiency improvements, mainly with a focus on promoting innovation and research.

In **Finland**, the "Green Growth – Towards a Sustainable Future" programme delivered by the Finnish Innovation Agency TEKES funds companies with growth potential in the area of energy and material-efficiency, bioeconomy and biomaterials, recycling and waste management. As an example, the programme has supported the development of an innovative method for processing construction waste materials into re-composite raw materials, aiming to achieve a 100% recycling rate for C&D waste.

In **Germany**, the initiative Circular Economy Construction *(Kreislaufwirtschaft Bau)* fosters the **circular economy** by regularly publishing **monitoring reports** and bringing together key construction stakeholders. Moreover, the Federal Ministry of Education and Research grants institutional funding of about EUR 232 million per year to Karlsruhe Institute of Technology for research projects including the development and marketing of Celitement® (granted EUR 4.3 million), which is environmentally sustainable cement with an energy consumption expected to be half of that of traditional Portland cement .

In **Belgium**, Greenbizz is a **business incubator** in the environmental sectors of eco-construction, renewable energies and eco-products. Greenbizz provides companies and start-ups with 8,000 m² of facilities and services to create and develop their green, sustainable or environment-linked projects.

In **Slovenia**, **the Competence Centre for Sustainable and Innovative Construction** *(KC TIGR)*, supported by the Ministry of Education, Science, Culture and Sport, brings together industry and public research institutions with the goal to

strengthen the sector by developing sustainable new technologies, competitive products, services and processes to the construction sector.

In **Sweden**, the Swedish Environmental Research Institute (IVL) has also established the BASTA system that aims to phase out hazardous materials through **registration and certification of building products**.

A number of initiatives are spearheaded by the private or NGO sector.

In **Luxembourg**, NEOBUILD is a private sector initiative supported by the Ministry of Economy and Foreign Trade. As a technological innovation pole, NEOBUILD aims to foster the emergence of **innovative sustainable construction technologies for SMEs**, to contribute and manage their development, and support their implementation in Luxembourg. In Portugal, the Sustainable Construction Platform is a non-profit organisation linking businesses, R&D centres, as well as municipalities. It manages **the Sustainable Habitat Cluster**, a broad cluster dedicated to promoting eco-innovation in the built environment. For the period 2014-2020, the Cluster is participating in various EU-funded projects.

6.
Conclusion

The European Union has set itself ambitious targets for improvements in the energy performance of the building environment and the resource efficiency of the construction sector more broadly. While progress is underway, driven by regulatory and economic factors, a number of obstacles remain. **Financial constraints** remain a major hurdle for households' ability to invest in the improvements of the housing stock, while **investments in the renovation of public buildings have stagnated** in the years of austerity that followed the 2007-2008 crisis. Investments have also been impeded by issues with access to finance and generally low awareness and knowledge of the technical and financing options available for improving the energy performance of the building stock. Last but not least, there are also **supply-side constraints** to be found in the **skills shortages** in the construction sector, particularly with regards to workforce qualified to advise on and carry out energy performance improvements.

In order to overcome the obstacles and take full advantage of the opportunities opened up by the discussed drivers, the following remarks should be considered when looking ahead.

- ✓ Increased **incentives for renovation and energy performance** improvements in residential buildings. Experience with different financing mechanisms shows that when set at the right level and tailored to the needs of different income groups, they are an effective means of stimulating consumers' demand. The combination of subsidies and loan or grant schemes that reach the large share of households inhabiting ageing buildings will raise the otherwise stagnant renovation spending in the EU MS.

- ✓ Increased focus on **measures for awareness raising and technical assistance**. A number of MS have already introduced measures addressing the need to accompany financing schemes with measures increasing consumers' awareness and understanding of the available options for energy performance improvements, including through the provision of advice and technical assistance for selecting, financing and implementing the most cost-effective solutions. The existing experience from such measures can serve to inform their broader take up in Europe.

- ✓ Increased focus on **measures to promote and support resource efficiency improvements** in the construction sector. The conducted review shows that apart from measures to implement the waste management obligations stemming from the Waste Framework Directive, there are few national policies and initiatives that provide strong incentives and support for increasing the resource efficiency of construction materials and processes.

- ✓ **Fostering R&D** can also be an important point in order to potentially reduce the cost of building high energy performing homes (through BIM technology, for instance) or in recycling/reusing waste. More support for research, collaboration and knowledge transfer between academia and industry actors will be essential for taking traditional construction methods to the 21st century.

- ✓ Further **support for skills development** for energy efficiency will be an important tool in narrowing the skills gap and shortage that represent a supply constraint for energy performance improvements.

Ultimately, these efforts will enable MS to meet their national, European and global energy and climate policy commitments, as well as increase the wellbeing of their citizens.