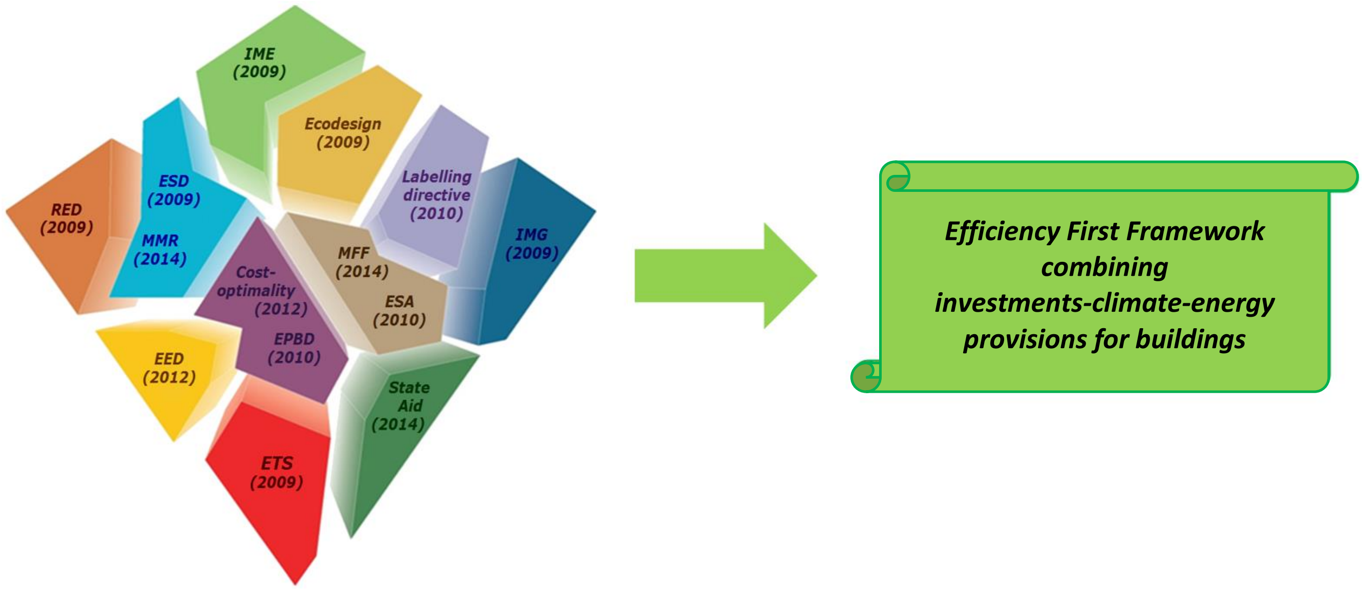
Energy Transition of the EU Building Stock

Unleashing the 4th Industrial Revolution in Europe



"If I'd asked my customers what they wanted, they'd have asked for a faster horse."

Henry Ford

Foreword

The Paris Climate Agreement is a unique opportunity for jobs and growth in Europe. It calls for a paradigm shift that can be best achieved through an ambitious, long-term, incentive based, strategy to decarbonise the EU energy system. We know that we have to do everything possible to achieve our ambitious goals and enable future generations to enjoy a predominantly carbon free, competitive economy. When looking to find our efficiency potential, our attention naturally turns to our building stock, which is responsible for about 40% of our total GHG emissions. The good news is that implementing energy efficiency measures is the most cost-effective way to achieve the reduction of CO_2 emissions in the EU, creating jobs and starting an industrial renaissance that also provides health and comfort to the population. Untapped efficiency potential in the context of "smart living" or "smart cities" are diverse and can be combined, ranging from innovation in the buildings sector to continuous driving concepts, particularly in urban environments. We simply must take advantage of these opportunities and realise such readily available sources of energy savings like in the building sector!

When it comes to buildings in the EU, we know that most of the potential savings come from addressing energy waste in existing buildings. This is a big challenge because in the past we were satisfied with rather modest efficiency improvements that allowed consumers to make measurable cost savings. However, that cannot be the way forward. The energy wasted by our buildings noticeably increases our gas dependency and the vulnerability of some of our citizens. In the European Parliament, we are convinced that the adoption of an ambitious, long term renovation framework based on setting positive incentives for the building stock in the EU and to provide the private sector the necessary regulatory certainty to drive large scale investments, thereby giving the EU a long lasting competitive advantage. I know in my own country of Austria, we take developing building standards very seriously and we have been a promoter of highly energy efficient new building designs. We now need to take some of our tried and tested concepts and apply them to existing buildings. Let me be clear, the energy transition of the building stock in the EU should not be perceived as a burden. In fact, the transformation of the building stock in the EU is an opportunity for jobs and growth, especially for SMEs, which represent the major share of enterprises active in the sector.

I welcome the objective of OPENEXP report to create awareness of the potential tied up in our buildings and for providing us with impulses for a more informed discussion. I am pleased to see that this study was undertaken in order to analyse all existing and relevant EU legislation that affects the energy performance of buildings to identify what is missing and to give ideas on how we could move forward. It is important that strong analytical work is undertaken and new ideas are discussed. This is to allow the full range of stakeholders – including my colleagues in the European Parliament – to examine the resulting effects of the acquis in this policy field and to be better prepared for the upcoming review and revision of EU climate and energy policy instruments. We cannot leave any stone unturned. We welcome the fresh, thought provoking ideas that this report gives us in order to take the next steps and improve EU legislation based on facts and figures.

Paul Rübig

Member of the European Parliament

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Executive summary

An energy renovation market is emerging in Europe

Energy renovation is playing a strong role as a stabiliser of the building sector and consequently of the European economy in the period since the financial crisis. Estimates of the energy renovation market was of the order of EUR 109 billion in 2015 in the EU 28 and created 882,900 jobs. The French, German and Italian energy renovation markets alone accounted for almost half of the EU energy renovation market. The energy renovation market of residential buildings had the highest share, 65%, out of the total energy renovation market.

Governmental policies, either those related to economic recovery or those related to the implementation of the EU 2020 climate and energy targets, played a major role in the emergence of the energy renovation market. EU funding, when well combined with national funds, allowed considerable support for the implementation of energy efficiency measures in existing buildings. This in turn, has limited the effect of the financial crisis on the residential sector by either sustaining existing jobs or creating new ones. However, austerity measures have hindered the emerging energy renovation market is some Member States.

The building sector, which is currently led by the renovation of existing buildings, is one of the pillars of the European Union's economy. The overall sector had a turnover of EUR 1.241 billion in the EU 28 in 2013, which was equivalent to more than 9% of the EU GDP that year. The sector employed almost 11 million persons in 2013. More than 3 million enterprises, out of which 94% were enterprises with less than 9 persons employed, were active in the building sector the same year. The share of the turnover due to the renovation of existing buildings increased from 47% in 2005 to 57% in 2015. The dominance of the renovation market in the total building market started in 2009, especially in Member States where economic recovery measures have specifically targeted the energy renovation of existing buildings.

The energy renovation market could grow if the EU has the ambition to increase its size

The size of the EU energy renovation market could increase by almost half the current energy renovation market if a 40% energy savings target is adopted for 2030. This would create more than one million additional jobs. A 40% energy savings target could allow for an increase of the renovation rates to almost 3%, while it is around 1% with the current 27% energy savings target. The increase of renovation rates would increase the volume of the renovation activity. This would give more confidence to investors and remove uncertainties about the future of the EU building market.

The building sector is known for its conservatism and lack of attraction of Millennials. Increasing the size of the energy renovation market would move investments towards research, innovation and modernisation of the sector through industrialisation. This would lead to the emergence of an EU energy renovation industry. Which will ensure that existing EU industries (insulation, windows, heating and cooling, automation, lighting, solar thermal, photovoltaics…) involved in energy renovation of the EU building stock will keep their competitive advantage in the global markets.

Energy renovation is a unique opportunity for the industrial renaissance of Europe

Increasing the size of the energy renovation market would unleash the 4th industrial revolution in Europe. It would require industry to move from the current step-by-step component-based energy renovation to an overall and one step energy renovation of each single building. Innovation will occur along the overall value-chain of the building sector. From the development of holistic prefabricated zero energy renovation kits to the transformation of the EU citizens from being passive consumers into being active prosumers. New actors, such as aggregators of small projects, will enter the market. Public funding should be dedicated to this transformation of the overall value-chain.

The industrial renaissance of Europe would require modern methods and methodologies to gather data and analyse them. The roll-out of smart-meters, as now required by the directives on the internal market in electricity and gas and the energy efficiency directive, if well-implemented will play an important role in the renovation of Europe. The roll-out of smart meters needs to be combined with energy models based on Geographical Information Systems (GIS), the use of drones for the inspections of buildings, and well-designed mandatory reporting templates for different provisions to close the data gap. The aim is to gather/generate over time the data needed for a better assessment of the progress towards the EU climate-energy targets and how achieving these targets make Europe meeting its priorities in term of jobs and growth. Overall, the objective is to have real-time data to better target needs and to adjust policies at the right moment.

The energy renovation market is an opportunity for small and medium enterprises as they are major players in the building sector. Public support is needed to reshape skills and upgrade facilities. The aim is to ensure that small and medium enterprises will benefit from the industrialisation of energy renovation. Solutions based on recyclability and low environmental impacts should be prioritised. These solutions could be co-financed by public funding under the circular economy package.

Moving towards an "Efficiency First" investment-climate-energy framework for buildings

An EU renovation strategy would be best developed through an integrated investment-climate-energy policy framework for buildings based on the "Efficiency First" principle and in light of the Paris Climate Agreement. Such an overarching framework would, as required by the better regulation package, streamline reporting and ensure coherence between the provisions currently included in at least 14 different instruments, Figure ES.1. It would also simplify implementation for Member States, avoid double-counting and facilitate compliance checking.

Provisions to reduce energy consumption and greenhouse gas emissions of the building stock are spread among at least 14 EU-wide policy instruments. Existing provisions include those related to the overall building stock, each building individually and building components and elements. Systems (heating, cooling and lighting) are not well addressed by the current provisions. Important progress on reporting on energy consumption and GHG emissions has been made in recent years as a result of these EU policy instruments. However, Member States are required to report separately to the Commission on the measures considered for each provision/instrument, although, very often, the same measures address different provisions in different instruments at the same time.

Under the Effort Sharing Decision, ESD, there is an implicit binding target to reduce greenhouse gas emissions of the building sector. This target is not supported by an EU requirement to set an energy savings target for buildings. Yet, two-thirds of the Member States have set, on a voluntary basis, an energy savings target for buildings. Member States report on various measures to achieve their ESD binding target and their indicative energy savings target. However, the fragmentation of the energy and climate provisions among different instruments does not allow to effectively assess the contribution of the building sector towards the 2020 climate and energy targets.

The fragmentation of the EU climate and energy policy instruments undermines the design and the implementation of an ambitious and long-term building renovation strategy and hinders the emergence of an EU energy renovation industry. This fragmentation, Figure ES.1, increases the reporting burden on Member States. It also makes the assessment of the effectiveness and the coherence of the overall EU investment, climate and energy policy package for buildings difficult if not impossible. The fragmentation of EU instruments does not encourage synergies between different policy departments at the EU and national levels nor between industries involved in energy renovation. On the contrary, it keeps each group in its own silo.

Figure ES.1 The EU 14 policy instruments aiming to increase investments in the energy transition of the EU building stock

Key point: The fragmentation of EU policy instruments leads to challenges and difficulties in implementing EU legislation and hence to missed economic opportunities.

The overarching "Efficiency First" framework for buildings should include a binding long-term carbon and energy savings targets, with milestones. This would give industry confidence to invest in the industrialisation of energy renovation. Which in turn, would lead to the establishment of an energy renovation industry. Existing industries (insulation, windows, heating and cooling, automation, lighting, solar thermal, photovoltaics…) and their value-chains would develop and provide the components needed for the energy renovation kits as they do today for the construction of new buildings. These energy renovation kits would need to be developed for buildings from each construction period, climate zone and building type.

A new governance structure would be needed to support the "Efficiency First" framework

The "Efficiency First" investment-climate-energy framework for buildings would require new governance structure including setting an EU Energy Renovation Facilitator and an EU Risk Sharing Facility. The upcoming legislative proposal on the governance of the Energy Union is a unique opportunity to discuss and set the ground for the institutional arrangements described below:

- **An EU Energy Renovation Facilitator would be needed to organise the demand and the supply.** Such an entity must be independent from existing EU institutions. It requires a multi-level governance structure to align various policy goals and engage stakeholders in the transformation of the EU building stock from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption. An important part of the policy alignment is to ensure that policies are aligned across different levels of government. An early and transparent engagement of key stakeholders in setting the target and planning processes, at each level of government, would increase the acceptance of the outcomes as well as stakeholders' commitments to assist with implementation and increased effectiveness.
- **An EU Risk Sharing Facility would be needed to ensure a more coherent use of public funding and continuous support to investments in energy renovation.** The aim of the Risk Sharing Facility is to mitigate the financial risk of energy renovation investments by providing loan guarantees to aggregators of companies investing in energy renovation projects. The objective is to reduce the perceived risk by investors by allowing for low-interest rates at the local level. Overall, the target is to move to a self-financed energy renovation market. The risk sharing facility should also provide finance for capacity building and knowledge sharing. Existing EU funding could be bundled to establish such a facility.

Local/regional authorities will be one of the major players in the market transformation of the EU building stock. Support to local/regional authorities, especially in Member States with GDP per capita lower than the EU average, would be needed to establish energy renovation facilitators at local/regional levels. Existing one-stop-shops at local/regional levels, which currently provide information, could evolve and play the role of the local/regional energy renovation facilitators. Energy renovation facilitators have to be independent third parties to ensure they will gain the confidence of all actors. Their role at local/regional levels would be to bring together all parties needed in the renovation cycle to ensure a high quality and timely energy renovation is delivered.

Energy renovation is an opportunity to empower EU citizens and address their concerns

The energy transition of the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, will address the growing concerns raised by fuel poverty. The EU is facing an unprecedented increase of the share of the population unable to keep their homes warm in winter. The energy transition of the EU building stock will ensure all EU citizens have access to energy services without distinction of income. Energy efficient buildings will also make buildings thermally comfortable in summer.

Efficiency improvements of buildings will reduce air pollution resulting from combustion of fossil fuels. Consequently, the health of EU citizens will be improved. Final energy consumption of the EU building stock represented 41% of total final energy consumption of the EU in 2013, with two-thirds of the energy consumed occurring in residential buildings. Almost one-third of the energy consumed in residential buildings was gas, out of which 79% was used for space heating. This results in an increase pollution of air. Reducing heating needs will also have a direct impact on reducing the EU gas dependency as 55% of the gas consumed in the EU is imported.

The identified energy renovation market is partly financed by households' energy taxes. However, energy taxes paid by households are not fully used for energy renovation. Mechanisms to better direct citizens' taxes towards the renovation of their homes would be needed to ensure a fair use of households' taxes. The aim is to shift households' energy expenditures from energy consumption to investments in energy renovation. Energy taxes set by Member States are proportionally higher when the volume of energy consumed is lower. This hinders energy savings and make more vulnerable consumers in risk of ending-up in fuel poverty.

EU citizens will be empowered by making buildings producers of energy savings and renewables. The increased share of energy savings and renewables in buildings will make them play an active role in the EU energy system. Integrating buildings in the EU energy system and allowing for fair competition between capacity generation and energy savings are needed. In the near future, buildings will play a major role in power-supply-system stability. They will provide electricity produced locally, serve as storage capacity and reduce peak demand. The transformation of the EU power system from a centralised to a decentralised one will empower EU citizens and make them "prosumers". Smart appliances will interact with smart grids and allow for more savings. Timers and controls will determine the best time slot to consume and/or to sell energy. Appliances will be automatically turned off at peak load when energy prices are high to allow consumers to sell their energy production at high prices and to increase the share of self-consumption.

Addressing the loopholes in the EU existing 14 instruments should be a priority for 2016

The opportunity to initiate the move towards the "Efficiency First" investment-climate-energy policy framework for buildings must start with the upcoming review/revision of the existing legislation. In late 2016, the EU will adopt proposals that will shape investment-climate-energy policies for buildings for years to come. This process must not *lock-out* the possibility to quickly evolve to a single, fully coherent, streamlined overarching policy framework for buildings aimed at achieving the necessary goal of energy transition of the EU building stock.

The on-going 2016 review/revision of EU investment-climate-energy instruments is a unique opportunity to strengthen existing provisions and promote ambitious renovation strategies. The existing EU instruments have contributed to raising awareness among market actors about the importance of the transformation of the building stock from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption. However, to ensure the energy transition of the EU building stock, existing instruments need to be amended and/or strengthened. Major loopholes identified under each instrument/provision are summarised in table ES.1. For each identified loophole, a recommendation for improvement is suggested. The aim is to set the ground for a pathway to capture the untapped savings potential in light of the EU priorities in terms of jobs, growth, the Energy Union Strategy Framework and the Paris Climate Agreement. Policy discussion on the recommendations in Table ES.1 below is the right first step to take.

Table 1 Identified loopholes in EU policy instruments and recommendations to overcome them for further discussion

EU instrument	Identified loopholes	Proposed modifications to consider under the on-going review/revision of EU instruments
EU 2030 climate and energy framework (27% energy saving target)	Renovation rates considered in the PRIMES model (1.48% until 2020 and of 1.84% after 2020 in the case of 27% energy savings target) are too low to boost investor confidence and to give a clear signal to market actors to invest in innovative technological and financing solutions.	-Increase energy renovation rates considered by PRIMES in the on-going review of the decarbonisation scenarios. -Adopt at least 40% energy savings target for 2030 to allow for an increase of energy renovation rates and to give market actors a long term perspective.
Effort Sharing Decision (ESD), Emission Trading Scheme (ETS) and Mechanism for Monitoring and Reporting (MMR)	The sum of Member States projections of their 2030 GHG emissions from buildings are 23% higher than those under the 27% energy savings target.	Require Member States to revise their GHG projections for buildings and ensure coherence between Member States projections of GHG and the EU 2030 climate and energy framework.
	Some Member States will overachieve their emissions reduction under ESD for the period 2013-2020.	Ensure Member States' 2030 projections of GHG emissions are based on accurate baselines.
	ESD allows Member States to over-allocate emission permits from the current period to the next period (2020-2030).	Remove the possibility to over-allocate emission permits for the next period.
	Member States report on the savings from all measures together without distinction between demand-side and supply side measures.	Require breakdown of the reporting on savings from demand-side and those due to renewables to assess coherence with the energy savings target and renewables target.
Internal market directives for gas and electricity (IME) and (IMG)	Internal market regulations allow for competition between supply side options only.	Include provisions to allow for fair competition between supply side options and energy savings (energy efficiency and demand response).
	Internal market regulations require Member States to develop "innovative pricing formulas". Pricing formulas developed by Member States do not motivate consumers to reduce their energy consumption.	Require Member States to consider higher energy taxes for high energy consumption bands and low energy taxes for low energy consumption bands.
Energy Efficiency Directive (EED)	-There is no specific requirement to report on the projected energy savings from the building stock. But some Member States report, on a voluntary basis, their projections of final energy consumption of their building stock under Articles 3, 4, 5 and 7. -There is no requirement to set an energy and/or carbon reduction target for the overall buildings stock. But, 16 Member States, the Flanders region and Gibraltar have reported, on a voluntary basis, an energy and/or carbon reduction target in their energy renovation strategies.	-Require Member States to report on their projected final energy consumption of their building stock for a defined year (2020, 2030) and group this reporting under current Article 3. -Require all Member States to set a long-term energy and/or carbon reduction target for the total building stock by 2050 with 2020 and 2030 milestones.
	Member States are required to report on the measures considered for energy renovation under Articles 4, 5 and 7.	Require Member States to be explicit about the expected savings for each measure or package of measures to assess coherence with the projections of the final energy consumption and group this reporting under one single

		Article on reporting.
	Renovation concept is defined in 4 different manners.	Replace all existing "renovation concepts" by one concept aiming at transform buildings from being energy waster to being highly energy efficient and energy producer leading to net zero energy consumption.
	Member States are allowed to opt for alternative measures, including behaviour change, for the renovation of public buildings in Article 5.	-Remove the possibility to opt for alternative measures which lower the ambition and lock the savings potential when public buildings are renovated to ensure public authorities lead by example. -Extend the provisions of Article 5 to cover all buildings owned and/or occupied by public authorities at different levels of governance within the Member States.
	The directive dedicates an entire article for split-incentives barrier while 70% of the EU population lives in owned-occupied dwellings and almost 60% of the EU population lives in single family homes.	Include provisions to allow for bundling small projects (single family houses) and address the affordability of energy renovation (high share of owners), especially in Member States with GDP per capita lower than the EU average.
Energy Performance of Buildings Directive (EPBD) and the cost-optimum methodology	Residential buildings often do not comply with the requirements when buildings undergo major renovation, especially when it comes to building elements.	-Remove the concept of major renovation. Each time a building is renovated, it has to be renovated to net zero energy consumption level. Minimum energy performance requirements for building elements and systems have to be met each time a building is renovated, especially if it involves the use of public funding. The net zero energy consumption requirement, combined with smart meters, will make compliance checking and enforcement easier to implement.
	Lighting systems are not considered as one of the systems for which minimum energy performance requirements have to be set.	Include lighting when setting requirements for technical building systems (Article 8 of the EPBD).
	End-uses included in Annex I are unclear as to whether lighting has to be included or not. But, Member States report to Eurostat on final energy consumption of all end-uses	Clarify Annex I and include all end-uses to allow for assessment of progress as the final energy consumption reported under Eurostat includes all end-uses and smart meters will measure the overall consumption.
	Energy Performance Certificates are not required to be based on operational or metered energy consumption.	Require the inclusion of design (asset rating) as well as operational rated energy consumption, the latter based on utility bills, when preparing Energy Performance Certificates.
Renewable Energy Directive (RED)	There is no reporting requirement on the increased share of renewables in buildings.	Require reporting on the increased share of renewables in buildings.
Implementing measures resulting from the combined Ecodesign and Labelling directives	Minimum energy performance requirements are set at the least-life cycle cost at the time the preparatory study is undertaken. As a result, by the time of the implementation, the market has already moved.	Set minimum energy performance requirements at the efficiency level of the best available technologies to ensure Ecodesign drives innovation.
	Energy performance requirements are component-based and do not reflect real usage conditions, especially when these components are part of energy	Require standardisation to take into account the system approach and real usage conditions when defining test conditions and estimating and/or

	systems (lighting, cooling, heating and ventilation)	measuring energy consumption.
	Lack of consolidated market data, misuse of allowed verification tolerances for market surveillance and general lack of market surveillance.	-Assess the possibility to integrate efficiency data in PRODCOM database. -Organise round robin testing for accredited laboratories to assess the relevance of the allowed verification tolerances. -Assess the possibility to consider market surveillance of energy consumption as part of the spot tests conducted under the CE marking procedure. -Shaming and publicly blaming manufacturers reporting wrong information. -Organise annual EU wide random testing campaigns.
Multi-Annual Financial Framework and Structural funds	Ex-ante conditionality is not always a pre-requisite for the use of the EU funds.	Include an ex-ante conditionality aiming to net zero energy consumption level for any use of EU funds.
	Grants do not allow for ambitious energy renovation of buildings but these are the preferred instruments used by Member States.	Provide support to Member States to move from grants and subsidies to the use of tailored financial instruments.
State Aid Rules	State Aid rules limit the use of EU funds for energy renovation.	Revise State Aid rules to ensure EU funds can be used for energy renovation.
Accounting rules	Guidance document for governmental accounting rules make it difficult to finance renovation of public buildings.	-Revise current accounting rules to consider energy renovation investments as an asset investment recognising the cash savings resulting from energy renovation investments. -Energy renovation investments should be considered as a productive debt and classified off balance sheet.
EU/EIB funds	High interest rates are considered for energy renovation investments as a result of the perceived risk by investors.	Consider an EU and/or EU/EIB guarantee to lower interest rates at local level, limit the perceived risk by investors and gain their confidence.

Key point: The review/revision of most of the EU instruments targeting energy renovation in 2016 is a unique opportunity to prepare the ground for the market transformation of the EU building stock from being an energy waster to being highly efficient and energy producer leading to net zero energy consumption.

Introduction

From an economic perspective, the building sector is the single largest sector contributing to the EU GDP and employment. The sector had a turnover of EUR 1.241 billion in the EU 28 in 2013 and employed almost 11 million persons that year. However, from the energy and climate perspective, the EU building stock is the single largest energy consumer and greenhouse gas (GHG) emitter. Its share of the EU final energy consumption was about 41% in 2013, while its contribution to the EU GHG emissions of end-use sectors was slightly above 40% in 2012.

This publication is an analytical report aiming to support the on-going review/revision of EU climate and energy policy instruments. The first objective of the report is to contribute to making 2016 the year of delivery for EU instruments aiming to reduce building's energy consumption and their related GHG emissions. The second objective of the report is to kick-start work on the paradigm shift introduced by the Energy Union Strategy Framework (EC, 2015-a) and confirmed by the Paris Climate Agreement (UNFCCC, 2015). The aim is to ensure that the energy transition of buildings in the EU will unleash the 4th industrial revolution. In the long run, this will give EU industry a competitive advantage in global markets.

The structure of the report is as follows:

- Chapter I presents, for the first time, an estimate of the EU energy renovation market. Estimates of the current EU energy renovation market are based on the market of the 17 Member States covered by EUROCONSTRUCT[1] (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Portugal, Slovakia, Spain, Sweden, The Netherlands and the United Kingdom). The Chapter concludes with an estimate of the energy renovation market for the EU28 if a 40% energy savings target is adopted. It also includes an estimate for job creation. Finally, the Chapter includes analysis of the non-market value of energy renovation such as energy geopolitics and equal access of EU citizens to energy services.
- Chapter II analyses the provisions included in the 14 EU policy instruments that target reducing energy consumption in buildings and the related GHG emissions. The analysis in the Chapter highlights that the fragmentation of the provisions among various instruments does not lead to the coherent and ambitious renovation strategy that is needed to enhance the EU economy and foster innovation. The Chapter includes specific recommendations to address each gap or loophole identified in the existing provisions.
- Chapter III contains a forward-looking vision for the buildings sector. It proposes the design of a long-term integrated EU investment-climate-energy policy framework for buildings. This framework would combine EU investment policies with the climate and energy policies that target the building sector. The Chapter proposes setting new administrative arrangements by establishing an EU energy renovation facilitator and an EU risk-sharing facility to ensure a smooth and effective implementation of the long-term integrated investment-climate-energy policy framework for buildings.

The report concludes by suggesting the steps to undertake for the design and the implementation of the proposed overarching integrated EU investment-climate-energy policy framework for buildings.

[1] The turnover of the building sector in these countries represented 75% of the EU 28 turnover of the sector in 2013

Chapter I: Energy renovation: a stabiliser of the EU economy

Highlights

- The EU energy renovation market is estimated at EUR 109 billion in 2015. This is equivalent to the combined GDP of Bulgaria, Estonia and Croatia that year. The residential energy renovation market represented 65% out of the total energy renovation market. The total number of jobs generated by energy renovation work is estimated at 882,900 jobs in 2015. The size of the EU energy renovation market would increase by almost half in 2030 and create more than one million jobs, if a 40% energy savings target is adopted at EU level.
- The German, Italian and French energy renovation markets accounted for almost half of the total EU energy renovation market. The German market is by far the leading energy renovation market, accounting for 22% of the total energy renovation market with its EUR 24 billion in 2015. The Italian market is the second energy renovation market with EUR 15 billion and the French market is third with its EUR 13 billion that year.
- Importantly, the share of renovation works in the construction market has overtaken the share of new building works. The tipping point was in 2009 when the share of both markets was equal. Since then, the share of the renovation market in the total building market has continued to increase. It reached, in 2015, 57% out of the total building market. Industry forecasts similar shares for the upcoming years, assuming that policies remain unchanged.
- Governmental policies played a major role in making the renovation market the dominant market of the building sector. The recovery measures implemented by Member States as a response to the financial and economic crisis and the sustainable construction measures developed in some Member States, when well combined with the EU climate and energy financial instruments (ERDF, CF, ETS…) have been the main drivers of the energy renovation market and consequently of the renovation market. However, austerity measures in several countries had the opposite effect on the emerging energy renovation market.
- Households contribute to the renovation of their buildings through energy taxes they pay as part of their energy costs. Energy taxes paid by households are not fully used for energy renovation. Financial mechanisms aiming to better channel households' energy taxes towards energy renovation of their buildings are needed. Furthermore, energy taxes should be lower in low energy consumption bands and higher in high energy consumption bands to stimulate energy savings. This would encourage households to make the shift from spending on energy consumption to investments in energy savings via renovation works.
- A more ambitious approach to energy renovation of the EU building stock, if well designed and effectively implemented, would contribute to drastically reduce gas imports and the EU energy dependency as a whole. Thus, this would reduce the geopolitical pressure on the EU, especially for Member States heavily dependent of one single supplier.
- The transformation of the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, would make EU citizens active "prosumers" and increase equality between EU citizens. This would ensure a robust infrastructure for future generations and lay the ground for a sustainable economic recovery. It would make access to modern energy services and to comfortable and healthy homes less dependent on income.

This Chapter provides analysis of the market value of energy renovation in Europe. Estimates of the EU energy renovation market are based on the detailed estimates made for the 17 Member States included in the EUROCONSTRUCT[2] *database (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Portugal, Slovakia, Spain, Sweden, The Netherlands and the United Kingdom). The chapter shows how the transformation of the EU building stock, from being an "unnecessary" energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, would enhance the EU economy while boosting the prominent role of the construction industry. The energy transition of the EU building stock would also boost the overall competitiveness of Europe, drive growth, create jobs and foster innovation in the EU.*

The analyses include the non-market value of energy renovation such as geopolitics by reducing the risks related to energy supply disruption and equality in the access to energy services by ensuring all EU citizens live in comfortable and healthy homes without distinction of income. The Chapter demonstrates how investments in the decarbonisation of the EU building stock would support the current priorities of the European Commission (EC) in terms of jobs, growth, fairness and democratic change (EC, 2014-a). The aim is to feed into the holistic and inclusive approach the European Commission (EC) is undertaking as part of the implementation of the Energy Union strategy (EC, 2015).

The estimates of the building market for all Member States are based on data provided by EUROSTAT in the Structural Business Statistics (SBS) database. The size of the energy renovation market is estimated by applying a weighting coefficient (ACEEE, 2008) to the renovation market for the 17 Member States included in EUROCONSTRUCT database. The future economic role of energy renovation is assessed for three out of the six decarbonisation scenarios considered for the 2030 climate and energy policy framework (EC, 2014-b). The three scenarios are:

i. *EE27 - as adopted by the European Council in 2014 (27% energy saving target)*
ii. *EE30 -to be borne in mind for the 2020 revision (30% energy saving target); and*
iii. *EE40 -as called for by the European Parliament (40% energy saving target)*

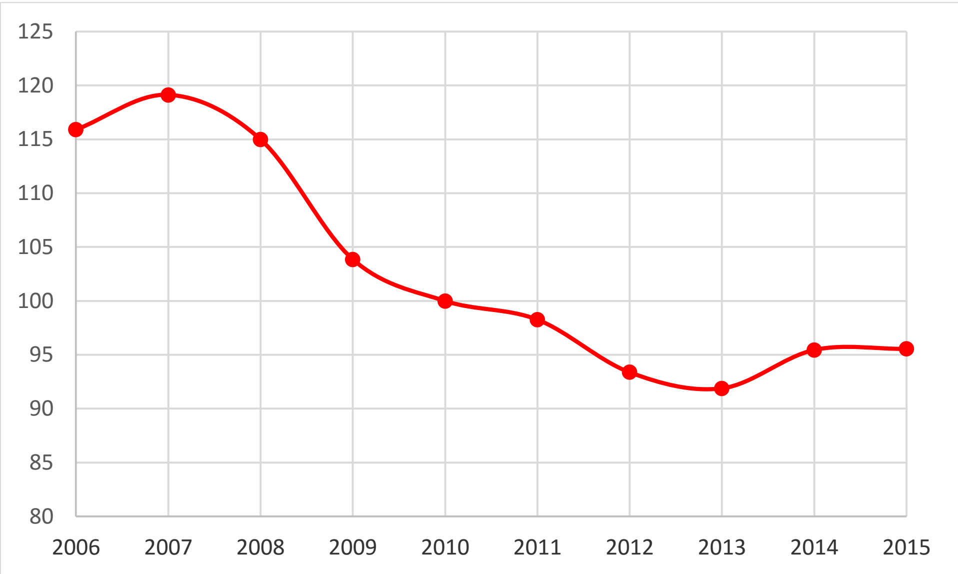
Analysis of the non-market value of energy renovation is based on EUROSTAT data related to energy balances, Social Inclusion and Living Conditions statistics (SILC) and those included in the database of Harmonised Indices for Consumer Prices (HICP) as well as the data provided by ODYSSEE database for the breakdown of energy consumption when needed.

The building sector had a turnover of EUR 1.241 billion in the EU 28 in 2013, which was equivalent to more than 9% of the EU GDP that year. Furthermore, almost 11 million persons were employed in the construction and/or the renovation of buildings in 2013. This was equivalent to 8% of total employment in non-financial business economy. More than 3 million enterprises, out of which 94% were Small and Medium Enterprises (SMEs) with less than 9 persons employed, were active in the building sector that year.

[2] EUROCONSTRUCT is the main network for construction, finance and business forecasting in Europe. More information is available at: http://www.euroconstruct.org

The building sector is recovering slowly from the economic and financial crisis. After several years of decrease in the volume of production, the volume index of production increased by 3.9% compared to the previous year in 2014 at the EU level (Figure 1.1). Latvia, Lithuania, Romania, Spain, Sweden and Ireland were the countries that experienced the highest increase of the volume index of production in 2014 compared to the previous year with an increase of 33.6%, 24.2%, 21.5%, 19.8%, 12.3% and 11% respectively (EUROSTAT, SBS). However, ten Member States (Austria, Belgium, Bulgaria, Croatia, Cyprus, France, Greece, Poland, Portugal and Slovakia) continue to experience a decrease of the volume index of production. The highest decrease was observed in Cyprus (-22%) followed by Portugal with (-8%) and the lowest one in Belgium (-0.1%) followed by Bulgaria (-0.2%) (EUROSTAT, SBS). The growth of volume index of production continued in 2015 compared to 2014 but at a moderate pace (+0.1%) (EUROSTAT, SBS) which is in line with the forecast made in 2014 by EUROCONSTRUCT group (EUROCONSTRUCT, 2014). Thus, we can see that the sector is recovering, but not everywhere, and the increase is still fragile.

Figure 1.1 Changes in the volume index of production of buildings in the EU 28 (Index: 2010=100)



Key point: 2014 was the first year of increase of the volume index of production of buildings since the financial and economic crisis

Source: EUROSTAT: Structural Business Statistics (SBS) database available at:
http://appsso.eurostat.ec.europa.eu/nui/show.do

Market value of energy renovation

The market value of energy renovation is defined as the contribution of energy renovation to growth and jobs as described in the following sections:

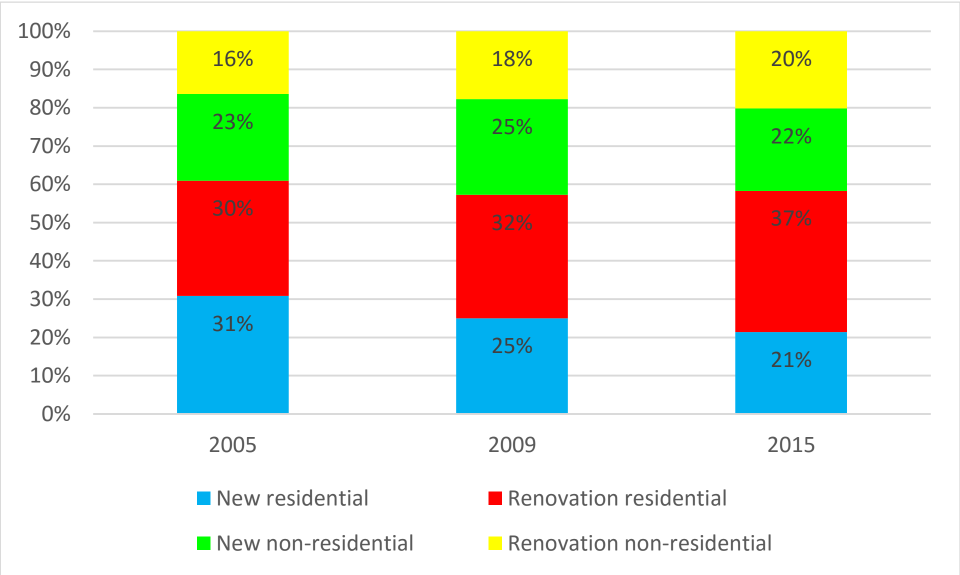
Evolution of market segments

Analysis of different market shares (renovation versus new buildings) per building segments (residential, non-residential) cannot be conducted at EU level as EUROSTAT does not provide the breakdown of data per segment. The only countries for which such information exists are those included in the EUROCONSTRUCT database which covers 17 Member States *(*Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Poland, Portugal, Slovakia, Spain, Sweden, The Netherlands and the United Kingdom). The building market in EUROCONSTRUCT countries represented 75% of the EU building sector in 2013. Thus, analysis of the building market in EUROCONSTRUCT area gives a representative overview of the EU building market.

At EU level

The building market in EUROCONSTRUCT countries was estimated at EUR 959 billion in 2015,[3] which is 11% lower than what it was in 2005. The residential market represented 58% of the total, which is three percentage points less than in 2005 (Figure 1.2). The residential market is estimated at EUR 559 billion in 2015 while it was EUR 658 billion in 2005. The renovation market is the dominant segment, accounting for 57% out of the total, which is ten percentage points increase compared to 2005 (Figure 1.2). The tipping point took place in 2009 when for the first time the market for new buildings and the one for renovation had an equal share out of the total. In the following years, the renovation market overtook the market of new buildings to reach 57% out of the total in 2015 (Figure 1.2). EUROCONSTRUCT forecasts similar shares for the upcoming years (EUROCONSTRUCT, 2014). The renovation market, especially the residential one, has largely benefitted from the recovery measures implemented after the financial and economic crisis (ECORYS, 2012). These measures made the renovation market a more reliable and steady form of construction activity (EUROCONSTRUCT, 2014).

Figure 1.2 Market share per building segment in EUROCONSTRUCT countries



Key point: The renovation market overtook the market for new buildings since 2010

Source: own calculations based on EUROCONSTRUCT data (EUROCONSTRUCT, 2014)

At Member State level

Factors influencing the demand for residential buildings include demographic and employment trends, household income, real estate prices and governmental support to the acquisition, construction or renovation of buildings such as tax incentives as well as low-interest rates. Regarding

[3] Data for 2015 are Forecast by EUROCONSTRUCT (EUROCONSTRUCT, 2014)

non-residential buildings, the main factors influencing the demand include the political, economic and financial stability of the country as well as its overall attractiveness to investors (e.g. skills, financing conditions in general, the labour market, etc.).

The construction of new residential buildings experienced a pre-financial crisis boom in some Member States (e.g. Spain and Ireland), which made this market segment over-perform. As a result, the residential market was not prioritised by some governments when the first set of recovery measures were designed. On the contrary, the residential market in countries such as Finland, Germany and Sweden experienced a downturn prior to the financial crisis. Consequently, these countries had a better knowledge of the effective measures to implement to rescue the building sector. The residential market also benefitted from the sustainable construction strategies developed by some governments (e.g. France, the Netherlands and the United Kingdom) prior to the financial and economic crisis.

Overall, in many countries, the renovation of existing buildings has been targeted by governmental policies. Furthermore, the financial and economic crisis was seen by some policy-makers as an opportunity to increase the renovation of existing buildings, especially residential ones, through the increased use of the European Cohesion Fund (CF) and the European Regional Development Fund (ERDF) as well as EU financial instruments such as the Joint European Support for Sustainable Investments in City Areas (JESSICA). However, in some countries, the financial and economic crisis led to discontinuity of renovation projects and the structural funds became the only financing opportunity. This made the take-up of EU funds challenging as they usually require co-financing (ECORYS, 2012).

The over-construction of residential buildings in some countries prior to the financial crisis and the implementation of recovery measures targeting the renovation of existing buildings increased the market share of the renovation market in 2015 compared to 2005 in the EUROCONSTRUCT area by 14% in the residential market and by 6% in the non-residential market (Table 1.1). Austria, Poland and the United Kingdom are the only countries where the share of the renovation market (both residential and non-residential) decreased in 2015 compared to 2005 while Ireland experienced a decrease in the non-residential renovation market. The decrease of the renovation market in these countries could be due to the negative impact of austerity measures implemented by each country individually (ECORYS, 2012).

The highest share of the residential renovation market out of the total building market was observed in 2015 in Italy and Denmark (82% each) followed by Germany (70%), Hungary and Portugal (with 66% each). The lowest share of residential renovation market was observed in Poland (30%), followed by Austria (32%), Czech Republic (37%) and Slovak Republic (38%). Hungary is the only Eastern Member State where the residential renovation market dominated the overall residential market. The share of the residential renovation market in 2015 was above 50%, which is equivalent to a 36% increase compared to 2005. The United Kingdom is the only Western Member State where the share of the residential renovation market was below 50% in 2015, which is eight percentage points decrease compared to 2005. Similarly, the highest share of the non-residential renovation market was observed in 2015 in Italy (69%), followed by Sweden and Germany with 61% each. The lowest share of non-residential renovation market was observed in Ireland (12%), followed by Poland (27%), Portugal and the United Kingdom, with 29% each (Table 1.1).

Table 1.1 Evolution of the share of the renovation market per building segment and country

Country	Residential market			Non-residential market		
	2005	2009	2015	2005	2009	2015
Austria	38%	38%	32%	34%	34%	28%
Belgium	53%	55%	61%	39%	37%	39%
Czech Republic	25%	24%	37%	36%	32%	40%
Denmark	66%	71%	82%	40%	39%	45%
Finland	40%	50%	60%	40%	39%	44%
France	51%	54%	59%	52%	51%	54%
Germany	63%	66%	70%	46%	46%	61%
Hungary	30%	38%	66%	25%	27%	46%
Ireland	17%	49%	57%	19%	17%	12%
Italy	58%	63%	82%	53%	56%	69%
Poland	37%	31%	30%	31%	26%	27%
Portugal	29%	33%	66%	16%	16%	29%
Slovak Republic	24%	20%	38%	20%	21%	31%
Spain	29%	39%	59%	34%	35%	53%
Sweden	57%	62%	60%	73%	74%	61%
The Netherlands	47%	49%	58%	46%	45%	50%
United Kingdom	57%	64%	49%	36%	33%	29%
EUROCONSTRUCT area	**49%**	**56%**	**63%**	**42%**	**41%**	**48%**

Key point: The share of the renovation market in both residential and non-residential segments has increased overall, but not everywhere.

Source: own calculations based on EUROCONSTRUCT data (EUROCONSTRUCT, 2014)

Estimates of the energy renovation market

The energy renovation market is one of the sectors that benefited from governmental responses to the financial and economic crisis. In fact, recovery measures implemented by Member States in the construction sector are mainly those related to efficiency improvements of existing residential buildings (ECORYS, 2012). Governments have either extended existing measures or introduced new ones. However, as mentioned in the previous section, austerity measures had a negative impact on the implementation of the planned recovery measures related to the building sector in some countries (e.g. Austria, Greece, Hungary, Ireland, Italy, Portugal and Spain). The most frequently used measures were grants financed partly by EU funding or through the sale of CO_2 emission credits as specified in the EU Emission Trading Scheme (ETS). The latter has been used by countries such as the Czech Republic, France and Hungary (ECORYS, 2012).

Energy performance improvements of buildings consist mainly of efficiency improvements of the envelope (increased insulation and replacement of windows) and energy systems (mainly heating systems in the case of residential buildings). The improvement of the envelope is usually embedded in broader renovation projects such as urban renewal, while the improvement of energy systems is more likely to take place when the system is broken and needs to be replaced. The improvement of buildings' energy efficiency each time a renovation action is undertaken, although it is not yet a common practice in the EU, is the way forward to ensure energy performance of buildings is improved. However, it makes estimating the energy renovation market challenging. It also raises the question of the energy efficiency investments' boundaries (e.g. shall efficiency-related investments include only technologies made with the purpose of energy savings or include also investments made for other purposes which lead to energy savings). These questions may explain the lack of data on energy efficiency investments and the difficulties occurring if such a task is undertaken. Despite this, some Member States such as France and Germany track public investments in the energy upgrade of existing buildings and provide, on an irregular basis, an overall estimate of the energy renovation market.

The first attempt to estimate the energy efficiency market for different sectors (buildings, industry, transport and utilities) was undertaken in the United States (US) (ACEEE, 2008). A macro-level assessment approach was undertaken and a weighting coefficient of 15% introduced to estimate the efficiency component out of any investment, which leads to efficiency improvements. Since 2013, the International Energy Agency (IEA) prepares an annual estimate of the global energy efficiency market. The IEA estimate of the global energy efficiency market is undertaken using six different methodologies (Box 1.1). One of the methodologies used by the IEA to estimate the global energy efficiency market is based on the US macro-level assessment approach described above. However, the IEA introduced a new weighting coefficient of 5% to estimate the efficiency component of investments leading to efficiency improvements (IEA, 2014). By doing so, the IEA estimates of the global energy efficiency market is in the same order of magnitude for five out of the six methodologies considered (Box 1.1). The only exception is the estimate made using the IEA World Energy Investment Outlook, which are almost half of the estimates resulting from the other methodologies (IEA, 2014).

Box 1.1 Methodologies to estimate the market of energy efficiency

The energy renovation market can be estimated by using either a bottom-up or a top-down approach. The bottom-up approach provides a robust estimate of the size of the energy renovation market. However, it requires detailed data that are not currently available. The top-down approach makes an estimate of the scale of the energy efficiency investments by evaluating trends in energy consumption and economic growth.

The IEA identified six different methodologies to estimate the global energy efficiency market:

1. Estimate based on the assumed energy efficiency component of the gross capital formation: The gross capital formation is defined as investments made in additions or improvements to, or the replacement of existing fixed assets. Estimates of the energy efficiency market are made by considering a weighting coefficient of the efficiency component of any investment which leads to efficiency improvement.
2. Estimate based on changes in energy intensity: Energy intensity is defined as the energy consumed to produce an economic output. Estimates of the energy efficiency market equates largely to the annual change in energy intensity after factoring out the impact of change in activity.
3. Estimate based on the Long-term Industrial Energy Forecast (LIEF) model: The LIEF model is based on the assumption that when energy efficiency measures are adopted, the cost of investment per unit of energy saved increases.
4. Estimate based on a Monte Carlo simulation: This approach expands on the LIEF model. It generates a range of values for the set of variables and then randomly assigns them within a Monte Carlo simulation. It, therefore, provides a range of possible investment magnitudes.
5. Estimate based on leveraging the amount of public finance dedicated to support the

implementation of energy efficiency measures with private investment. Leverage ratios are estimated based on the United Nations' Advisory Group on Climate Change Financing.

6. Estimate based on bottom-up data on stock adoption and the energy efficiency component of unit costs to model an estimated energy efficiency investment: The IEA World Energy Investment Outlook provides estimates for global energy efficiency investments under the IEA New Policies Scenarios. This scenario takes into account current energy efficiency policies and the planned ones.

Source: Energy Efficiency Market Report, IEA, 2014
http://www.iea.org/publications/freepublications/publication/EEMR2014.pdf

Energy renovation is described in the literature as "man-power" intensive. It creates more jobs than new capacity generation, especially if jobs beyond the renovation work itself are taken into account (Quirion, 2013). However, the issue of the boundaries of energy efficiency, described above, apply as well to the estimates of the number of jobs generated by efficiency measures. The macro-level assessment methodology used in the US suggests a weighting coefficient of 8.1 jobs per million invested (ACEEE, 2008). Recently, more EU focussed, employment estimates show that gross EU 28 employment in the supply of energy efficiency goods and services sold in 2010 was approximately 900,000 jobs when considering only the activities for which the main motivation for the purchase is to save energy. The estimates of gross EU28 employment in energy efficiency increases to approximately 2.4 million jobs by including activities that have the potential to bring energy savings, but are not purchased primarily for that purpose. The latter amounts to approximately 1% of total EU employment (CE, 2015).

The energy renovation market and the jobs resulting from efficiency improvement of existing buildings are estimated, for the purpose of this report, using the macro-level assessment introduced by the US methodology. The weighting coefficient used to assess the energy efficiency component of the renovation market is 15% as suggested by the US study (ACEEE, 2008). Jobs resulting from energy renovation works are also estimated using the US weighting coefficient of 8.1 jobs per million invested (ACEEE, 2008).

Current energy renovation market

The total energy renovation market in the selected 17 Member States for which EUROCONSTRUCT provides data on the renovation market is estimated at EUR 82 billion for 2015 (Table 1.2). Given that the building market of the EUROCONSTRUCT area represents 75% of the total EU building market. The EU energy renovation market is estimated at EUR 109 billion in 2015. This is equivalent to the combined GDP of Bulgaria, Estonia and Croatia that year. Residential energy renovation market represented 65% out of the total energy renovation market. Efficiency improvements of residential buildings is driven by financing measures, mainly grants, implemented by Member States as part of their energy renovation strategies (see Chapter II). These measures have a direct impact on boosting employment in the construction sector and consequently in the overall economy. The total number of jobs generated by energy renovation work is estimated at 882,900 jobs[4] in 2015.

The German, Italian and French energy renovation markets accounted for 64% out of the EUROCONSTRUCT area energy renovation market (Table 1.2). The German market is by far the

[4] This figure is in the same order of magnitude than what is reported in the literature (CE, 2015)

leading energy renovation market, accounting for 30% of the total EUROCONSTRUCT area energy renovation market with its EUR 24 billion, followed by the Italian market with its EUR 15 billion and the French one with its EUR 13 billion (Table 1.2). At the segment level, the German market accounted for 32% of the total residential energy renovation market and for 25% of the total non-residential energy renovation market (Figure 1.3). The Italian market followed with 19% out of the total residential energy renovation market and 17% out of the total non-residential energy renovation market (Figure 1.3).

Table 1.2 Estimates of the size of the energy renovation market in EUROCONSTRUCT countries

Million €	Residential energy renovation market	Non-residential energy renovation market	Total energy renovation market
Austria	766	412	1178
Belgium	1622	880	2501
Czech Republic	169	505	674
Denmark	1675	441	2116
Finland	1098	705	1803
France	8099	4948	13047
Germany	16750	7321	24071
Hungary	161	236	396
Ireland	418	38	456
Italy	10084	4903	14987
Poland	526	760	1286
Portugal	608	176	784
Slovak Republic	63	94	156
Spain	2317	1862	4178
Sweden	1147	993	2140
The Netherlands	2159	1434	3592
United Kingdom	5396	3342	8737
EUROCONSTRUCT area	53055	29046	82101

Key point: The German, Italian and French markets lead the EU energy renovation market.

Source: own calculations based on EUROCONSTRUCT data (EUROCONSTRUCT, 2014)

Grants allocated by governments to energy renovation are partly financed by energy taxes. Household energy prices include an energy tax component in all EU Member States. In the EUROCONSTRUCT area, total energy taxes[5] paid by households in 2013[6] were EUR 108 billion (EUROSTAT) while total energy renovation market was at EUR 52 billion that year. This suggests that more could be done in terms of directing households' energy taxes towards energy renovation of their buildings. This conclusion is confirmed when considering current levels of renovation investments per dwelling. Dividing the current renovation market per country by the number of permanently occupied dwellings[7] in the country leads to an investment in energy renovation ranging from €33 per dwelling in the Slovak Republic to €596 per dwelling in Denmark. These figures should be compared with estimated energy renovation costs, which range from €200 per m^2 to €450 per m^2 (JRC, 2015-a). Clearly, the current level of investment in energy renovation is far from meeting the energy renovation needs in the EU, preventing citizens from comfortable homes and low energy bills.

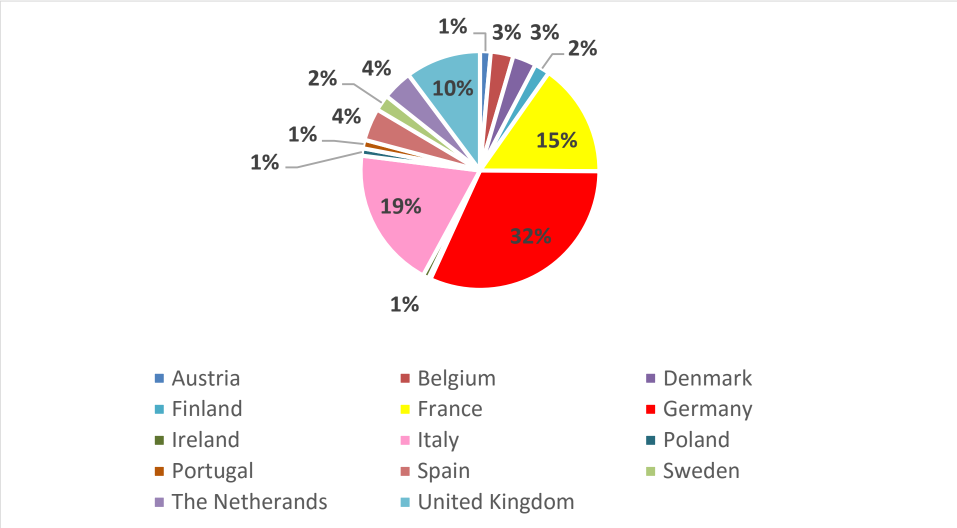
[5] These include those related to transport

[6] Last year for which data are available for all EUROCONSTRUCT area

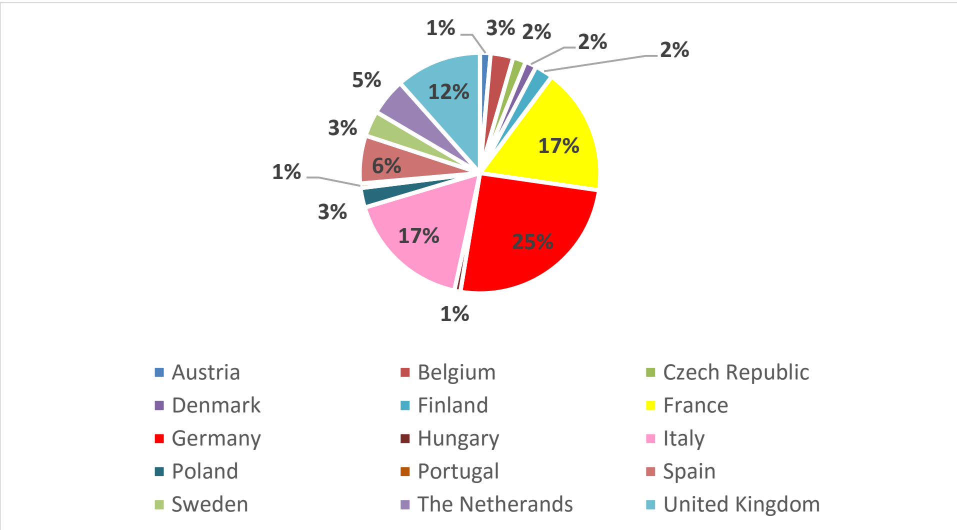
[7] Data provided by ODYSSEE

Well designed and effectively implemented energy renovation measures reduce energy demand for space heating which is the main end-use in residential buildings in most EU Member States. Given that gas is the main energy source used for heating in Europe (JRC, 2015-a), energy renovation would reduce households' gas expenditures. These expenditures reached EUR 1294 billion in 2014 (EUROSTAT, SBS) in 15 Member States[8] out of the 17 covered by EUROCONSTRUCT. Residential energy renovation markets in these countries represented 3.9% of the total gas expenditures that year. Financial instruments would be needed to shift households' energy expenditures from energy consumption to investments in energy renovation (see Chapter III).

Figure 1.3 Countries' share of the energy renovation market per segment in EUROCONSTRUCT area



a-Residential energy renovation market



b-Non-residential energy renovation market

Key point: Germany is leading in the energy renovation of both residential and non-residential buildings, followed by Italy for the residential market and Italy and France for the non-residential one.

Source: own calculations based on EUROCONSTRUCT data (EUROCONSTRUCT, 2014)

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8 Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Ireland, Italy, Poland, Portugal, Slovak Republic Spain, the Netherlands and United Kingdom

Future energy renovation market

The future economic role of energy renovation is assessed for three out of the six decarbonisation scenarios considered for the 2030 climate and energy policy framework (EC, 2014-b); the scenarios are:

i. EE27 - as adopted by the European Council in 2014 (27% energy saving target)
ii. EE30 -to be borne in mind for the 2020 revision (30% energy saving target); and
iii. EE40 -as called for by the European Parliament (40% energy saving target)

Estimates of the future energy renovation market are calculated by considering the same weighting coefficient of 15% for the efficiency component of the construction[9] market. Data used for these calculations are those provided in the impact assessment related to energy efficiency and its contribution to energy security (EC, 2014-b) using two models GEM-E3 and E3ME. Details on the analytical framework are included in annex I:

i. GEM-E3, a neo-classic model, which assumes that the investment to implement energy efficiency measures would crowd out other investment;
ii. E3ME, a post-Keynesian model, which allows the energy efficiency investment to be additional.

The construction market in 2030 is calculated by applying the percentage changes for each decarbonisation scenario to the construction market projected in the reference scenario. The share of the energy renovation market out of the total building market is assumed to be at 57% as was the case in 2015 and projected to be in the short-term by EUROCONSTRUCT.

Using the GEM-E3 model, the 2030 energy renovation market would range from EUR 109 billion with the 27% energy saving target to EUR 122 billion if a 40% energy savings target is adopted. Using the E3ME model, the energy renovation market would range from EUR 110 billion with the 27% energy saving target to EUR 149 billion if a 40% energy saving target is adopted (Table 1.2). Estimates of the 2030 energy renovation market are almost equal using GEM-E3 and E3ME in the case of the 27% and the 30% energy savings targets. This could be explained by the small differences between the renovation rates used for the 27% and the 30% energy savings scenarios (see Chapter II). The 40% energy savings target is the only one that could transform the energy renovation market by increasing its size by almost half of the current one.

Table 1.3 Size of the 2030 energy renovation market under EC decarbonisation scenarios

Billion €	EE27	EE30	EE40
GEM-E3	109	112	122
E3ME	110	113	149

Key point: The size of the 2030 energy renovation market could increase by almost half of the 2015 energy renovation market if a 40 % energy savings target is adopted.

Source: own calculations based on impact assessment data (EC, 2014-b)

The employment impact of energy renovation in 2030 based on the decarbonisation scenarios is estimated by considering the weighting coefficient of 8.1 jobs per million invested. Using GEM-E3

[9] This is referred to in the impact assessment (EC, 2014-b) as the production value

model, total energy renovation jobs would range from 882,900 with the 27% energy savings target to 988,200 if a 40% energy savings target is adopted. Using E3ME model, total energy renovation jobs would range from 891,000 with the 27% energy savings target to 1,206,900 if a 40% energy savings target is adopted. This is more than the current estimates of total direct jobs due to energy efficiency all sectors together (CE, 2015).

Non-market value of energy renovation

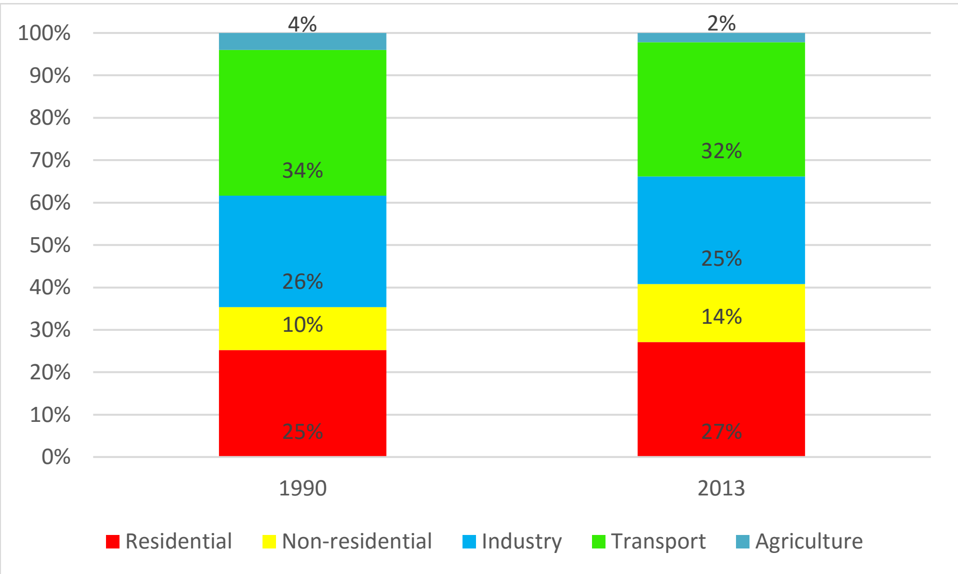
The non-market values, still having an economic and/or financial aspect, that are considered for the purpose of this report include:

- the impact of energy renovation on the geopolitical situation confronting the EU by reducing the EU exposure risk to energy supply disruption; and
- the equal access to energy services by ensuring all EU citizens live in comfortable homes without distinction of income.

Impact of energy renovation on energy geopolitics

The building stock is the largest single consumer of energy in Europe. It's final energy consumption out of the total EU final energy consumption reached 41% in 2013, which is six percentage points increase compared to 1990 (Figure 1.4). Residential buildings consumed 65% energy out of the total buildings' energy consumption. Gas is the main energy carrier used in residential buildings, its share out of the total residential energy consumption was 40% that year while the one of electricity was 26%. The main use of gas in buildings is for space heating. The overall gas consumption of buildings (residential and non-residential) reached 159 Mtoe in 2013, which is equivalent to 46% of total gas imports that year.

Figure 1.4 Share of final energy consumption per sector (EU 28)



Key point: The share of final energy consumption of buildings (residential and non-residential) increased by 6% between 1990 and 2013.

Source: EUROSTAT energy balances

The EU gas import dependency ratio was 65.3% in 2013, 20% above the 1990 level. The increased gas dependency made the EU more vulnerable to gas supply insecurity. This is particularly true for those Member States (Belgium, Estonia, the Czech Republic, Latvia, Lithuania and Portugal) relying for 100% for their supply on imported gas from one single supplier. Energy renovation of the EU building stock, if well designed and effectively implemented, will reduce heating needs and consequently the need for gas imports. This in turn would limit the permanent threat of gas supply disruption from neighbouring countries and improve overall geopolitics. Furthermore, the economic savings made on not importing gas can be re-directed to investments in more sustainable and job creating options.

Equality in the access to energy services

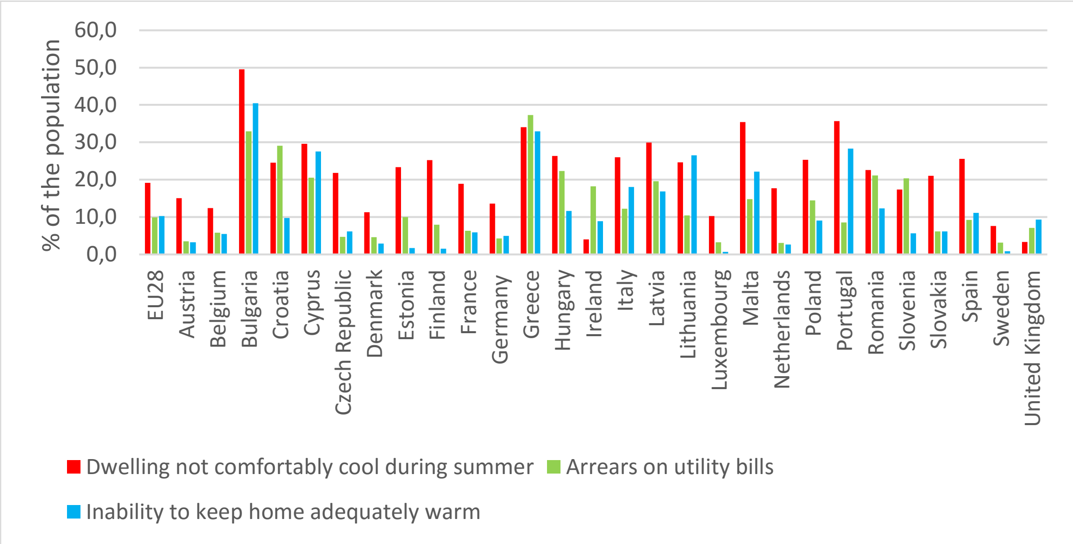
Another important non-market aspect, that is fundamental to the founding concepts of the EU, which an inclusive energy renovation strategy would bring is a more equal access for all EU citizens to modern and affordable energy services. This would happen without any social or income distinction. Buildings are constructed to provide comfortable working and living conditions. However, the quality of buildings, the increase in consumer energy prices and higher unemployment rates as well as decreased wages have contributed to increase the share of the population unable to keep their homes warm in winter and/or comfortably cool in summer. This has a direct impact on the health of EU citizens (VELUX, 2016) and consequently on public budgets and productivity.

The proportion of the EU population unable to keep their homes warm – with the impact on health, comfort – increased from 9.5% in 2010 to 10.2% in 2014. The highest increase was observed in Greece from 15.4% in 2010 to 32.9% in 2014. Bulgaria, had the highest share of its population unable to keep their homes warm at an appropriate level, 40.5% the same year. Despite the warm climate in the south of Europe, 27.5% of the Cypriot population was unable to keep their homes warm in 2014 against 26.5% in Lithuania (Figure 1.5). It is often forgotten by decision makers that in the south, winters create serious problems in poorly designed and constructed buildings. The combination of these factors has led to an increase of the share of the population facing fuel poverty in Europe, especially in Member States with GDP per capita lower than the EU average.

Beyond climatic conditions, the quality of the envelope is the first parameter that makes homes comfortably warm in winter. Similarly, a well-designed building envelope will keep homes comfortably cool in summer and reduce excess deaths resulting from heat waves. The proportion of the EU population living in dwellings not comfortably cool in summer was at 19.1%. The highest share was observed in Bulgaria, 49.5%, followed by Portugal and Malta, with more than 35%. Despite the location in the North of Europe, the share of the Latvian population unable to keep their homes comfortably cool in summer was 29.9% and 34.6% in Lithuania (Figure 1.5).

The increase in energy prices, especially in Member States with GDP per capita lower than the EU average, resulted in an increase from 9.2% in 2010 to 10.2% in 2014 of the share of the population with arrears in their energy bills. The highest share of the population with arrears in their energy bills was observed in 2014 in Greece (37.2%), followed by Bulgaria (32.9%), Croatia (29.1%), Hungary (22.3%) and Cyprus (20.5%) as shown in Figure 1.5.

Figure 1.5 Percentage of the population unable to keep their homes warm in winter, with arrears in utility bills and living in homes uncomfortably cool in summer per Member State



Key point: Member States with per GDP per capita lower than the EU average have the highest share of the population facing fuel poverty.

Source: EUROSTAT SILC database

The percentage of population unable to keep their homes warm in winter and with arrears in their utility bills is given for 2014 while the percentage of population living in homes not comfortably cool in summer is given for 2012.

The impact of energy prices on the capacity of households to pay their energy bills is exacerbated by the structure of energy prices. In fact, in almost all countries (the only exceptions are Greece and Italy for electricity prices) energy taxes considered in the lowest energy consumption bands are much higher than those in the highest energy consumption bands (see Annexe III). Not only the structure of energy prices is not encouraging consumers to save energy, but in the case of vulnerable consumers, it increases the weight of their energy expenditures as their consumption is de facto in the lowest energy consumption bands that include the highest energy taxes (see Annex III).

Furthermore, energy renovation of existing buildings would lower the contribution of buildings to air pollution. This contribution was estimated, in 2013, at 43% of total EU emissions of Particulate Matter with a diameter of 2.5 µm or less ($PM_{2.5}$), 58% of total EU emissions of Particulate Matter with a diameter of 10 µm or less (PM_{10}), 73% of total EU emissions of Benzo[a]pyrene (BaP) and 47% of total EU Carbon monoxide (CO) emissions (EEA, 2015-a). These emissions increase the number of premature deaths in Europe, especially in poor areas, and consequently the economic costs (mortality and morbidity) due to air pollution.

The energy transition of the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, is needed to ensure that all EU citizens live in comfortable homes in winter as well as in summer and to lower premature deaths due to air pollution. Current policies and financing schemes do not allow for this transition to take place as demonstrated in the following Chapter. Setting a 2050 vision to transform the overall EU building stock via a consistent, ambitious investment-climate-energy policy framework, will ensure that the EU moves away from hidden subsidies to fossil fuels. These subsidies are used to partially pay for the fossil fuel energy bills of low-income families, without offering them comfortable homes.

Chapter II: Does current EU legislation boost or hinder zero energy renovation?

Highlights

- At least 14 EU policy instruments target the energy transition of the EU building stock. Member States have to report on the provisions included in each instrument separately. This increases the risk of double counting and makes the assessment of the coherence of the overall policy framework difficult.
- The difficulties above are exacerbated by various definitions of energy renovation in EU instruments. A streamlined policy framework with a clear long-term target to transform the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, is needed to ensure coherence with the EU international climate commitment and trigger a self-sustained energy renovation market.
- Member States' projections of GHG emissions for 2030 and energy consumption for 2020 are not coherent with the EU 2020 and 2030 climate and energy targets. Despite these incoherencies, Member States reported only few additional measures. Regulatory measures reported are those related to the implementation of the EPBD. Financial measures reported are mainly grants, either because they are easy to design and implement or because of the budgetary and accounting constraints in the case of public buildings.
- The energy transition of the EU building stock has to be taken into account in EU-wide policies such as the Stability and Growth Pact and the Multi-Annual Financial Framework to trigger private investments in energy renovation and avoid financing solutions that lock the savings potential. The EC should provide guidance and support to the design of measures with high energy savings potential. It should ensure that none of the EU provisions in non-energy instruments hinders energy renovation. The next version of the renovation strategies, required under the EED and due to be delivered before May 2017, should be about effective implementation of measures with high savings potential.
- EU funding should prioritise much more Member States with GDP per capita lower than the EU average, low technical capacity, high share of the population owner-occupier of single-family homes and high share of the population facing fuel poverty. Support should be provided to these countries to design and implement large-scale energy renovation programmes which will drive growth, create local jobs and foster innovation.
- Households' electricity and gas taxes hinder energy savings. They encourage EU citizens to consume more energy as they are higher in lower energy consumption bands and lower in higher energy consumption bands. Current electricity and gas pricing make more vulnerable consumers in risk of ending-up in fuel poverty.
- Central governments are not leading by example in the renovation of the buildings they own and occupy. Alternative measures proposed under Article 5 of the EED should be eliminated and the requirement of 3% annual renovation rate should be extended to all buildings owned and/or occupied by public authorities at national, regional and local levels.
- Compliance checking, enforcement and a systems approach to product policies are instrumental for the energy transition of the EU building stock. Strengthening the existing provisions is an important step towards the deployment of best available technologies and fostering innovation.

Chapter I presented an assessment of the current EU energy renovation market. It highlighted the important role governmental intervention played in kick-starting the energy renovation market in Europe. The analysis showed that in 2030 the size of the EU energy renovation market could increase by almost half of the current energy renovation market if a 40% energy savings target is adopted.

This Chapter analyses the stringency of the provisions related to GHG emissions reduction and energy savings included in EU climate-energy policy and financial instruments. It assesses the coherence of existing provisions with the 2030 climate and energy targets. The Chapter identifies the loopholes in the existing provisions and makes recommendations to ensure the ultimate goal of transforming the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, will be met by 2050. Where possible an assessment of the interactions of different measures and provisions is included. Analysis of the implementation of the existing provisions at Member States level is out of the scope of this study.

The measures analysed include:

i. ***Regulatory instruments,*** *such as those setting a maximum final and/or primary energy consumption and GHG emissions at the building stock level, the individual building level and at the level of each technical building system and element of the building.*
ii. ***Information instruments*** *targeting the empowerment of EU consumers by providing them with accurate and timely information on the expected energy consumption of buildings, technical building systems and building elements.*
iii. ***Economic instruments*** *aimed at creating the financing conditions that would encourage investments in the implementation of energy savings and carbon reduction measures.*
iv. ***Other instruments*** *which include research and development, information and knowledge sharing, capacity building, inspection and any other provision that cannot be included in the first three categories.*

The analyses are based on EU requirements and on Member States' reporting on the measures considered, by them, to achieve their GHG emissions reduction targets, their energy savings targets as well as their targets for the increased share of renewables in the total final energy consumption. Where available and relevant, a literature review has been undertaken and interviews with experts have been conducted.

The European Union has set itself climate and energy targets for 2020 (EC, 2007). The three EU targets include a 20% binding target for GHG emissions reduction compared to 1990 levels, a binding target of 20% share of renewables in total final energy consumption and an indicative target of 20% savings in primary energy consumption compared to the 2007 PRIMES projections. The three targets have to be met at both the EU and at Member State levels.

In October 2014, the European Council agreed on the 2030 climate and energy policy framework and endorsed climate and energy targets for 2030 (EC, 2014-c). The package includes:

i. A binding target at EU and Member State levels of at least 40% GHG emissions reduction compared to 1990 levels.

ii. A binding target at EU level of at least a 27% share of renewables in total final energy consumption for 2030.
iii. An indicative target at EU level of at least 27% energy savings of primary energy consumption compared to 2007 PRIMES projections. The target will be reviewed by 2020, with an EU level target of 30% in mind.

In February 2015, the EU adopted the Energy Union Strategy Framework (EC, 2015-a) aiming to ensure that Europe has a secure, affordable and climate friendly energy system. The Energy Union Strategy Framework called on the EU to *"fundamentally rethink energy efficiency and treat it as an energy source in its own right, representing the value of energy saved*". It also highlighted that as part of the market design review, the EC "*will ensure that energy efficiency and demand side response can compete on equal terms with generation capacity*".

In December 2015, the EC agreed, on behalf of its Member States, to the Paris Climate Agreement (UNFCCC, 2015) which calls to "*aggregate emission pathways consistent with holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursing efforts to limit temperature increase to 1.5°C."* The transposition of the Paris Climate Agreement into a domestic policy framework at the EU level has yet to be decided.

This year, the EC is undertaking a review and/or revision of almost all EU legislation related to climate and energy policies. The analysis below aims to feed into this process and to enlighten stakeholders and policy-makers on the existing provisions that deliver savings and/or put the building stock on track with the long term decarbonisation goals. These provisions should be strengthened while those that lock-in the savings potential should be eliminated from EU legislation.

EU climate and energy legislation related to buildings

The EU has developed a comprehensive set of policy and financial instruments to achieve its 2020 climate and energy targets. These instruments are made-up of various regulations, decisions and directives (Table 2.1) that have been developed and adopted step by step, sector by sector over the last decades (JRC, 2015-b). When necessary these instruments are supplemented with guidance documents and the relevant implementing regulations to ensure their effective implementation. Member States are requested to report on a regular basis on the transposition of EU provisions into national legislation and on the progress made towards energy and climate targets.

The provisions that describe measures intended to lead to reduced energy consumption, GHG emissions and to an increase in the share of renewables in the energy mix of buildings are included in at least 14 EU policy instruments (Table 2.1). Additionally, the guidance document on the impacts of energy performance contracts on governments accounts (EC, 2015-b) is also scrutinised given its relevance for the energy renovation market, especially when it comes to public buildings.

1. Directive (2003/87/EC) on GHG emissions allowance trading scheme referred to in the following sections as ETS directive (EC, 2003).

2. Directive (2009/29/EC) on expending on GHG emissions allowance trading scheme referred to in the following sections as ETS directive (EC, 2009-a).

3. Decision (No 406/2009/EC) on the effort of Member States to reduce their GHG emissions to meet the community's GHG emissions reduction commitments up to 2020, referred to in the following sections as ESD (EC, 2009-b).

4. Regulation (No 525/2013) on a mechanism for monitoring and reporting GHG emissions and for reporting other information at national and the EU level relevant to climate change, referred to in the following sections as MMR (EC, 2013-a).

5. Directive (2012/27/EC) on energy efficiency referred to in the following sections as EED.

6. Directive (2010/31/EC) on the energy performance of buildings referred to in the following sections as EPBD (EC, 2010-a).

7. The delegated regulation (No 244/2012) establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements (EC, 2012-b).

8. Directive (2009/28/EC) on the promotion of the use of energy from renewable sources referred to in the following sections as RED (EC, 2009-c).

9. Directive (2009/125/EC) establishing a framework for setting of eco-design requirements for energy-related products, referred to in the following sections as Ecodesign directive (EC, 2009-d).

10. Directive (2010/30/EU) on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products, referred to in the following sections as labelling directive (EC, 2010-b).
    Under the eco-design and the labelling directives the implementing measures related to heating, cooling, lighting and domestic refrigerators have also been analysed.

11. Directives (2009/72/EC) on the internal market in electricity, referred to in the following sections as IME (EC, 2009-e).

12. Directives (2009/73/EC) on the internal market in natural gas, referred to in the following sections as IMG (EC, 2009-f).

13. Regulation No 651/2014 on categories of aid compatible with the internal market (EC, 2014-d) and its guidelines on State Aid for Environmental Protection and Energy (EC, 2014-e).

14. Regulation No 1311/2013 on the Multiannual Financial Framework for the years 2014-2020, referred to in the following sections as MFF (EC, 2013-b).

Table 2.1 Provisions, from EU legislation, related to reducing GHG emissions and energy consumption in buildings, per policy category

Category	EU legislation	Provision
Regulatory instruments	ETS & MMR	Maximum GHG emissions in ETS sectors (power and heat generation) and reporting on GHG emissions as required by MMR.
	ESD & MMR	Maximum GHG emissions in non-ETS sectors such as buildings and reporting on GHG emissions as required by MMR.
	EED (Article 3)	Indicative national energy efficiency target for the overall economy.
	EED (Article 5)	Annual renovation rate of 3% of total floor area heated and/or cooled buildings owned and occupied by central government. Member States can opt for alternative measures if they achieve an equivalent amount of savings.
	EED (Article 7)	Standards and norms to improve energy efficiency of buildings and products with the aim to achieve an annual amount of savings equivalent to those that would have been achieved under the energy efficiency obligation scheme.
	RED (Articles 3, 5 and 13)	Mandatory national overall targets and measures for the use of energy from renewable sources. District heating & cooling produced from renewable sources as well as aerothermal, geothermal and hydrothermal heat energy captured by heat pumps and used for buildings have to be included in the calculation of the target.
	EPBD (Articles 4, 5, 6, 7 & 9) & Cost-optimum regulation	Minimum energy performance requirements for buildings and building units must be set with a view to achieving cost-optimal levels. The provision applies for new buildings and existing buildings, building units and building elements that are subject to major renovation.
	RED (Article 13)	Minimum levels of energy from renewable sources in new buildings and existing ones when they undergo major renovation.
	EPBD (Article 8)	System requirements in respect the performance of technical building systems (e.g. heating).
	Ecodesign	Minimum energy performance requirements for energy-related products covered by implementing measures.
Information instruments	EPBD (Articles 11, 12 & 13)	Energy performance certificate (label) when a building is constructed, sold or rented out to new tenant. For buildings occupied by a public authority the requirement applies only for those with useful floor area over 250 m^2. The building label should include at least

		the energy performance of the building and recommendations for measures to undertake if a building undergoes major renovation.
	EED (Articles 9, 10 and 11)	Metering heat, electricity and gas consumption and providing information on current and historical consumption.
	IME & IMG (Article3)	Information on the contribution of each energy source to the overall energy mix and on CO_2 emissions and radioactive waste.
	Labelling directive	Energy consumption and, where relevant, other essential information relevant to the use phase and supplementary information concerning energy-related products.
Economic instruments	ETS	Trading GHG emissions and using emission credits for energy renovation.
	ESD	Use of revenues from annual emission allocations to develop innovative financing mechanisms aiming to improve energy performance of buildings.
	IME & IMG (Article 3)	Developing innovative pricing formulas.
	EED (Articles 18, 19 & 20)	-Financial instruments, incentives, grants and loans to support energy efficiency service projects. -Energy Efficiency National Fund, Financing and Technical Support. -Taking measures to remove regulatory barriers such as split-incentives.
	EPBD (Article 10)	Financial incentives and measures to remove market barriers to buildings' energy efficiency improvements.
	State Aid	Conditions for granting state aid for energy renovation projects.
	MFF	Annual ceilings on commitments by category of expenditures.
	Guidance document on accounting	Accounting and budgeting for energy performance contracts.
Others	EPBD, RED, EED	Training, capacity building, information and knowledge sharing, audits, inspection of heating and cooling systems.

Key point: The fragmentation of the provisions related to reducing GHG emissions and energy consumption in buildings results in an unclear pathway that does not incite good implementation.

Source: Compiled by the author from various EU policy instruments

The provisions identified in Table 2.1 are scrutinised in this Chapter. The identified loopholes are analysed and a recommendation to overcome them is suggested. Before going in-depth in the analysis of these loopholes, it is important to first highlight how energy renovation is defined in EU legislation as well as the important role that the modernisation and energy transition of the EU building stock is expected to play in the decarbonisation of the EU energy system by 2030.

Definition of energy renovation in EU legislation

Different terminologies are used in EU legislation to define energy renovation. The EED (EC, 2012-a) introduced the concepts of deep renovation, cost-effective deep renovation, staged deep renovation, substantial refurbishment and comprehensive refurbishment. The EPBD (EC, 2010-a) introduced the concept of major renovation. This multiplicity of concepts may lead to confusion in Member States and among market actors when it comes to implementation. Furthermore, it makes the evaluation of the contribution of energy renovation to the EU long-term decarbonisation targets difficult, if not impossible, as demonstrated below by the wide differences between the definitions considered by each concept:

Deep renovation:

i. Recital 16 of the EED specifies that the long-term strategy for mobilizing investments in the renovation of national building stock should address "*cost-effective deep renovations which lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-renovation levels leading to a very high energy performance. Such deep renovations could be carried out in stages*".

ii. Article 4, paragraph c of the EED requests Member States to include in their long-term strategy for mobilising investment in the renovation of national building stock, policies and measures to stimulate "*cost-effective deep renovations of buildings, including staged deep renovations"*

iii. Article 5, paragraph 6 of the EED on the exemplary role of public bodies' buildings suggests as an alternative measure to renovation "*measures for behavioural change*" that would allow equivalent savings as "*cost-effective deep renovations".*

Substantial refurbishment:
Article 2, paragraph 44 of the EED defines substantial refurbishment as a "*refurbishment whose cost exceeds 50% of the investment cost for a new comparable unit".*

Comprehensive refurbishment:
Article 5, paragraph 1 of the EED on exemplary of public buildings proposes when implementing "*measures for comprehensive renovation of central government buildings*" to consider "*the building as a whole, including the building envelope, equipment, operation and maintenance".*

Major-renovation:
Article 2, paragraph 10 of the EPBD defines major renovation as a renovation of a building where:

a. "The total cost of the renovation relating to the building envelope or technical systems is higher than 25% of the value of the building, excluding the value of the land upon which the building is situated;

or

b. *More than 25% of the surface of the building envelope undergoes renovation*".

Major renovation is mentioned in the EED, recitals 17 and 30 and in article 9, paragraph b on metering. The EED refers to *"major renovation as set-out in EPBD*". Similarly, the RED refers to major renovation in its article 13, paragraph 4 and 5 where it is stated "*major renovation as set-out in EPBD*".

Effective implementation of any legislation in the building sector requires time to change mind-sets, develop technical capacity, business models and the roll-out of the technologies needed. It is therefore important to avoid confusion and have **one single definition for energy renovation** in all EU instruments. This definition should take account of the EU long-term decarbonisation targets in light of the Paris Climate Agreement (UNFCCC, 2015) and the Energy Union Strategy Framework (EC, 2015-a). Furthermore, given that the current energy renovation market is mainly driven by governmental intervention (see Chapter I), evaluation of the impact of energy renovation on public budgets has to be an important parameter to consider when defining energy renovation.

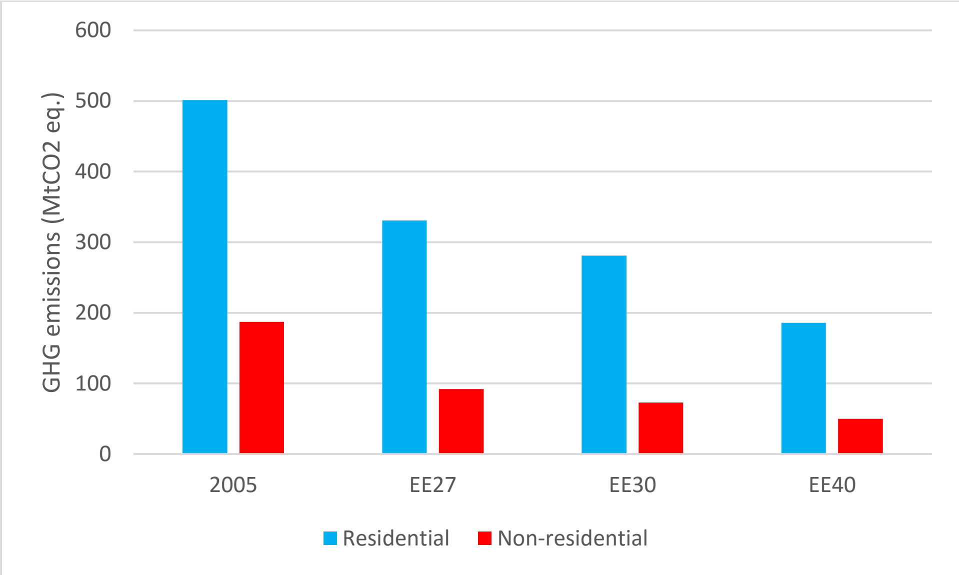
Based on the above, **energy renovation** should be defined as a renovation which leads to **transform EU buildings from being energy wasters to being highly energy efficient and energy producers, leading to net zero energy consumption[10].** Assessing progress towards the EU climate and energy targets would be easier as Member States are already reporting to EUROSTAT on the energy consumption of their building stock for all end-uses and by energy sources. This would also make compliance checking of energy performance of buildings and verification doable. Moreover, the roll-out of smart meters would provide consumers with timely information about their energy consumption and its energy mix. Consumers would, therefore, be able to decide when to consume energy and which energy to consume. This in turn would empower EU citizens and contribute to making them, in the long run, "prosumers."

Expected role of energy renovation in the EU 2030 energy system

The EC decarbonisation scenarios considered for the design of the 2030 climate and energy targets anticipates that the building stock will lead the decarbonisation of the demand side of the EU energy system (JRC, 201-b). Compared to 2005 levels, GHG emissions are projected to fall by 33.8% in the residential sector and by 50.5% in non-residential buildings when considering the 27% energy savings target by 2030. Emissions reduction have to go further down if a 40% energy savings target is adopted. Compared to the 2005 levels, emissions in the residential sector would have to be reduced by 62.9% while in the non-residential sector, the projected emissions reduction is at 73% (EC, 2014-a) (Figure 3.1).

[10] Net zero energy consumption refers to zero fossil fuels consumption.

Figure 2.1 GHG emissions reduction in the EC decarbonisation scenarios EE27, EE30 and EE40 compared to the 2005 GHG emissions level in residential and non-residential buildings



Key point: GHG emissions reduction in non-residential sector are projected to be higher than those in residential one in the EC decarbonisation scenarios.

Source: Impact assessment on energy efficiency and its contribution to energy security (EC, 2014-b)

The projected decarbonisation of the EU building stock results from the assumption that annual renovation rates will increase over time (Table 2.2) leading to reduced energy consumption and increasing the integration of renewables in buildings. Questions remain as to whether the renovation rates will increase in the absence of an overall ambitious target for energy savings. The renovation rates assumed by the EC are higher than the market rate (around 1%), especially when considering those needed to meet a 40% energy savings target, if adopted (Table 2.2).

Table 2.2 Renovation rates considered in the EC decarbonisation scenarios

Period	27% energy savings target	30% energy savings target	40% energy savings target
2015-2020	1.48%	1.61%	1.65%
2021-2030	1.84%	2.21%	2.42%

Key point: Renovation rates considered for the 40% energy savings target are the only ones which could drive large-scale energy renovations and trigger private investments.

Source: Impact assessment on energy efficiency and its contribution to energy security (EC, 2014-b)

Achieving a high level of business leaders' confidence to invest in energy renovation needs a stable regulatory framework (EEFIG, 2015) which will ensure that a sufficient volume of buildings will have to be renovated every year. The current 2030 energy savings target of 27% is unlikely to create the necessary volume which would make this transformation happen as the renovation rates required to achieve this target are too close to the current ones. **The 40% energy savings target, with annual renovation rates close to 3%, is the only one that has the probability of driving the large-scale renovation projects needed to trigger private investments in energy renovation.**

Regulatory instruments

Maximum GHG emissions for the overall building stock

The EU 2020 GHG emissions reduction target has to be met at both the EU and Member States levels for the overall economy. EU climate legislation, ETS and ESD, sets annual binding targets for each Member State for the sectors covered by each instrument (EC, 2003, 2009-a&b). It neither sets sectoral targets nor requires Member States to set a target at a sectoral level. Based on Member States reporting, the building sector, 99% of whose direct emissions are covered under the ESD and 1% under the ETS, is the non-ETS sector with the highest emissions reduction projected by Member States (EEA, 2015-b).

In practice, Member States' projections of sectoral GHG emissions could be considered as implicit binding sectoral targets. In fact, Member States are required to report on current and projected emissions in the sectors to be used to meet their overall GHG emissions reduction (EC, 2013-a). However, it is unclear if Member States are allowed to consider a trade-off of their sectoral targets over time. Furthermore, Member States are required to report, on a mandatory basis, on the list of current individual measures and, on a voluntary basis, on the planned measures to achieve their GHG emissions reduction in each sector (EEA, 2015-c).

The building sector is identified in Annex III of MMR (EC, 2013-a) under two sub-sectors: i) households and, ii) commercial and institutional. Member States are required to report on a set of priority indicators and complementary ones for each sub-sector.

Priority indicators are those related to:

- Specific CO_2 emissions of households (t/dwelling) which is calculated as a ratio between CO_2 emissions from fossil fuel consumption by households (kt) and the stock of permanently occupied dwellings (1000);
- CO_2 intensity of the commercial and institutional sector (t/million €) which is calculated as a ratio of CO_2 emissions from fossil fuel consumption in commercial and institutional sector (kt) and the gross value-added of services (EUR billion).

Supplementary indicators are those related to:

- Specific CO_2 emissions of households for space heating (t/m^2) which is calculated as a ratio between CO_2 emissions for space heating in households (kt) and the surface area of permanently occupied dwellings (million m^2);
- CO_2 intensity of the commercial and institutional sector for space heating (kg/m^2) which is calculated as a ratio of CO_2 emissions from space heating in commercial and institutional sector (kt) and the surface area of services buildings (million m^2).

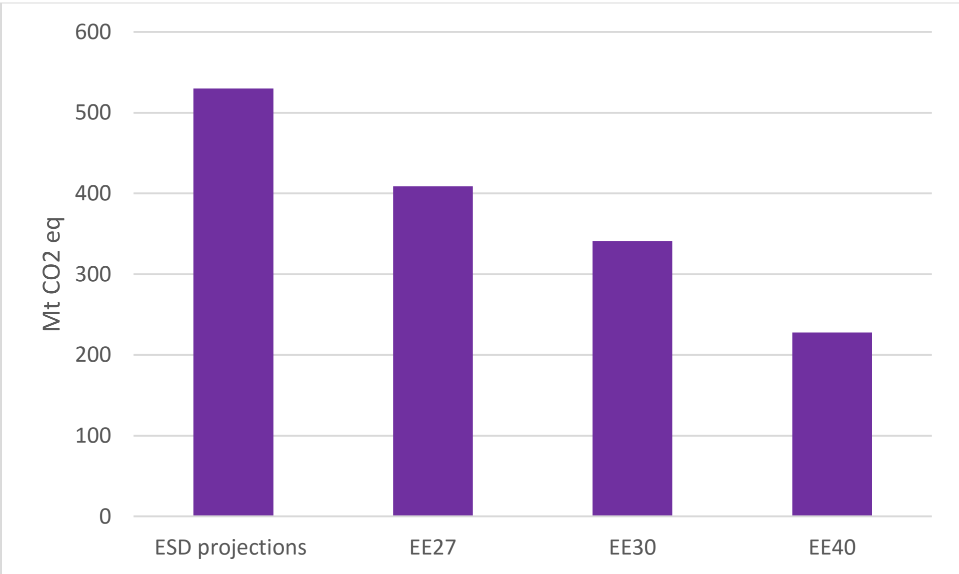
Assessment of the ambition level of Member States GHG emissions reduction

Member States' projections of GHG emissions show that, at the EU level, ESD emissions were below the sum of national ESD targets in 2013 and will remain below the sum of national ESD targets in every year between 2013 and 2020 (EEA, 2015-b). At Member States level, 23 out of the 28 Member States expect that their ESD emissions will stay below their annual ESD targets in every year from

2015 until 2020. Emissions in Austria, Belgium, Ireland and Luxembourg could exceed, with the current measures, ESD targets for one or more years of the 2013-2020 period. These countries could use the surplus of Annual Emission Allocations (AEAs) from earlier years and if not sufficient could transfer AEAs from other Member States, with a limit of 5%, or use international project-based emission credits (EEA, 2015-b).

The positive 2020 emissions reduction picture described above is challenged by the sum of Member States' 2030 buildings' GHG emissions projections. The projected sum of the 2030 GHG buildings' emissions reported by Member States are 558 $MtCO_2eq$. when considering current measures and 530 $MtCO_2eq$. when considering additional measures (EEA, 2015-b). These emissions are much higher than the 2030 EC estimates for buildings' GHG emissions under the decarbonisation scenarios. The ongoing ESD discussions, in conjunction with the forthcoming review of the EED and the EPBD, should, **at least, close the 23% gap between Member States' 2030 sum of buildings' GHG emissions projection,** when considering additional measures, **and those expected under the 27% energy savings target** (Figure 2.2).

Figure 2.2 Member States 2030 buildings' GHG emissions projection under ESD and buildings' GHG emissions considered under the EC decarbonisation scenarios



Key point: Member States 2030 GHG projections for buildings under ESD are higher than those under the EC decarbonisation scenarios.

Source:
ESD projections: Trends and projections in Europe 2015, (EEA,2015-b)
EE27, EE30 and EE40, Impact assessment on energy efficiency and its contribution to energy security (EC, 2014-a)

The comparison above raises questions about the ambition level of the 2020 ESD targets and the baselines used when these targets were set. **Accurate baselines are needed for the post-2020 ESD targets** to avoid experiencing, in 2030, the overachievement of GHG emissions reduction reported by some Member States for the period 2013-2020. **Removing the possibility to allocate emission permits for the next period** would ensure the design and effective implementation of more stringent energy efficiency measures for the post 2020 period. Improving the reporting on emissions reduction and **requiring Member States to report on the breakdown of the emissions reduction**

achieved by the supply and the demand side would allow for an assessment of the stringency of energy efficiency measures and their real impact.

The 2030 ESD targets need to be set with the EU 2050 emissions reduction target in mind and in light of the Energy Union Strategy Framework (EC, 2015a) as well as the Paris Climate Agreement (UNFCCC, 2015). Member States should only be taking into consideration measures that deliver long-term mitigation potential, especially when their implementation involves the use of public funding. These measures are usually postponed because of a lack of a long-term policy vision and the financing schemes which would allow this vision to materialise. As a result, efficiency measures considered at national and local levels are very often those with very short pay-back times and low energy savings. Overall, the lack of the long-term vision is counter-productive as it increases the risk of lock-in-effect and puts the EU at risk of not meeting its international climate commitment.

The on-going review/revision of EU climate and energy legislation is a unique opportunity to set the vision needed to ensure the energy transition, and consequently the decarbonisation of the EU building stock. The first step towards this vision is to **require Member States to set a binding GHG emissions reduction target for buildings** based on their national circumstances. The acceptability of such a requirement by Member States should not be problematic as many countries have already set energy and/or carbon targets (see next section). Furthermore, energy renovation is primarily an industrial project which would drive growth, create local jobs and ensure the long-term competitiveness of the EU by fostering innovation across the overall value-chain (see Chapter III).

Maximum energy consumption

Buildings represent the largest single consumer of energy in the EU. The share of buildings' final energy consumption out of the total EU final energy consumption reached 41% in 2013, which is three percentage points than the share in 2011 (EUROSTAT, Energy balances). Energy consumption of residential buildings was at 296 Mtoe in 2013 which is equivalent to the 2000 level consumption, while the energy consumption of non-residential buildings was at 160 Mtoe which is 22% higher than the 2000 level consumption.

Table 2.3 Decomposition analysis of final energy consumption for the period 2000-2013

Sector	Total change	Climate effect (Mtoe)	Activity level (Mtoe)	Comfort and social factors (Mtoe)	Labour productivity (Mtoe)	Energy savings (Mtoe)	Others (Mtoe)
Residential	+0.5%	+17.8	+38.7	+29.4	NA	-62.3	-22.1
Non-residential	+22%	+6	+31.6	NA	-6.7	-10.3	+9.2

Key point: Energy savings measures had more impact on residential buildings than non-residential ones in compensating for increased number and size of buildings in the EU.

Source: ODYSSEE, (ENERDATA, 2015)

The variation of final energy consumption is due to the climatic effect, the activity level (more dwellings in the case of residential buildings and value added for non-residential ones), comfort and social factors (larger homes and more appliances per dwellings), change in labour productivity for non-residential buildings, energy savings and other effects such as behaviour change. Analysis of the variation of final energy consumption of buildings for the period 2000-2013 shows that energy efficiency measures have largely compensated for the increased number of dwellings and their size, but their effect was limited in the case of non-residential buildings (Table 2.3).

At the building stock level

EU instruments do not require Member States to set a target aiming specifically to reduce energy consumption of their building stock. However, Member States' reporting on various EU requirements under the EED allowed to calculate energy savings. Furthermore, Member States' reporting shows that two-thirds of the countries have set, on a voluntary basis, targets to reduce energy consumption of their building stock as demonstrated in the following section.

1. Under Articles 3 and 7 of the EED

The EU 2020 indicative energy savings target has to be met at the EU and Member States levels for the overall economy. The two articles that are directly linked to the indicative energy savings target are Articles 3 and 7 of the EED.

Article 3 of the EED requires Member States to "*set an indicative national energy efficiency target, based on either primary or final energy consumption, primary or final energy savings, or energy intensity*". Furthermore, each year starting from 2013, Member States are required to report "*on the progress achieved towards national energy efficiency targets*" as stated in Article 24 of the EED. Based on the last reporting from Member States on Article 3, the EU may fall short in meeting its 2020 energy efficiency target as the sum of national indicative targets corresponds to 17.6% primary energy savings compared to PRIMES 2007 projections (EC, 2015-c).

The EED does not require Member States to break down their national indicative targets into sectoral targets. Member States' reporting on Article 3 of the EED, shows that 16 countries (Belgium, Bulgaria, Croatia, Cyprus, Denmark, Estonia, France, Germany, Ireland, Italy, Latvia, Luxembourg, Malta, Slovenia, Sweden and the United Kingdom) have provided their 2020 projections for final energy consumption per sector while the Netherlands provided its sectoral projections in terms of primary energy consumption (EC services). These projections allowed to calculate energy savings for the period 2013-2020 (Table 2.4).

Article 7 of the EED requires Member States to *set "an energy efficiency obligation scheme"*. The scheme shall ensure that "*a cumulative end-use energy savings target is achieved by 2020"*. The "*target shall be at least equivalent to achieving new annual savings of 1.5% of the annual energy sales to final consumers".* Member States "*may opt to take other policies and measures to achieve energy savings among final customers*" provided that the "annual amount of new energy savings" is equivalent to those that would have been generated by the implementation of the 1.5% obligation scheme. Member States' reporting on savings under Article 7 allows a partial calculation on energy savings in buildings to be made (Table 2.4).

Table 2.4 Calculated buildings' energy savings based on Member States 2020 sectoral projections

Country/savings for the period 2013-2020	Under Article 3	Under Article 7
Belgium	12%	4%
Bulgaria	+9% (no savings)	25%
Croatia	11%	5%
Cyprus	51%	9%
Denmark	4%	NA
Estonia	6%	2%
France	27%	10%
Germany	15%	5%
Ireland	19%	6%
Italy	14%	5%
Latvia	+14% (no savings)	11%
Luxembourg	+13%(no savings)	NA
Malta	+7% (no savings)	6%
Slovenia	+4% (no savings)	NA
Sweden	+7% (no savings)	7%
United Kingdom	10%	11%

Key point: The fragmentation of reporting on 2020 projections leads to incoherencies in calculated energy savings based on reporting requirements of Articles 3 and 7.

Source:
-Savings under Article 3 were calculated by the author based on Member States' reporting of their buildings' final energy consumption and EUROSTAT data for 2013
-Savings under Article 7 were calculated by Jan Rosenow based on Member States' reporting on their energy savings obligation and EUROSTAT for 2013 data

Savings calculated under Article 7 are lower than those calculated under Article 3 as a large portion of savings in buildings under Article 7 comes from crosscutting measures where it has not been possible to assign them to sectors[11]. Moreover, sectoral projections of final energy consumption in Bulgaria, Latvia, Luxembourg, Malta, Slovenia and Sweden under Article 3 would lead to an increase of final energy consumption by 2020 while the sectoral savings under Article 7 show a decrease of final energy consumption of buildings in 2020. The mismatch between the savings calculated under Article 3 and those calculated under Article 7 and the difficulties to calculate the overall savings under Article 7 demonstrates the need for a more **streamlined, sectoral reporting of energy savings** to ensure coherence and make tracking progress possible.

Under Article 3, the highest expected savings based on the reported projection of final energy consumption in 2020 would take place in Cyprus (51%). Achieving this amount of savings in Cyprus is doubtful given the current Cypriot buildings' policy framework, the lack of technical capacity and financing mechanisms aimed at reducing energy consumption in buildings. The second highest expected savings in buildings should take place in France. The French energy transition law adopted in 2015 is ambitious. However, the implementation of the renovation requirement of 500,000 dwellings per year is only planned to start in 2017 (LTECV, 2015). The calculated savings for Denmark based on the country's reported sectoral projection of final energy consumption is too low (4%).

[11] Private communication with Jan Rosenow.

Further investigation would be needed given the ambition level of the Danish energy transition strategy.

Under Article 7, Member States' reporting shows that 23 countries have opted for alternative measures, either alone or combined with energy efficiency obligations. The total number of measures considered by Member States to achieve their energy savings obligation (under both the energy efficiency obligations and the alternative option) is 479. The breakdown of the savings per sector shows that 42% of the overall savings will take place in the building sector (T. Fawcett & J. Rosenow, 2016). Savings from financing schemes and grants are estimated to represent 19% out of the total and those from taxes 14% out of the total. The remaining savings are expected from regulations and/or voluntary agreements (11%), standards and norms (9%) and a small contribution from training, national energy efficiency funds, energy labels and other policy measures (T. Fawcett & J. Rosenow, 2016).

Under Article 7, Member States report on measures related to standards and norms for buildings while under Article 4, Member States do not report on standards and norms. The EED specifies that the standards and norms reported under Article 7 should be different and additional to those that are mandatory and adopted under EU legislation. Furthermore, the savings to consider under Article 7 should be new savings additional to existing ones. It is unlikely that this is the case as under Article 4, (see following section), the only regulatory measures reported are those related to the implementation of the EPBD provisions and the savings expected from the implementation of existing EU legislation are not new ones. Assessing the credibility and the coherence of the savings in the building sector as reported under both Article 4 and Article 7 is therefore not possible. To avoid double counting and reporting and to ensure coherence, the **reporting on energy savings and/or projected final energy consumption of buildings should be grouped under one single article.**

2. Under Article 4 of the EED

Member States are required under Article 4 of the EED (EC, 2012-a) to develop long-term strategies to mobilise investments in renovation of the building stock, although the renovation concept as described in EU legislation (see above) is rather confusing ranging from cost-effective deep renovation to behavioural change as if by changing users' behaviour, buildings will stop leaking. Member States refer in their renovation strategies to renovation, deep renovation and cost-effective renovation without specifying the meaning of the concept used, if any, in the national legislation.

Based on Member States' reporting under Article 4 of the EED (EC, 2012-a), 17 countries, the Flanders region in Belgium and the territory of Gibraltar included in their renovation strategies, submitted to the EC, an energy and/or carbon savings target for their overall building stock (JRC, 2016). Targets considered by Member States range from reducing heating consumption (space heating and hot water) to energy savings on final and/or primary energy consumption and a long-term target to deliver a zero or carbon-free building stock. The period considered by Member States to achieve their buildings' energy and/or targets is either 2020, 2030 or 2050 (Table 2.5).

Table 2.5 Energy and/or Carbon reduction targets as set, on voluntary basis, by Member States and reported in their renovation strategies under Article 4

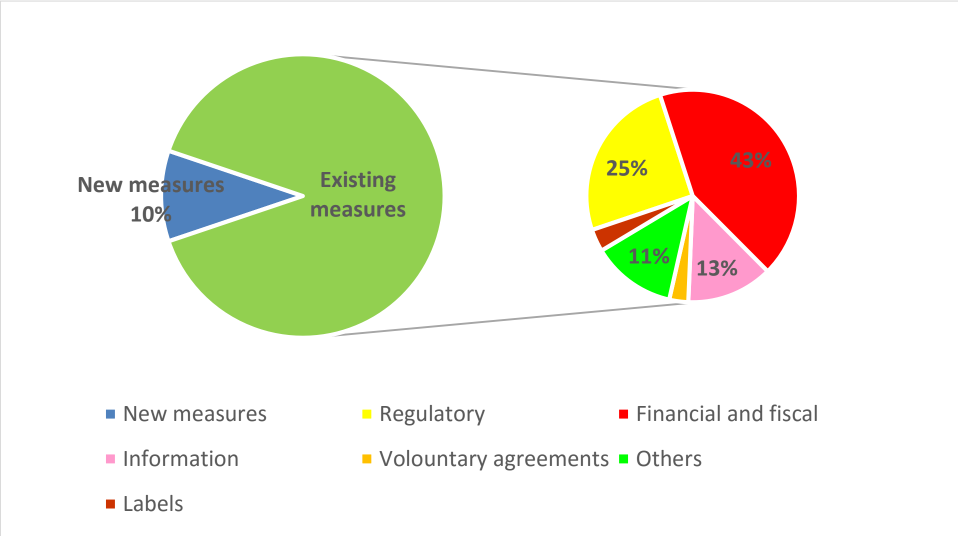
Country	Energy savings target	Country	Energy savings target
Austria	3% reduction of heating consumption by 2020 compared to 2013.	Greece	Renovation of at least 80% of the existing building stock by 2050.
Belgium Flanders	4288 GWH energy savings in final energy consumption and 4581 GWH energy savings in primary energy consumption by 2020.	Hungary	Annual energy savings of 49PJ over the period 2013-2020.
Croatia	80% GHG emission reduction by 2050.	Ireland	-Nearly Zero Emissions Building stock by 2050. -33% energy savings in public buildings by 2020.
Czech Republic	45% reduction in heating consumption by 2020 compared to 2013.	Latvia	Energy savings of 186 GWh in public buildings over the period 2014-2020 as a result of the implementation of the 3% annual renovation rate (Article 5).
Denmark	35% net energy reduction in heating and hot water by 2050 compared to 2011.	Lithuania	Energy savings of at least 500 GWh of thermal energy by 2020.
Estonia	Annual energy savings of 3.5PJ.	The Netherlands	-Renovation of 300,000 dwellings annually by at least two energy label steps. -Average social rental property to achieve at least energy class B of the Dutch label by 2020. -80% of private rental to achieve at least energy class C of the Dutch label by 2020. -Average energy class A for the overall building stock by 2030.
Finland	Energy savings of 8% by 2020 and 37% by 2050.	Slovakia	Energy savings of 6928.6 GWh by 2030.
France	-60% reduction of final energy consumption by 2050 compared to 2010. -Renovation of 500,000 dwellings annually starting from 2017. -Before 2025, all privately owned residential buildings with primary energy consumption of more than 330 kWh/m^2 have to be renovated.	Slovenia	-Energy savings of at least 16% by 2020 in final energy consumption. -Energy savings of at least 30% by 2030 in final energy consumption. -Almost carbon-free building stock by 2050.
Germany	Savings of 377 PJ per year over the period 2008-2020.	Sweden	Energy savings of 12 % to 25% for heating and hot water final energy consumption by 2020.
Gibraltar	Energy savings of 6.7 GWh of primary energy consumption by 2020 and 88.8 GWh by 2050.		

Key point: Energy and/or carbon savings targets in the building sector are already common practice across two-thirds of the Member States.

Source: Synthesis report on the assessment of Member States' building renovation strategies (JRC, 2016)

The total number of measures reported by Member States, under Article 4 of the EED, is 425 out of which 90% are existing measures. Within the existing measures, 43% are financial and fiscal ones, out of which about 90% are grants. Regulatory measures, which represented 25% of the total existing measures reported, are mainly related to the implementation of the EPBD provisions and thus to new buildings as the major renovation concept hinders the implementation of energy requirements when buildings are renovated (see next section). Training, capacity building and others represented about 13% of the existing measures (Figure 2.3). Similarly, 36% of the planned measures are related to financing, followed by 25% regulatory measures that should result from the implementation of the EPBD provisions.

Figure 2.3 Share of measures reported by Member States in their renovation strategies per type



Key point: 90% of the measures considered in the renovation strategies are existing ones.

Source: own calculations based on Member States reporting under Article 4 (JRC, 2016)

Renovation strategies reported by Member States under Article 4 of the EED are obviously an important step towards a better understanding of the measures undertaken by countries to ensure the modernisation and energy transition of their building stocks. The reporting highlighted that setting an energy and/or carbon savings target is now a common practice in at least 17 countries and two sub-national regions (Table 2.5). However, analysis of the stringency of targets and their coherence with the EU long-term decarbonisation objective is not possible as the targets have been set for different time-periods and using different metrics.

The expected savings from the measures considered under the renovation strategies are not reported. This makes the assessment of the coherence between the targets (Table 2.5) and the measures reported (Figure 2.3) not possible. Furthermore, the measures reported in the renovation strategies do not refer to the ones reported under Article 7 (see previous section) and vice versa. It is, therefore, difficult to assess if there is double counting and/or additionality.

The next version of the renovation strategies is due by April 2017. The on-going review/revision of the EED is an opportunity to strengthen Article 4 by **requiring Member States to set a long-term binding energy reduction target of their buildings with agreed milestones and metrics that would lead to the achievement of net zero energy building stock by 2050**.

3. Under Article 5 of the EED

Under Article 5 of the EED, Member States are required to renovate 3% of the total floor area of heated and/or cooled buildings owned and occupied by central government, each year. The idea behind specific requirements for buildings owned and occupied by central governments is to stress the leading role of public authorities in the energy transition. However, alternative approaches to energy renovation are allowed by the same Article of the directive. Among the alternative measures allowed are those related to i) behavioural change of occupants as if by changing user's behaviour public buildings will stop leaking, ii) deep renovation which raises questions about the expected stringency of the requirements to be set under the EPBD and iii) demolition and selling buildings which brings into question the motivation of the public sector in countries that opted for these alternatives. This illustrates very well the gap in ambition between the default approach and the approach that would be needed to show real leadership in the transition of the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption.

Member States reporting under Article 5 shows that only 9 Member States (Bulgaria, Estonia, Greece, Hungary, Lithuania, Latvia, Luxembourg, Romania, Slovenia) have opted for an annual renovation rate of 3% of the heated and/or cooled buildings owned and occupied by their central governments. This is coherent with the expected leading role of the public sector. However, it is worth noting that most of these Member States are countries with i) GDP per capita lower than the EU average which makes financing energy renovation challenging, ii) have weak energy performance requirements in their building energy codes (IEA, 2013) which will not lead to ambitious renovations and iii) have huge need for capacity building and skills upgrading which makes the quality of the renovation doubtful. EU funding should prioritise these countries that opted for the 3% renovation rates. This would offer these countries an opportunity to build the technical capacity needed to scale-up energy renovation.

Among the alternative measures considered by Member States, behaviour change of users is the only one that has been reported by all the 19 Member States that opted for alternative measures, followed by the replacement of energy systems (Table 2.5). Budgetary pressure on governments and the accounting methodology for public investments (see section on economic instruments) may explain their choice to opt for alternative measures with short pay-back time and low investments but low energy savings as well.

The decision of 19 Members States to opt for alternative measures instead of renovating 3% of the buildings owned and occupied by central governments is, in reality, a missed opportunity for learning by doing and setting an example to the wider public. The pressure on governments to reduce their expenditures, with no exceptions, questions the prioritisation of the energy transition in EU policies. A more coherent approach to energy renovation that should go beyond energy policies, is needed to allow for the **elimination of those alternative measures which lower the ambition of the energy transition of the EU building stock**, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption.

Table 2.6 Alternative measures to the 3% annual renovation rates of buildings owned and occupied by central governments considered by Member States

Measure /Country	Belgium	Czech republic	Denmark	Germany	Ireland	Spain	France	Croatia	Italy	Cyprus	Malta	Netherlands	Austria	Poland	Slovakia	Finland	Sweden	UK
Behaviour change	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Deep renovation	X (Flanders Region)								x									
Renovation of the envelope	X		X				X		x			x						x
Replacement of technical systems	X		X				X		x					x		x		
Selling off buildings	X (Brussels)						x					x						
Supply with renewable energy sources	X (Brussels)								x					x				
Demolition							x											
Others			x	x					x		x							x

Key point: The alternative measures considered by public authorities, for the renovation of buildings owned and occupied by central governments, questions the leading role of the public sector in the energy transition.

Source: EC services based on 2014 data.

At the individual building level

Provisions for setting minimum energy performance requirements at the building level when buildings are renovated have been included in the EPBD (EC, 2010-a) since its first adoption in 2002. The directive has been instrumental in extending building energy codes to existing buildings (IEA, 2013-a). Member States are required to calculate cost-optimum levels of minimum energy performance requirements using the framework methodology established by the delegated act on cost-optimality (EC, 2012-b). Recent analysis of minimum energy performance requirements set by Member States for existing buildings shows a gap of more than 15%, in about half of the countries, between the current minimum energy performance requirements for existing buildings and the calculated cost-optimum levels (ECOFYS, 2015-a).

However, the scope for the implementation of minimum energy performance requirements for existing buildings has been narrowed by introducing the concept of major renovation. Article 2 of the EPBD defines major renovation as a renovation of a building "*where the total cost of the renovation is higher than 25% of the value of the building, excluding the value of the land, or more than 25% of the surface of the building envelope undergoes renovation".* Various EC research funded projects (CORDIS, 2015) show that energy renovation currently taking place is mainly about the replacement of windows, heating, cooling and lighting systems or the insulation of the roof only. The total cost of these measures cannot be higher, even when the measures are combined, than 25% of the value of the building and the roof does not represent 25% of the envelope. It is, therefore, unlikely that current renovation work falls under the scope of "major renovation". Consequently, there is currently no need to set minimum energy performance requirements when a renovation is undertaken given the type of measures implemented. This may explain why Member States were not able to report on compliance rates regarding minimum energy performance requirements for existing buildings (ICF, 2015). To ensure the energy transition of buildings will take place, the **concept of major renovation should be removed from the legislation. Setting minimum energy requirements should apply each time a building is renovated**.

Moreover, the EPBD is confusing about the end-uses to consider when setting minimum energy performance requirements. Paragraph 1 of Annex I refers to heating needs (space heating and hot water) and cooling needs while paragraph 3 of the same annex requires lighting needs for non-residential buildings and ventilation needs for all building types to be taken into account. As a result, some Member States include lighting and ventilation needs when setting minimum energy performance requirements and others do not (CSTB, 2015 & IEA, 2013-a). Given that Member States report to EUROSTAT annually on energy consumption of all end-uses, **minimum energy requirements should be set for all end-uses** to allow for tracking progress.

Furthermore, the EPBD introduced the overall performance-based approach which considers the building in a holistic manner. This approach takes into account the interactions between the built environment, the envelope, building systems and the users. The aim is to limit the lock-in-effect which, usually, results from incremental increase of the energy performance of buildings when renovated. However, the issues identified above make it difficult to assess the impact of the EPBD on reducing energy consumption of existing buildings. On the other hand, Member States report on an annual basis to EUROSTAT the final energy consumption for all end-uses per energy source of the overall building stock, without distinguishing between new and existing buildings.

Evaluation of policy instruments is an important step in the overall policy-making process. Consistency between the provisions set in EU policy instruments and the reporting requirements is therefore needed to assess progress. Reporting requirements should be based on what is effectively measurable such as the energy consumption for all end-uses per energy source. The EU and Member States would benefit from using **one single renovation concept** which would allow progress towards the EU climate and energy targets to be assessed. The on-going review/revision of the EPBD is an opportunity for **replacing the major renovation concept with a requirement that all renovations are planned to lead to the transformation of the EU buildings from being energy wasters to being highly energy efficient and energy producer leading to net zero energy consumption.** The net zero energy requirement will also make compliance checking and enforcement easier to implement.

At the technical building systems and building elements levels

Under Article 8 of the EPBD, Member States are required to set "*system requirements in respect of the overall energy performance, the proper installation, and the appropriate dimensioning, adjustment and control of the technical building systems which are installed in existing buildings*". The EPBD specifies that *system requirements should at least cover heating and hot water systems as well as air-conditioning and large ventilation systems.* The requirement does not include lighting. **Setting minimum energy requirements for buildings systems should be extended to lighting systems**, especially in the non-residential sector as the system approach allows for additional savings. Furthermore, information on the transposition and the implementation of the provisions included in Article 8 of the EPBD are scarce. Further investigation of the implementation of the system requirement in different Member States is needed to ensure the full savings potential is captured.

Moreover, the performance approach introduced by the EPBD when setting minimum energy performance requirements for the overall building, and the package label for heaters, facilitate to set system requirements. However, despite the fact that the optimization of technical building systems is not linked to major renovations, technical building system requirements are not set/taken into account properly, e.g. when heating and cooling systems are replaced (CA, 2016).

Furthermore, while under the Ecodesign directive (EC, 2009-d) requirements for heating equipment are per product, an efficiency ranking for energy labelling purposes was established e.g. looking into combinations of fossil-fuel and RES-based heat generators. The review of the implementing measures for lighting products and pumps was an opportunity to extend the system approach to these product families. The **system approach should also be considered when the implementing measures for cooling products will be revised, and the setting of eco-design requirements for systems should be re-assessed.**

Under Article 4 of the EPBD, Member States are required to "*take the necessary measures to ensure that minimum energy performance requirements are set for building elements that form part of the building envelope when they are replaced or retrofitted, with a view of achieving cost-optimal* *levels*." Requirements on building elements are included in building energy codes in most countries (IEA, 2013-a). Analyses of minimum energy requirements set by Member States for building elements of existing buildings show a gap of more than 15%, in about half of the countries, between the current minimum energy performance requirements for building elements of existing buildings and the calculated cost-optimum levels (ECOFYS, 2015-a). Compliance data on building elements are lacking (ICF, 2015) which makes the assessment of the effective impact of this provision difficult.

At the energy-related products level

The Ecodesign directive (EC, 2009-d) established a framework for setting eco-design requirements for energy related products. Requirements under Ecodesign implementing measures are set at the Least Life Cycle Cost (LLCC) defined by the preparatory study for each product family based on the sales and costs data made available by the industry and market research firms by the time the study is undertaken. Member States report on a bi-annual basis to EUROSTAT, PRODCOM database, on the production of manufactured goods including those regulated by Ecodesign. However, PRODCOM database does not include imported products and product categories included in this database do not match with the product families considered under Ecodesign. Moreover, PRODCOM database does not include the breakdown by energy performance and/or energy classes.

The time between the initiation of the preparatory study and the effective implementation of the minimum energy performance requirements is, on average, between 3 to 4 years[12]. However, in the case of heating products, it took much longer. The preparatory study was initiated in 2005 and the implementation of the first Ecodesign tier took place in 2015. For product families that resulted in minimum energy performance requirements in a reasonable time frame there is a risk that these requirements do not go far beyond business as usual and do not reach the Ecodesign ambition of lowest life cycle costs (ECOFYS, 2012-a). In fact, by the time the first Ecodesign tier takes effect, the efficiency and cost data used by the preparatory study are outdated. Very often the technology has progressed and the market has moved before Ecodesign measures are implemented which make them less effective (see Annex III). Another alternative to the LLCC approach is to **set minimum energy efficiency requirements at the efficiency level of the best available technology at the time of the study** (Box 2.1).

Box 2.1 Japan Top runner programme for energy-related products

The Japanese product policy is known as the "Top-runner" programme. Under the influence of the Top Runner programme in Japan "average efficiencies have moved well ahead of European ones" (ARMINES, 2007).
The aim of the Top runner programme is to continuously stimulate technological improvements by manufacturers towards an increased energy efficiency of selected product family. The programme is based on the identification of the most efficient technology in the market which is then turned into top runner standard. Similar products have to meet the standard of the most efficient product before a defined target year is reached. The target year ranges from 3 to 12 years depending on the replacement of the products and the competition level.

[12] Up to 2 years are needed for the preparatory study, 1.5 year on average is needed from the preparatory study to the final regulation and 1 year between the regulation becoming final and the first standard coming into effect. The only exception has been the study on stand-by.

The top runner programme is completed with a mandatory comparative labelling scheme for the five important types of appliances and a voluntary labelling scheme for other products. The labelling scheme includes information on energy consumption and cost savings of the product. To encourage consumers to buy the most efficient products, they are offered "eco-points" which can be exchanged with energy efficient products or prepaid cards.
To encourage retailers to sell the most efficient products, a programme selects stores, which are active in selling and promoting energy efficient products. Retailers who have pushed energy-efficient products outstandingly receive an award. Their stores can be labelled as "Top-energy efficient product retailing promotion store".
Last but not least, Japan has also established a recycling programme. Collection centres and recycling points exist since 2004. As a result, 40% to 50% of each product is recovered in Japan and the rest is exported for recycling overseas (ARMINES, 2007)

Source: Your guide to energy efficiency in buildings, (BigEE, 2014)
http://www.bigee.net/en/policy/guide/appliances/recommended/

Recent assessment of Ecodesign impact states that 9% of the energy savings in primary energy for the period 1990-2010 would have resulted from the EU products policy (VHK, 2015). This evaluation is based on the savings reported in the impact assessment related to each product family. In reality the savings from the EU product policy is lower for at least the following reasons:

- By the time the first Ecodesign tier is implemented, technology has improved. This lowers the effect of the policy measure, as described above. This is exacerbated by the lack of data on the efficiency level of different technologies. The EC proposal for setting a framework for energy efficiency labelling includes, in its Article 8 (EC, 2010-b), the need to establish a product database. Assessing the possibility of i**ntegrating efficiency data in PRODCOM could be an option for the product database.**

- Market surveillance activities, which should be conducted by Member States, are not effective, nor sufficient (ECOFYS, 2012-b). Estimates in the literature of missed savings due to non-compliance range between 10% and 50% (ECOFYS, 2012-b). Market surveillance activities require financial and human resources which are not available in several Member States. **Bundling the existing fragmented resources at Member States level into an EU wide market surveillance activity** would allow for more checks and a better coordination of testing in national laboratories. A database of regulated products would greatly help market surveillance authorities; having all the information needed in one single place, will make it easier to check the coherence between the declared performance to national authorities and those in the shops. Assessing the possibility of **integrating market surveillance activities related to energy efficiency with the existing market surveillance activities under the CE marking** would contribute to streamlining market surveillance activities and reducing costs. One way to reduce non-compliance rates would be to **shame and publicly blame manufacturers reporting wrong data.**

- When performing market surveillance activities, national authorities are required to test one single unit per model. The tested model is considered to comply with the applicable requirements within the limit of the allowed tolerances (see Annex IV). If the tested model fails the test, three additional units are tested and the calculated average value has to comply with the applicable requirements within the limit of the allowed tolerances. Contrary to what is stated in the draft delegated regulation on the use of tolerances (EC, 2016), tolerances are different from uncertainty of measurements which are dealt with in test procedures of each product (Meier, 1997). Tolerances have been introduced in the 1950's, in the US by a voluntary industry led market surveillance activities, to take into account deviations in production. The automation of production has eliminated these types of deviations making the need for tolerances obsolete. Tolerances provided for in the verification procedure are intended for use only by market surveillance authorities (EC, 2016-a). In practice, some manufacturers misuse the allowed tolerances and declare more favourable energy efficiency levels in their technical documentation which leads to additional lost savings. **Round Robin testing of regulated products by accredited laboratories would permit an assessment of the relevance of the allowed tolerances.**

- Market surveillances activities require testing products based on the agreed test procedures. A good test procedure should reflect actual usage conditions, be repeatable and provide accurate results. It should also accurately reflect the relative performance of different design options for a given appliance and cover a wide range of models within that category of product (Meier, 1997). Ideally, testing should be inexpensive and easy to modify to accommodate new technological features. Unfortunately, most of the test procedures do not fulfil all the requirements above. As a result, energy consumption of any appliance in real usage conditions is higher than the tested one (ECOS, 2016). **Adapting test procedures to usage conditions and new technological features, smart tools, would allow for a better assessment of the expected energy savings.**

Requirements for supply with renewables

The EU has set itself a binding target of 20% share of renewables in total final energy consumption by 2020 at the EU and Member States levels. In 2009, the EU adopted the Renewable Energy Directive RED (EC, 2009-c) to ensure the renewables target will be met. Based on the latest data provided by EUROSTAT, the share of renewables in total final energy consumption increased from 12.35% in 2009 to 15.96% in 2014. Moreover, Member States are required under Article 5 of the RED to report on the share of renewables in their gross final electricity consumption, heating and cooling and transport. Based on the latest data reported by Member States to EUROSTAT, the share of renewables in gross final electricity production increased from 19% in 2009 to 27.45% in 2014 while the share of renewables in heating and cooling increased from 14.69% in 2009 to 17.73% in 2014.

The RED does not include requirements on increasing the share of renewables in the building sector as a whole. However, in its Article 13, the RED requires Member States to "*introduce in their building regulations and codes appropriate measures in order to increase the share of all kinds of energy from renewable sources in the building sector*". Furthermore, the directive explicitly requires Member States to introduce renewables in buildings when they undergo major renovation. Under the same Article, the directive states that "*Member States shall, in their building regulations and codes or by other means with equivalent effect, where appropriate, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major* *renovation*. *Member States shall permit those minimum levels to be fulfilled, through district heating and cooling using a significant proportion of renewable energy sources.*"

The role of renewables in the decarbonisation of buildings is acknowledged in the EPBD (recital 28) which calls on Member States to "*encourage architects and planners to properly consider the optimal combination of improvements in energy efficiency, use of energy from renewable sources and use of district heating and cooling for both new and existing buildings*". Furthermore, Member States are required to report under Article 9 of the EPBD on "*the measures concerning the use of renewable sources in new buildings and existing buildings undergoing major renovation*". In practice, every time building energy codes are revised, Member States introduce requirements on supplying buildings with renewable energy sources (IEA, 2013-a).

The overall energy consumption in buildings from renewable energy sources is unknown as there is no specific requirement to report on it. The energy mix of the building sector is today dominated by electricity (33.8%) and gas (33%), followed by oil (12%), renewables (11%) and heat (7.31%). Given the important share of electricity out of the total building consumption and the increased share of renewables in gross final electricity production, it is likely that renewables represent, already, an important share of buildings' energy consumption, especially if heat consumption in buildings is taken into account.

The 2030 binding target at the EU level to increase the share of renewables in final energy consumption by at least 27% would lead to a further increase of the share of renewables in the energy mix supplied to buildings. Furthermore, if buildings are renovated they would have to be supplied, to a very large extent, with renewable energy sources. Renewable energy will be either produced locally or distributed through the grids and district heating and cooling systems.

The proposed EC strategy for heating and cooling (EC, 2016-b) will also accelerate the increase of renewables in the energy mix supplied to buildings as Member States are required to increase the share of renewables in heating and cooling (EC, 2009-c). Overall, the more energy efficient buildings will be, the more important will the role of renewables be in the decarbonisation of the overall EU energy system (Box 2.2). Moreover, an energy efficient building stock, supplied with renewables, will reduce the peak demand and allow for more flexibility of the EU energy system (ECOFYS, 2015-b) while empowering EU citizens (see Chapter III). Assessing progress towards the supply to buildings by renewables would necessitate introducing a **reporting requirement on the share of renewables in the energy mix supplied to buildings in the revised RED.**

Box 2.2 Getting the fundamentals right

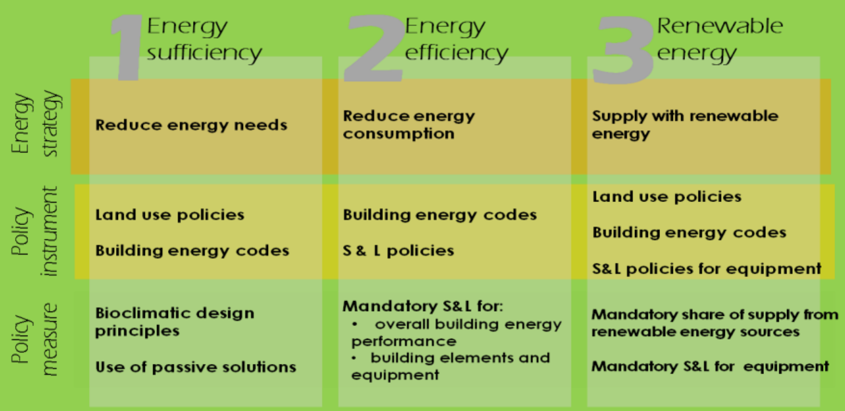
The path towards net zero energy consumption for all end-uses requires the implementation of energy sufficiency measures, energy efficiency measures and to supply buildings with renewable energy sources (Figure 2.4).

Energy sufficiency measures aim to reduce the extent of energy services (heating, cooling, and lighting) needed to operate and maintain the required comfort level in a building. Sufficiency measures include the orientation of the building *vis-a-vis* the sun, its placement with respect to surroundings, daylight and sunshine. The form, volume and orientation of the building, the ratio of glazed areas, the colour of roofs and walls and the use of natural shading are the sufficiency measures to consider at the design stage. Energy management of the building and behaviour of the users are the sufficiency measures to consider at the operation stage.

Energy efficiency measures are technological solutions that are designed to provide energy services at lower levels of energy consumption. Efficiency measures include the improvement of the envelope by optimising its performance through insulation and air tightness requirements. The aim is to reduce unnecessary energy losses through each building element, thereby minimising the consumption of heating and cooling systems. Efficiency measures include using best available technologies for each energy system/equipment to reduce their consumption.

The supply with renewable energy sources, generated by the building itself or from its surroundings is the third pillar to achieve zero energy buildings. Renewable energy sources reduce GHG emissions due to energy consumption of buildings and the need for grid-based supply while empowering consumers. The more stringent the energy sufficiency and energy efficiency measures are, the higher the impact of renewables in the decarbonisation of the building stock will be.

Figure 2.4 The path towards net zero energy consumption for all end-uses



Key point: The more energy efficient a building is, the more important will be the impact of renewables in the decarbonisation of the EU building stock

S&L: Standards and labelling
Source: Modernising building energy codes to secure our global energy future, (IEA, 2013-b)
http://www.iea.org/publications/freepublications/publication/PolicyPathwaysModernisingBuildingEnergyCodes.pdf

Information instruments

At the building level

Under Article 12 of the EPBD, Member States are required to ensure an energy performance certificate is issued and presented to the prospective new tenant or buyer of a building or building units which are constructed, sold or rented. For buildings occupied by public authorities and frequently visited by the public, the requirement above applies only for those buildings with total useful floor area over 250 m^2. Public authorities are required to ensure the energy performance certificate is correctly and publicly displayed. The aim is to raise awareness regarding energy consumption and to reinforce the leading role of public authorities in the energy transition.

In practice, in most Member States, the energy performance certificate became an additional document provided by the owner to the buyer when a transaction takes place. The cost of issuing the energy performance certificate, which varies widely among Member States, is indirectly invoiced to the buyer (CA, 2016). There is a little evidence on the influence of the energy performance certificate in the final choice of the buyer because of the lack of evaluation of this policy instrument. Literature suggests that buildings with high energy classes in small and medium-size cities are better priced than those with low energy classes (BIOIS, 2013).

The energy consumption indicated in the energy performance certificate is usually an asset rating. The EPBD Concerted Action considers this approach disadvantageous and calls for the **inclusion of operational ratings** (CA, 2016)**.** Furthermore, the credibility of energy performance certificates is, currently, questionable as there is a lack of compliance checking of the data reported as well as a lack of transparency. In most Member States, either energy performance certificate databases do not exist or, when they exist, consumers cannot access them because of data protection issues. Last but not least, in most Member States, the layout of the energy performance certificate is unfriendly and includes information not necessarily needed by consumers but that might be needed by policy-makers (CA, 2016).

There is also no evidence about the triggering effect of an energy performance certificate on energy renovation practices. Member States' reporting on the renovation strategies shows that The Netherlands is the only country where renovation targets are based on the energy classes included in the energy performance certificate (Table 2.5). Literature review shows similar trend in the United Kingdom. In practice, some countries, regions and municipalities link financial incentives to the energy class achieved by the building after renovation. However, representatives from Member States at the EPBD Concerted Action would like the energy performance certificate's role to be strengthened, for example, by making it mandatory for projects co-financed by the European Investment Bank (EIB). Similarly, several stakeholders reported in their responses to the recent EPBD public consultation on the need to strengthen the energy performance certificate, notably by consolidating the training of certifiers and by letting EPC evolve towards a more holistic building improvement plan.

At energy-related product level

The labelling directive (EC, 2010-b) is solely dedicated to providing information to consumers about the energy consumption of products regulated under Ecodesign. Energy classes considered for the label are based on the preparatory studies related to setting minimum energy performance requirements for each product. Consequently, the loopholes identified above in Ecodesign provisions also apply to the labelling directive provisions.

At end-use level

Provisions to provide information on energy use were first included in the internal market directives for electricity and gas (EC, 2009-e&f). Member States are required under these two directives to "*ensure consumers are provided all energy consumption data including the contribution of each energy source to the overall fuel mix for what concerns electricity*". CO_2 emissions and other environmental impacts should also be provided. The information should be provided for *the "preceding year in a comprehensible and, at a national level, clearly comparable manner"*. Member States are also encouraged to roll-out smart meters for natural gas and/or electricity by 2020.

The EED introduced provisions on "*metering and billing thermal consumption when heating, cooling and/or hot water are supplied by district networks or from a central source servicing multiple buildings and/or dwellings*". Member States are required to ensure smart meters are installed when technically feasible and cost-effective for new buildings and those undergoing major renovation. Consolidated information on the implementation of the provisions on thermal metering is not yet available, as the transposition date was June 2014. It is therefore not possible to assess whether or not providing information on heat consumption triggers energy renovation and/or behaviour change.

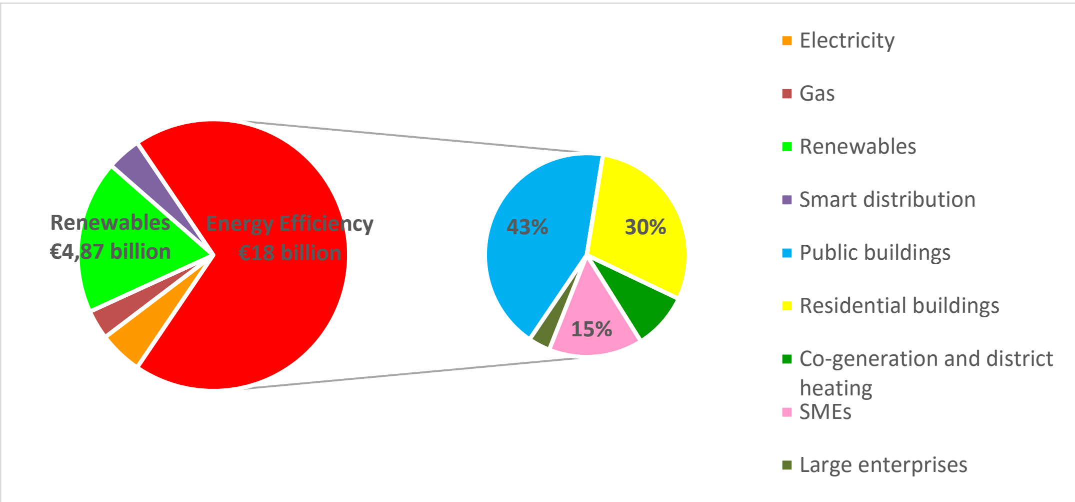
Economic instruments

Investment in energy efficiency projects was identified as one of the priority areas to strengthen Europe's competitiveness (EC, 2014-a). The EC has developed various instruments, combining the existing EU funds with those from the EIB and the European Bank for Reconstruction and Development (EBRD), to boost energy renovation investments. The main instruments targeting energy renovation are analysed below.

The Multi-annual financial framework

The Multiannual Financial Framework (MFF), (EC, 2013-b) and its implementing regulation is the EU instrument which sets ceilings on commitments by category of expenditures. Over the period 2014-2020, 7.6% of the European Structural and Investment Fund (ESIF) will be dedicated to investments in energy (electricity, gas, renewables and energy efficiency). Compared to the previous period, EU funds dedicated to energy efficiency have tripled reaching EUR 18 billion, which is equivalent to 69% of total ESIF dedicated to energy. Public buildings and residential ones will be the main beneficiary of EU support to energy efficiency (Figure 2.5) with more than EUR 13 billion dedicated to energy renovation; four times more than in the previous period.

Figure 2.5 Share of ESIF dedicated to energy efficiency per sector



Key point: Energy renovation is the main beneficiary of EU funds dedicated to energy efficiency for the period 2014-2020.

Source: own calculations based on DG REGIO data available at: http://ec.europa.eu/regional_policy/en/policy/evaluations/data-for-research/

Furthermore, the EC has conducted, in 2015, an ex-post evaluation of the use of ESIF over the period 2007-2013, as required by Article 10 of the EED. The evaluation showed that Member States with GDP per capita higher than the EU average benefitted for more than two-thirds of the available funding in the previous period. For the period 2014-2020, Member States with GDP per capita lower than the EU average will be prioritised with two-thirds of ESIF to be allocated to these countries.

During the previous period, a total of 129 mechanisms aiming to support energy efficiency in public and residential buildings were developed using ESIF, out of which more than two-thirds were grants (EC, 2015-e). The reasons behind the high share of grants include constraints on public authorities on loan commitments, cultural reluctance to accept loan commitments and the administrative complexity for national agencies (EC, 2015-e). For the period 2014-2020, funds will be distributed either as grants for investment and project development assistance or as loans, guarantees and equity.

The ex-post evaluation of ESIF over the period 2007-2013 has also revealed that project selection criteria were often loosely defined. The assessment of the effectiveness of EU funds in terms of energy and carbon savings has therefore been made difficult, if not impossible, as standardised criteria were not used for the assessment of the projects that applied for funding. There was also no standard reporting. The evaluation recommended the development of "off-the-shelf" templates for loans (EC, 2015-e). To address this weakness, the EC is considering **an ex-ante conditionality for the use of EU funds**. However, if the conditionality is based on the EPBD, as it states today, it is unlikely that it would lead to the transformation of the EU building stock to net zero energy consumption.

Moreover, the Investment Plan for Europe (Juncker Plan) considers the partial use of the European Fund for Strategic Investment (EFSI) for loans, equity and guarantees (EC, 2014-e). An EU guarantee of EUR 16 billion, combined with EUR 5 billion from EIB, is being created, with an expected leverage factor of 15 (EC, 2014-e). Some energy renovation projects have already benefitted and/or are under assessment to benefit from this guarantee. However, there is no guarantee specifically dedicated to energy renovation. Such a guarantee is needed to give a clear signal to investors and reduce the perceived risk of energy renovation investments.

In fact, energy renovation investments suffer from the assumption that energy savings do not last long and from the endless debate on the so-called rebound effect. Consequently, energy renovation investments are regarded as unattractive and high interest rates are considered when assessing the opportunity to invest in energy efficiency. **An EU guarantee specifically dedicated to energy renovation investments,** if well combined with energy performance contracting, would mitigate the financial and technical risks of energy renovation work, allow for de-risking energy renovation investments and attract more investors (JRC, 2015-a&b).

Besides, under the Horizon 2020 programme for secure, clean and efficient energy, EUR 5.931 million will be dedicated for non-nuclear energy research over the same period. Likewise, the existing EU funds under the European Energy Efficiency Fund (EEEF), the European Local Energy Assistance (ELENA), the Joint Assistance to Support projects in European regions (JASPERS) and the Environment and Climate Action Fund (LIFE) will all continue to support Member States/regional and local authorities in their capacity building efforts as well as project development assistance.

State Aid rules

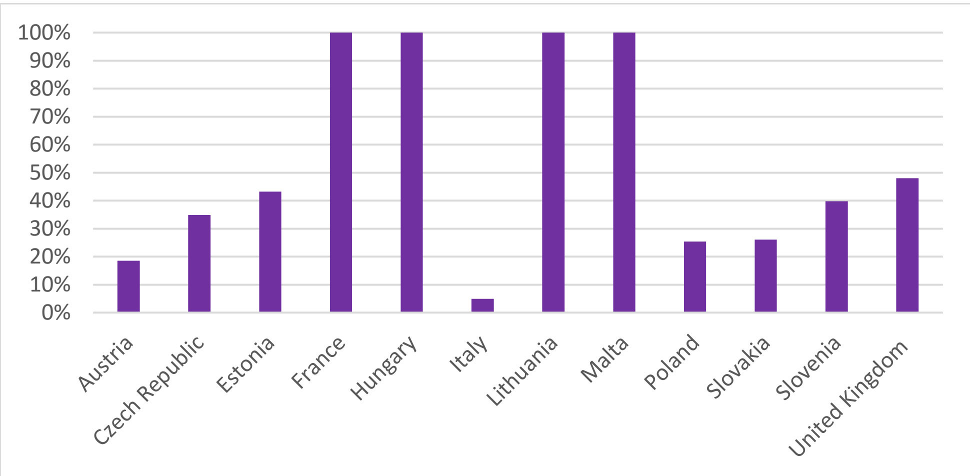
While various EU instruments are encouraging Member States to provide financial incentives for renovations through grants and other financial measures, one should not overlook the possibility that these measures very likely constitute state aid and cannot be implemented without prior approval from the EC. The conditions for granting such approval are laid down in the General Block Exemption Regulation (GBER) for smaller aid measures (EC, 2014-d), and in the Guidelines on State aid for environmental protection and energy (EEAG) for larger aid projects (EC, 2014-e).

The EEAG explicitly recognise that state aid might be necessary to support efficiency-related renovations in buildings (point 142 of EEAG). However, the amount of aid which may be granted by a Member State for an individual renovation project ranges between 30% and 50% of eligible costs. These eligible costs are defined as the extra-investment directly linked to energy efficiency improvement that must go beyond EU minimum energy requirements. This means that, even if other EU legislation requires Member States to provide financial incentives for the renovation of buildings, the effectiveness of this requirement might be undermined by the application of the state aid rules. **The EC should make sure that the revised State Aid rules do not hinder investments in energy renovation**.

Emission Trading Scheme

Provisions for carbon pricing are included in the ETS directives (EC, 2003 & 2009-a) that is meant to be one of the main instrument to finance the decarbonisation of the EU energy system. Member States are required under Article 17 of the MMR to report to the EC on the use of auctioning revenue and project credits. The template for reporting requires Member States to provide the amount of auctioning revenue used for each sector/decarbonisation measure. In practice, not all Member States provide details on the use of ETS revenues. Based on the data available, the share of auctioning revenues dedicated to energy renovation varied in 2014 from 100% (France, Hungary, Lithuania and Malta) to 5% in Italy (Figure 2.6).

Figure 2.6 Share of 2014 ETS revenues used for energy renovation in selected countries



Key point: France, Hungary, Lithuania and Malta used all their ETS revenues for energy renovation in 2014.

Source: Own calculations based on Member States reporting available on EEA reporting obligations database http://rod.eionet.europa.eu

Furthermore, given the oversupply of allowances during the ETS phase I, carbon prices went down and did not recover since the economic downturn. In the absence of an international agreement on carbon pricing, it is unlikely that carbon prices will go up significantly in the short-term in Europe. Therefore, given the current carbon pricing, the EU should not rely too much on ETS revenues to finance its energy transition and the renovation of its building stock.

Internal Market Regulations for Electricity and Gas

Provisions for electricity and gas pricing are included in the internal market regulations for electricity (EC, 2009-e) IME and gas (EC, 2009-f) IMG. Member States are required to develop "*innovative pricing formulas*" in order to promote energy efficiency measures. In practice, electricity and gas prices paid by the end-users include an energy tax. Member States report to EUROSTAT, on a bi-annual basis, the breakdown of their electricity and gas prices into three components; energy and supply, network costs, taxes and levies.

However, energy taxes considered by Member States for the lower energy consumption bands for both gas and electricity are higher than those considered for higher energy consumption bands[13] (see Annex II). This does not motivate households to save energy. Moreover, it makes low-income families more vulnerable which may in part explain the increase in the share of the EU population facing fuel poverty (see Chapter I). **Energy taxes should be higher for high energy consumption bands and lower for low energy consumption bands to stimulate energy savings and protect vulnerable consumers.**

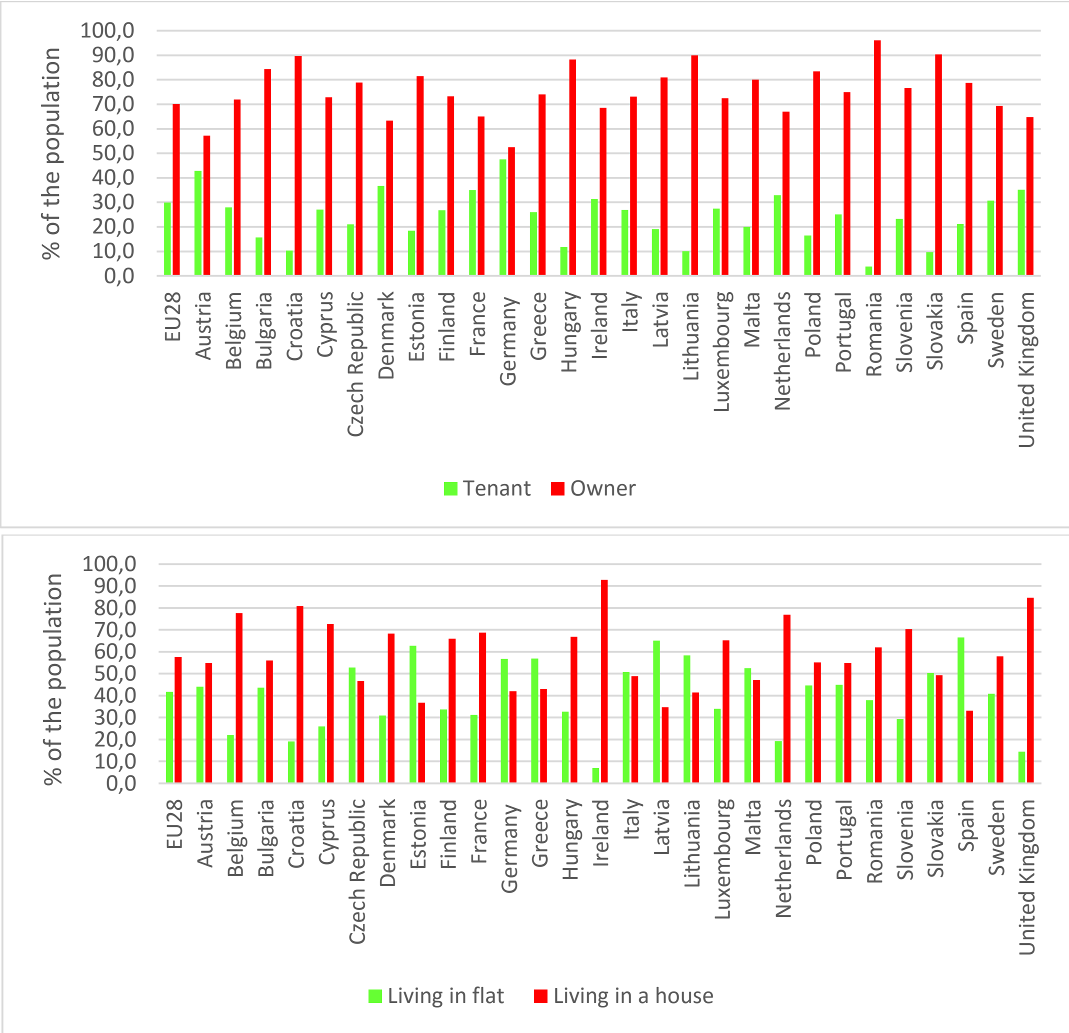
Energy Efficiency Directive

Under Article 20 of the EED, Member States are required to "*develop energy efficiency national funds, financing and technical support.* The *EC shall assist Member States directly or via the EU financial institutions in setting-up financial facilities and technical support schemes aiming at increasing energy efficiency investments".* Member States' reporting under Article 7 of the EED shows that seven Member States (Belgium, Estonia, France, Latvia, Romania, Slovenia, Spain) included in their alternative measures setting-up energy efficiency national funds (Ricardo, 2015). Information on the structure of these funds and their scope is not yet available. It is therefore not possible to assess the impact of these measures on the energy renovation market.

Under Article 19 of the EED, Member States are required to "*take appropriate measures to remove regulatory and non-regulatory barriers*." Split incentives between the owner and the tenant of a building or among owners is one of the barriers to energy renovation identified by the EED. The split-incentive became one of the major focal points of the EC in recent years while in practice 70% of the EU population lives in owner-occupied dwellings and almost 60% of the EU population lives in single family homes (JRC, 2015-a). Resources should not focus so much on the split incentives only but also address the renovation of small projects given the high share of owner-occupiers and single-family homes, especially in Member States with GDP per capita lower than the EU average (Figure 2.7). **Resources need to be dedicated to inventing appropriate mechanisms to bundle small projects together and building large-scale renovation projects**.

[13] The only exceptions are electricity taxes in Italy and Greece

Figure 2.7 Share of the population per tenant status and type of dwelling in 2014



Key point: Mechanisms to bundle small projects are needed to allow for energy renovation of single family homes and the high share of privately owned dwellings.

Source: EUROSTAT SILC database

Member States reporting under different provisions show that grants are the preferred instrument to finance energy renovation. The average cost of energy renovation in the EU ranges from €250/m^2 to €450/m^2 (JRC, 2015-a), by considering an average size of homes of 75 m^2, the average total energy renovation cost will range from €18,750 to €33,750 per home. It is clear that grants, which are usually less than €3,000, do not allow for financing the renovation of the overall building.

Energy renovation costs have to go down to make the renovation affordable for EU citizens without distinction of income. Currently, the cost of net zero energy renovation can be higher than the value of the house itself, especially in Member States with GDP per capita lower than the EU average (JRC, 2015-a). Industrialisation of energy renovation and large-scale renovation programmes are needed to lower energy renovation costs (see Annexe V). Overall, energy renovation needs to move from a costly component-based renovation financed by grants to an industrial and self-financed overall renovation (see Chapter III).

Accounting rules of governmental expenditures

Member States reporting on Article 5 of the EED showed that only few countries have opted for the renovation of their public buildings. The budgetary pressure on governments resulting from the Stability and Growth Pact (EC, 1997) and the EC interpretation of *International Financial Reporting Standards* (IFRS), recently confirmed by EUROSTAT guidance on the impacts of energy performance contracts on governments accounts (EC, 2015-b), do not encourage governments to invest in the renovation of buildings they own and occupy.

Energy renovation investments require capital budget to cover their costs despite being delivered and financed wholly or in part by private sector partners. Energy renovation investments are, therefore, recorded by the current accounting rules as being on balance sheet and counted towards public sector debt. The **current accounting rules should be reviewing and consider energy renovation investments as an asset investment recognising the cash savings resulting from energy renovation investments**. **Energy renovation investments should be considered a productive debt and classified off balance sheet.** This would allow for private-public partnerships to engage in a long-term energy renovation of public buildings by using energy performance contracting.

The way forward

An important progress has been made in reporting on various measures and instruments developed at national level and EU funding dedicated to energy renovation has increased. However, progress in reporting does not mean progress towards the decarbonisation of the EU building stock by 2050, the over reliance on grants provides evidence that net zero energy renovation is not privileged and the scale of the challenge requires a high leverage factor of EU funds.

The fragmentation of the provisions among EU instruments with various timeframes for reporting lead to inconsistencies and incoherencies. Moreover, the fragmentation of the EU funds among different institutions makes very often the combination of existing funds complex if not impossible, especially for Member States lacking technical capacity. A risk sharing facility, which would bundle existing EU funds, would facilitate the access to EU funds and give more confidence to investors.

Overall, a coherent and streamlined policy framework with a clear target of transforming the EU building stock, from being an energy waster to being highly energy efficient and energy producer, leading to net zero energy consumption, is needed to trigger a self-sustained energy renovation market. This in turn would unleash the 4th industrial revolution which would drive growth, create jobs foster innovation and enhance the competitiveness of EU industry. Such a framework is proposed in the following Chapter.

Chapter III: Making the whole greater than the sum of the parts

Highlights

- *Efficiency First* policy framework combining the existing EU investment framework with the existing EU climate-energy framework is needed to ensure that the modernisation and energy transition of the EU building stock occurs in a timely manner. The framework should aim at unleashing the 4th industrial revolution in the EU by industrialising energy renovation and creating a self-financed energy renovation market.
- A legally binding 2050 carbon and energy savings target for buildings should be set to give a clear signal to investors and industry. The ambition level of the target should be aligned with the EU priorities in terms of jobs, growth, the ambition level of the Energy Union Strategy Framework and in light of the Paris Climate commitment.
- An evolution towards comprehensive, coherent and streamlined investment-climate-energy overarching policy framework for buildings should be immediately initiated to support the implementation of the *Efficiency First* principle. Such an approach should include the existing provisions that are currently fragmented across at least 14 EU policy instruments. It should provide for streamlined reporting and aim at simplifying implementation at Member State level.
- The upcoming EU governance is a unique opportunity to consider new administrative arrangements for energy efficiency including an EU Energy Renovation Facilitator and an EU Risk Sharing Facility:
    - The role of the EU Energy Renovation Facilitator consists in identifying the risks, ensuring they are assigned to appropriate organisations and sharing mitigation options among risk owners. The facilitator should not be a risk owner to avoid conflicting priorities in the identification of the risks and the mitigation options. The energy renovation facilitator should be independent from existing structures. At EU level, the facilitator should report to a board composed of the President of the European Parliament, the President of the European Commission and the President of the European Council. Similar facilitators could be established at national and/or local level as appropriate.
    - The EU risk sharing facility would provide loan guarantees either directly to projects or through national banks and provide finance for capacity building and knowledge sharing across Member States. Existing EU funding, including those considered for the Juncker Investment Plan could be bundled to establish such a facility.
- The *Efficiency First* framework for buildings will foster technological innovation. Governmental support would be needed to invest in research and development of zero energy renovation kits per building type, climate zone and construction period. These kits should aim at reducing the environmental footprint of buildings and consider the integration of buildings to the EU energy system by producing energy, the improvement of their energy performance and the control and maintenance, over time, of their technical systems.
- To close the current data gap, data gathered by smart meters should be combined with geo-location models based on Geographical Information Systems (GIS). Investing in modern data sharing platforms will improve the quality of the data and facilitate access to data.
- The industrialisation of energy renovation is an opportunity for SMEs to upgrade facilities and reshape skills. Public support would be needed to ensure SMEs benefit from this transformation.

Chapter I presented an estimate of the current EU energy renovation market. It showed that if a 40% energy savings target is adopted for 2030 at EU level, the size of the EU renovation market could increase by almost half of the current energy renovation market.
Chapter II identified existing loopholes in current EU legislation that addresses the reduction of energy consumption and GHG emissions of the EU building stock. The analysis was conducted with the objective of increasing the size of the EU energy renovation market in mind.

As a challenge to current practice, this Chapter is forward-looking. It proposes a paradigm shift in the vision of energy renovation from the current grant-financed component renovation to an industrialised and self-financed holistic energy renovation. To kick-start the design of the proposed framework, loopholes identified in current legislation need to be addressed as part of the ongoing review/revision process. The proposal in this Chapter suggests making energy renovation an EU industrial project aiming to drive growth, create jobs and enhance the competitiveness of EU industry. The pathway towards the industrialisation of energy renovation is inspired by successful and competitive EU industries.

This long-term investment-climate-energy policy framework is proposed to support the industrialisation of zero energy renovation level across the EU. The proposed framework combines the OECD green investment policy framework for low-carbon and resilient infrastructure (OECD, 2012) and the existing integrated framework for Enterprise Risk Management (ERM). The proposal relies on the EU priorities in terms of jobs, growth and competitiveness as well as the ambition level introduced by the Paris Climate Agreement (UNFCCC, 2015) and the Efficiency First principle called for by the Energy Union Framework Strategy (EC, 2015-a). The aim is to unleash the 4th industrial revolution in Europe.

The Paris Climate Agreement (UNFCCC, 2015) confirmed the forward-looking vision of the Energy Union Strategy Framework proposed by the EC (EC, 2015-a). This vision is based on the *Efficiency First principle* which aims to ensure that *energy savings compete on equal terms with generation capacity*. The combined Paris Climate Agreement and the Energy Union Strategy Framework creates a unique leapfrogging opportunity to shift the EU from expenditures on energy imports to heat buildings to asset investments in net zero energy renovation programmes.

The challenge is to integrate EU climate and energy goals into the EU investment framework that aims to enhance the competitiveness of Europe. The first step towards this integration is to consider EU climate and energy policies in the broader context of the EU priorities on jobs, growth, fairness and democratic change (EC, 2014-a). The budgetary constraints (EC, 1997) and the scale of the investment needed to transform the EU building stock, from being an energy waster to being highly energy efficient and energy producer, leading to net zero energy consumption, require large scale private sector engagement. A stable and consistent regulatory framework is, therefore, needed to underpin the confidence of the private sector in the scaling-up of the energy renovation market.

The following sections discuss, from an industrialisation perspective, the components that must be considered for the emergence of an integrated investment and climate-energy framework. The aim is to improve current enabling conditions targeting the modernisation and energy transition of the EU building stock and to scale-up private sector investments in net zero energy renovation programmes. The framework is based on the assumption that existing loopholes identified in the current provisions would be addressed as part of the 2016 review/revision of the EU climate and energy policy instruments currently being undertaken by the EC.

The OECD green investment policy framework for low-carbon and climate resilient infrastructure

The OECD green investment policy framework for low-carbon and resilient infrastructure is an integrated framework for domestic investment and climate change policies. The framework is guided by the assumption that climate change policies, to be effectively implemented, need to be considered in the broader national policy context, one that has the enabling environment for investment at its centre (OECD, 2012).

The challenge is to combine the policy objectives of an investment framework with those of a climate change framework. Policy objectives of an investment framework include increasing private investment to support economic development and enhance well-being. Transparency, policy coherence, protection of intellectual property rights and non-discrimination are the guiding principles of investment policies. The climate change policy framework aims to limit global warming to well below 2°C. Such a framework is guided by predictability, stability, cost-effectiveness, policy coherence, innovation, mechanisms to address market barriers, monitoring and evaluation.

The OECD has identified five elements for governments to consider when designing an integrated green investment policy framework aiming to decarbonise infrastructure (Figure 3.1). These elements include:

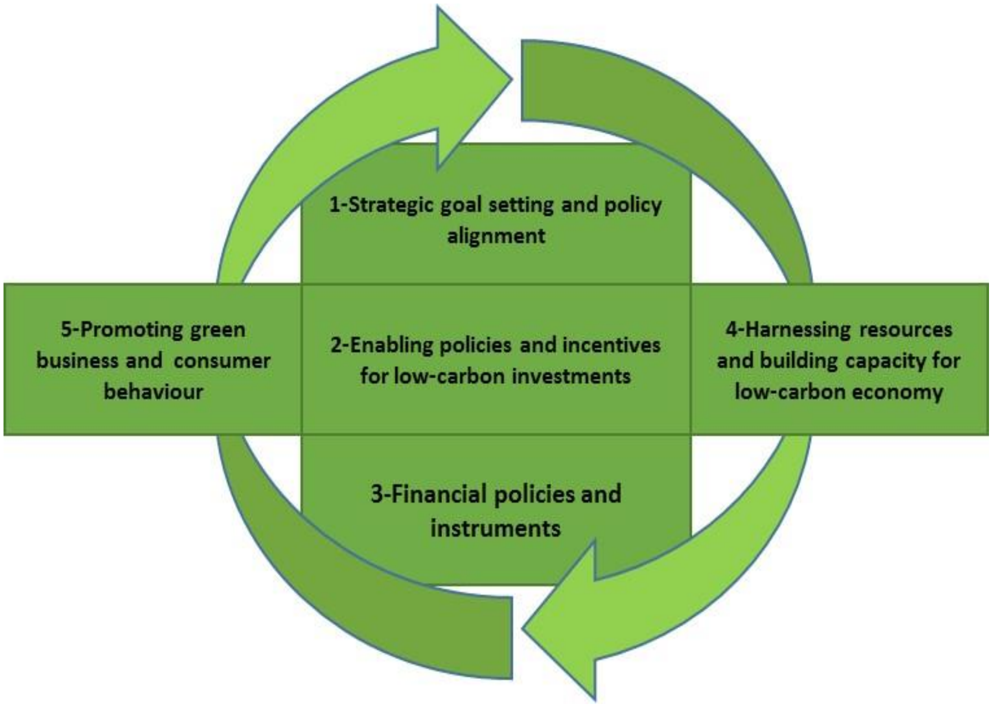
1. **Strategic goal setting and policy alignment**: a legally binding framework for achieving decarbonisation would build confidence in new markets for green technologies and infrastructure, by ensuring continuity of investment regardless of political change. This requires aligning investment and climate policy timescales as much as possible. Policy alignment includes aligning incentives with policy objectives and engaging stakeholders in goal setting at different levels of governance.
2. **Enabling policies and incentives for low-carbon investments:** Policies to enable investments are not specific to climate change. They include transparency, non-discrimination, policy coherence and protection of intellectual property rights. Disclosing information, including information related to the performance of investments in decarbonisation, is key to investment decisions. Regulatory and other policies such as information instruments can help to stimulate markets for decarbonisation and remove barriers to investments.
3. **Financial policies and instruments:** The scale of investments needed to achieve low-carbon infrastructure requires using public finance strategically to leverage and attract private capital. Innovative financial instruments such as credit lines and loan guarantees are necessary to address the perceived risks by investors. Improved contract design of public-private partnerships would allow for better sharing the risks between public and private sectors. This in turn will increase investments in publicly owned infrastructure, especially in the context of limited public

budgets. Another important aspect of financial policies is to define clear eligibility criteria and pre-announced timelines, including for the phasing out of financial incentives.

4. **Harnessing resources and building capacity for a low-carbon economy:** Technological innovation is an important element of the transition to a low-carbon infrastructure. Governmental support is needed to foster innovation. This in turn will lower the overall cost of decarbonisation. Education, training, skills upgrade and building capacity for assessment, monitoring and enforcement are other areas that require governmental intervention.

5. **Promoting green business and consumer behaviour:** Sharing knowledge, raising awareness of businesses and consumers will streamline the processes of enabling behavioural change towards a low-carbon economy and infrastructure.

Figure 3.1 The five pillars of the OECD green investment policy framework



Key point: A comprehensive investment-climate change framework is needed to decarbonise infrastructure

Source: Towards a green investment policy framework for low-carbon and climate resilient infrastructure, (OECD, 2012)

Integrated Framework for Enterprise Risk Management (ERM)

Risk management is a common practice in industry, at least since the 1950's in OECD countries. For a long time, dealing with risks was based on tactical analysis of each risk individually. This approach leads, very often, to sub-optimal risk management. In other words, an optimal risk mitigation decision for one business unit might well be sub-optimal for the overall organisation.

In 1988, a modern approach to risk mitigation in industry was introduced. The new approach, known as Enterprise Risk Management (ERM), is based on a holistic view of risks. ERM argues that an organisation should manage enterprise risks in a single and comprehensive programme to take into account the interrelations between risks and optimising their overall mitigation (Hampton, 2009 & COSO, 2004).

The ERM approach permits the identification of major risks that an organisation and/or a project may face. It also allows for forecasting risks and their impacts on the business processes and/or the success of a project. Last but not least, an ERM approach allows risks to be addressed in a systematic and coordinated plan, leading to an effective implementation of the plan, and for holding key individuals/units/organisations responsible for managing risks within the scope of their responsibilities.

Literature (Hampton, 2009 & COSO, 2004) identifies seven elements to consider when designing an ERM. These elements include:

1. **Recognising the Upside of risk:** ERM incorporates risk opportunity. It acknowledges the interaction between risks and considers that an exposure does not occur in isolation. Each risk affects other risks.

2. **Identifying Risk Owners:** ERM assigns a risk-owner to each category of risk. Each single entity/individual has an identified single risk. The risk owner is selected based on his knowledge, experience and capacity to establish real ownership of the risk.

3. **Aligning Risk Accountability:** ERM aligns responsibility and accountability for risk management with the business model of the risk owner. To ensure risk alignment will work smoothly, risk categories need to be aligned with risk owners.

4. **Creating a Central Risk Function (CRF):** ERM recommends creating a Central Risk Function. This is a separate unit/organisation. The CRF should not manage any risk, its role should be limited to the identification of risks that might otherwise be missed and to facilitate discussions on risks among risk owners. The CRF is instrumental in reducing the effect of the “silo” culture.

5. **Creating an ERM Knowledge Warehouse**: ERM requires a risk management support tool to share identified risks and recognise the scope of each exposure. Over time, this tool becomes a repository to show how risks are evaluated and mitigated as well as a tool that exposes the relationships between different risks.

6. **Involving high level management:** The CRF should report directly to the highest managerial level to reduce delays and ensure coherence with the overall strategy.

7. **Using a Standard Risk Evaluation process:** Using a standard process for the evaluation of risks mitigation by each risk owner allows for knowledge sharing on risk mitigation options across the organisation/project.

The elements of the integrated ERM framework summarised above have been translated by business schools into specific programmes, easy to use and adaptable by each industry. Innovative industries use these programmes when developing new products/solutions. It allows them to better mitigate risks related to the development, marketing and operations of the new product/solution.

The EU can take inspiration from this advanced approach in the design of a coherent, streamlined policy framework for the buildings sector and the governance needed to its effective implementation. Leadership is needed to show the way and the forthcoming revision to energy efficiency legislation as well as the upcoming governance proposal should be exploited in order to take the first steps.

Efficiency First policy framework proposal for the building sector

The current energy renovation market, identified in Chapter I, is a component-based renovation market largely financed by grants which combine EU and national funds. The component approach to energy renovation reflects well the fragmentation of the provisions in the EU instruments aiming to reduce buildings' energy consumption and their GHG emissions as described in Chapter II. These instruments are designed and managed by various EC services, with sometimes conflicting priorities (e.g. impact of austerity measures on energy renovation described in Chapter II). Furthermore, in the absence of an energy renovation industry, these instruments address different segments of the industry with, very often, conflicting interests. The fragmentation of EC services, the industry and EU policy instruments (Figure 3.2) in charge of delivering energy renovation makes the alignment of stakeholders towards ambitious energy renovation strategies challenging (Box 3.1).

Box 3.1 The BUILD UPON Project - Exploring stakeholders' alignment towards ambitious energy renovation strategies

The BUILD UPON project aims at identifying which organisations need to work together to design and implement ambitious building renovation strategies over the long-term. The project proposes a series of dynamic stakeholder maps at both EU and Member States levels. The objective is to explore how stakeholders' alignment can be dynamically tracked over time to scale-up the energy renovation market. This is based on the observation that stakeholders are insufficiently aligned and therefore 'network health' (degree of alignment and consequent impact) is a critical condition to track and improve in a more systematic way.

The maps are built by grouping stakeholders into twelve colour-coded categories, aimed at capturing the main groups and major dynamics that influence outcomes for the renovation strategies. Where stakeholders may be significantly different in nature (e.g. architects and manufacturers) but broadly represent the same system dynamic (i.e. both 'supply' retrofit solutions to the market in some way) they are grouped together in a category (in this example, 'construction businesses').

Based on a numerical scoring system, the maps provide a visualisation of:

- Each stakeholder's relative potential to influence positive outcomes for the national renovation strategy. The aim is to explore "systems influence", moving away from "political influence" to look at which actors have the power to influence real outcomes on the ground, based on organisational factors such as the size of the network, and research on the role of different actors on system dynamics.
- How aligned are the stakeholders in support of the national renovation strategies/ambitious renovation? The maps contain perspective bias, as clear common objectives have not been agreed within the strategies, although various category experts have been consulted on the data in the maps to build a more objective picture.

Each of the stakeholder maps is paired with a similar initiative mapping tool: the 'RenoWiki', which maps building renovation initiatives run by key stakeholder organisations across the public, private and tertiary sectors.

These are mapped across the following categories, which are a high level summary of the detailed market barriers (and consequent key areas of action) across the BUILD UPON markets:

1. Awareness Raising Initiatives (e.g. Campaigns, EPCs)
2. Skills & Capacity Building Initiatives (e.g. Training Courses)
3. Financial & Economic Initiatives (e.g. Subsidies, Loans, Tax Breaks)
4. Policy & Regulatory Initiatives
5. Organisational & Administrative Initiatives (e.g. Databases of EPCs / Accredited Energy Assessors)

Over 750 initiatives have been identified and mapped in the RenoWiki. These initiatives aim at supporting the building renovation market in some way across the 13 countries represented in the BUILD UPON project. They are likely to represent only a portion of the full number of existing initiatives.

Analysis of the initiatives shows that despite the very considerable amount of resource going into scaling the market for building renovation:

- very few initiatives actually track their impact or make such impact data readily available;
- almost all initiatives that track their impact do this in entirely different ways. Whilst different impact indicators are necessary to track progress against differing specific objectives, no systemic consideration is given to use a selected number of "common" impact indicators across initiatives to encourage alignment.

This failure to link the incremental impacts of single initiatives, with interim targets across key areas of action and with the overall market targets at the EU and Member States policy level means there is no overall coherence to the renovation market or the resources going into growing it. The absence of real impact data also means any attempts to measure real progress year by year in relation to levels of awareness and demand, capacity of the workforce, financial flow etc… are currently theoretical.

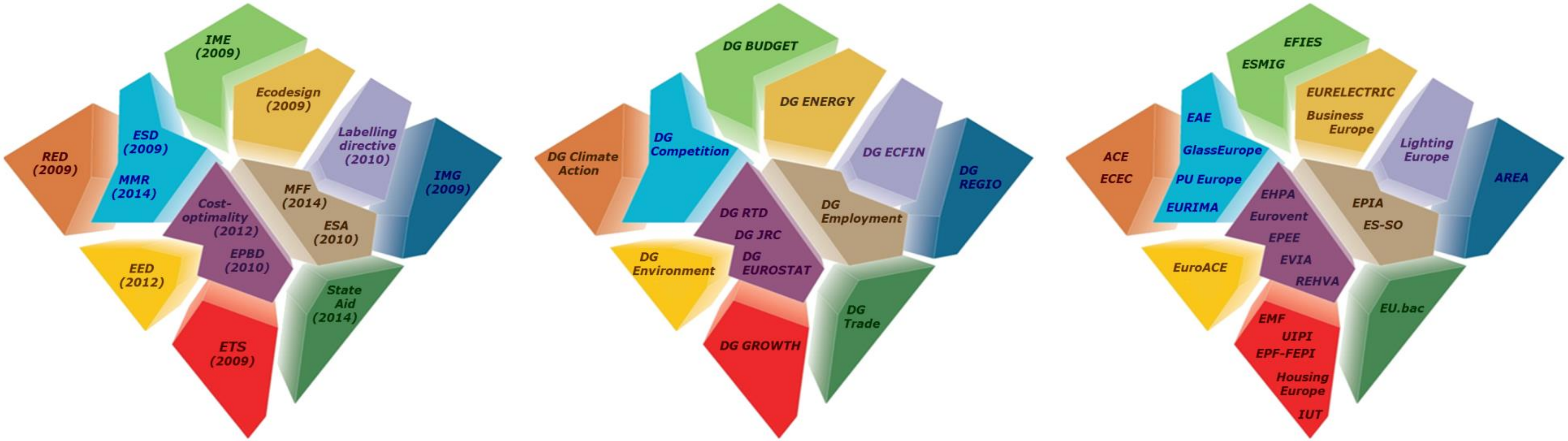
If the goals of the Paris Climate Agreement are to be implemented, national renovation strategies with well-coordinated public policies are likely to be insufficient. Instead, coordinating across all actions aimed at tackling market barriers and scaling the rate and depth of renovation (public, private and civil society), will need to be the real objective of national renovation strategies.

Source: Private communication with James Drinkwater (Build-Upon project)

It can be argued that the ambition level of the Energy Union Strategy Framework (EC, 2015-a), the Paris Climate Agreement (UNFCCC, 2015) and the emerging industrial competition from the non-OECD countries make it compulsory for the EU and its Member States to move from the traditional component based energy renovation to a modern and industrialised one. To get there, disruptive models will have to emerge that incite change in the construction sector as a whole. The three levels of fragmentation identified below (Figure 3.2), need to be tackled as their combination hinders the realisation of the potential of the paradigm shift needed to industrialise energy renovation.

The pathway towards the industrialisation of energy renovation will need different policy and investment settings. The OECD green investment policy framework for low-carbon and resilient infrastructure could serve as a basis for the design of this framework. Furthermore, the industrialisation of energy renovation should be considered as an industrial project which would unleash the 4th industrial revolution in Europe. The integrated framework for ERM could be used to identify the risks such a project may face. The aim is to ensure their mitigation is optimised. The combination of these two frameworks with the aim of industrialising energy renovation would translate to the following elements if an *Efficiency First* investment-climate-energy policy framework for the building sector is put in place.

Figure 3.2 The three levels of fragmentation (policy instruments, EC services and industry)



a-EU instruments b-EC services C-industry and buildings' organisations

Key point: The fragmentation of EC services, industry and EU instruments hinders the industrialisation of energy renovation.

Setting a binding 2050 carbon and energy savings target for the EU building stock in light of the Paris Climate Agreement

Setting a binding target for buildings is one of the principles introduced by the President of the EC, Jean-Claude Juncker, in his political statement for Europe (EC, 2014-a). A legally binding 2050 carbon and energy savings targets for buildings, firmly based on the *Efficiency First* principle, would create the necessary confidence needed among investors and ensure continuity of investments regardless of political change. A binding 2050 carbon and energy savings target for buildings, with milestones, would remove the uncertainties about the policy and regulatory frameworks which affect business opportunities and increase the perceived risks.

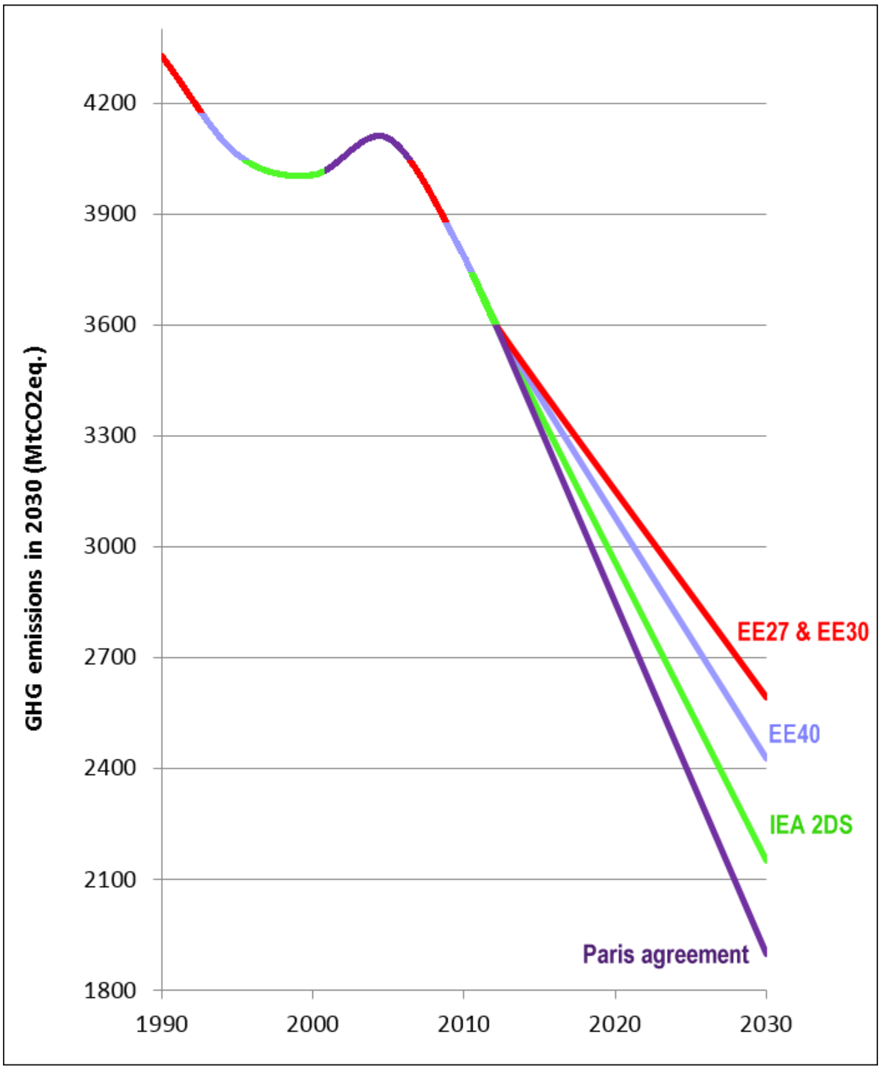
The conditions needed to ensure that aggregate GHG emissions pathways are "*consistent with holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit temperature increase to 1.5°C*" as stated in the Paris Climate Agreement, are not yet known. However, it is likely that meeting the Paris climate commitment will lead to global emissions below the current IEA emissions' estimates for a 2°C scenario. Based on this assumption, the EU 2030 emissions are compared, for the purpose of this report, to the current IEA emissions' estimates for the EU contribution to keep global warming at 2°C.

It must be noted, however, that the modelling methodologies and the assumptions behind the IEA and the EU models are not fully comparable, this first attempt to align EU carbon savings with the Paris Climate Agreement shows that, almost certainly, an extra effort will be required for the EU to be on the Paris Climate Agreement path (Figure 3.3). An EU level, 40% energy savings target for 2030 would lead to 11% more emissions than the IEA emissions' for Europe in the two degrees scenario (2DS). Therefore, this level of ambition should be the basis to consider if an energy savings target for buildings is to be set.

Furthermore, the 40% energy savings target, with renovation rates close to 3%, is also the lowest target that would drive the large-scale energy renovation programmes needed to trigger private investments. It would ensure a sufficient volume of buildings to be renovated each year (see chapter II). This would support the industrialisation strategy of energy renovation with the aim to ensure the energy transition of the EU building stock from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption.

Moreover, an ambitious energy savings target would reduce risks of climate change and their associated costs. This would limit the cumulative CO_2 emissions in the atmosphere and reduce the long-term decarbonisation costs. Inertia and low ambition may provide some benefits for some market actors in the short-term but certainly not in the longer one and for the overall society (IPCC, 2014).

Figure 3.3 Emissions gap between the current EU climate targets and the Paris Climate commitment



Key point: The proposed binding carbon and energy savings target for buildings needs to be aligned with the Paris Climate Agreement.

Source:
EE27, EE30 & EE40: Impact assessment on energy efficiency and its contribution to energy security (EC, 2014-b)
IEA 2DS: Energy Technology Perspectives (IEA, 2016)
Paris agreement: own estimate

Designing a streamlined and coherent investment-climate-energy overarching policy framework for buildings to set enabling conditions for achieving the binding 2050 carbon and energy savings targets

Designing an overarching investment-climate-energy policy framework for buildings would ensure coherence between the existing provisions aiming to reduce buildings' energy consumption and their related GHG emissions and those of investment policies. This overarching policy framework should be firmly based on the Efficiency First principle and include the 2050 binding energy and carbon savings target with agreed milestones. Such an instrument would streamline reporting and simplify implementation at the Member State level (Wyns, 2016). It would give investors and industry a clear signal about the path towards the modernisation and the energy transition of the EU building stock. Having a clear trajectory would in turn facilitate stakeholders' alignment.

De-risking energy renovation investments

The scale of investments needed to ensure the energy transition of the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, requires strategic use of public funding to leverage private capital. The deployment of private finance in energy renovation requires mitigation of the perceived financial risks of such investments. In addition to the long-term vision to 2050, an EU risk sharing facility which would provide loan guarantees, either directly to the projects or through national banks, should be introduced as this would reduce the financial risk through a first loss guarantee. Existing EU funding, including those considered for the Juncker Investment Plan could be bundled to establish such a facility.

Setting new governance structure at the EU level

The industrialisation of energy renovation would require that the risks related to the project or programme are carefully assessed like innovative industries do for any new product or service that they develop. The ERM framework recommends the creation of a Central Risk Function to facilitate the implementation of the project. The aim is to identify the risks, help in the categorisation of risks and their assignment to the most appropriate organisations to be risk owners. The facilitator should be independent from the existing EU structures. Strategic decisions should be taken by the board of the facilitator which should be composed of the President of the European Parliament, the President of the European Commission and the President of the European Council. It is expected that the “silo” culture would be reduced if such a facilitator role is established. Similar facilitators could be established at national/regional/local levels as appropriate.

The Energy Renovation Facilitator and the Risk Sharing Facility will set the ground for a new governance structure for the industrialisation of energy renovation. ERM programmes used by innovative industries could be adapted to ensure that all the risks that the project or programme may face are taken into account (Box 3.2). The up-coming EC governance proposal of the Energy Union is a unique opportunity to consider the new administrative arrangements needed for the transition of the EU building stock.

Box 3.2 Adapting the AIRBUS risk management tool to the industrialisation of energy renovation

To manage the development, marketing and operations of the AIRBUS A380, the company implemented a key risk management initiative, known as the Power 8 programme.

The first step of the Power8 programme is to identify the risks and group them by categories. Each risk category is assigned to a specific structure. If needed, new structures are established. The structures are grouped in a business model which ensures that there is no overlap between the mandates of the structures and that financial and human resources are secured for each structure.

The management of risks related to the A380 project based on the Power8 programme has resulted in establishing:

i. An Airbus A380 company to lead the project which played the role of a Central Risk Function;
ii. An A380 aircraft structure for setting-up an efficient aircraft production, integrating the complex supply chain, and improving and streamlining the assembly of the giant plane when mass production begins;
iii. An A 380 financial operations structure to manage the financial risk, handle cash and manage cash

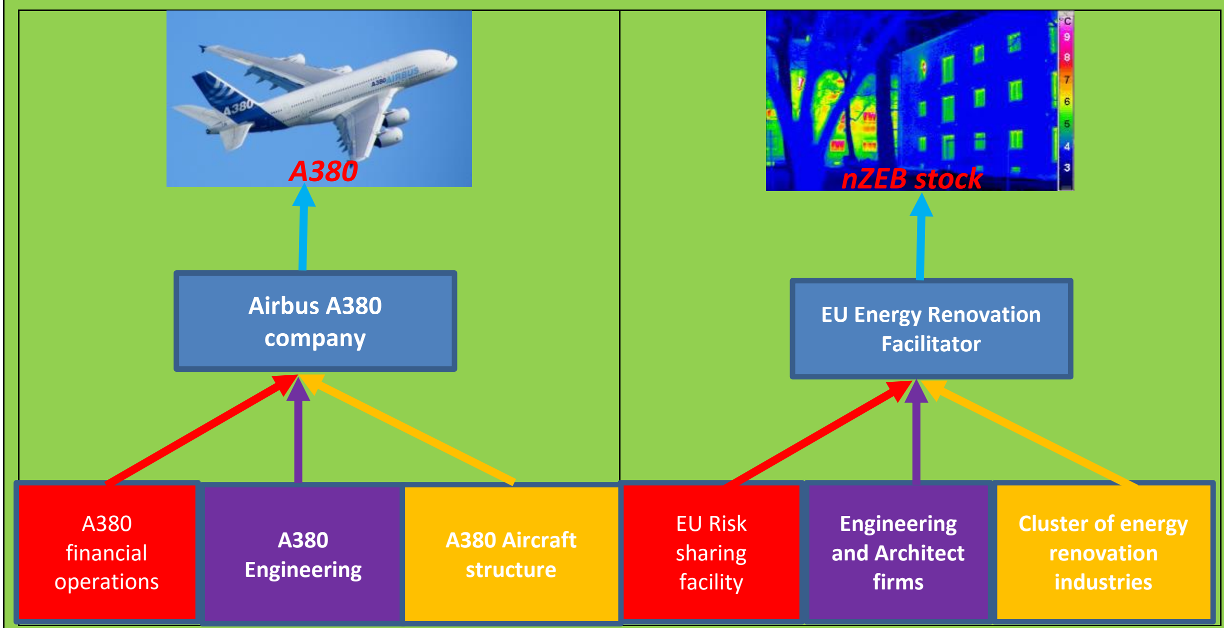
flow as well as shortening the development time to full production, and solving problems in manufacturing and operations;

iv. An A380 engineering structure to manage technical risks and ensure the supply chain deliveries are of high quality.

An early attempt to identify risks related to the industrialisation of energy renovation using the Power8 program as inspiration would lead to the establishment of the following structures:

i. An EU energy renovation facilitator;
ii. An EU risk sharing facility;
iii. A pool of engineering and architecture firms;
iv. An aggregator of supply chain.

Figure 3.4 Analogy between A380 and the industrialisation of energy renovation to deliver net zero energy building stock by 2050



Key point: The energy transition of the EU building stock could be another successful EU industrial adventure.

Source: Interviews and Fundamentals of Enterprise Risk Management -How Top companies assess risk, manage exposure, and seize opportunity. John. H. Hampton, 2010.

Harnessing resources and building capacity

The energy transition of the EU building stock, from being an energy waster today to being a highly energy efficient and energy producer leading to net zero energy consumption, will lead to innovation along the overall value-chain of the building sector from the design of renovation solutions to the operation of buildings and their interoperability with the EU energy system (WEF, 2016). The sections below describe three major areas of innovation, which require particular attention by all market actors. The identified areas are interlinked and need to be developed all together.

Industrialisation of zero energy renovation kits

The energy renovation market identified in Chapter I is a largely component-based energy renovation market, usually implemented step by step, often with long delivery times and high costs.

The energy transition of the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, requires moving away from current practices. One promising approach that is currently emerging is a shift to industrialised energy renovation kits that allow for the renovation of the full building in one step. These kits generally allow for the renewal of the external envelope and the renewal of the heating, cooling and ventilation equipment, including new easy-to-operate controls. The industrialisation of zero energy renovation kits can boost the productivity of renovation projects. It will also significantly reduce delivery and times and disruption to occupants. The standardisation of the elements and components included in such kits holds the potential to reduce the overall cost of energy renovation. It should provide greater certainty over outcomes while reducing maintenance for the end-users over the life of the building. Industrialisation would also enable better sequencing in the renovation process (WEF, 2016).

Pilot projects such as Energiesprong in The Netherlands have developed such kits for the Dutch social housing built after 1945 and before the implementation of energy codes for buildings in the country (see Annex V). The approach used in The Netherlands emerged from a government-funded effort that led to the emergence of industrialised net zero energy renovation. Similar pilot projects are being launched, with EU support, in France and the United Kingdom. This technological transformation has led to the emergence of new actors such as aggregators of different components. These aggregators ensure that high quality net zero energy renovation kits are delivered.

The development of similar zero energy renovation kits for each building type, each construction period and each climate zone in the EU could give a significant boost, in many Member States, to the energy renovation market (JRC, 2015-a). Investments in research, development, installation and monitoring of these kits will be needed. EU funding, especially those dedicated to the Horizon 2020 programme, could play an important role in this technological transformation by providing support to large scale development of these kits and to the sharing of knowledge and lessons learned from their implementation and use.

Zero energy renovation kits are an opportunity to use emerging solutions in the building material industry. These solutions range from incremental innovation of traditional materials and existing characteristics to the generation of new material combinations with additional multifunctional characteristics to radically innovative materials with entirely new functionalities and the integration of mechanical, electrical and plumbing systems. Many innovative solutions have been applied at small-scale in a few countries (see Annex V). The energy transition of the overall EU building stock is an opportunity for large-scale applications of already existing innovative solutions and/or better adaptation of current technological developments.

Zero energy renovation kits should be developed with optimised whole life cycle costs and incorporating principles of sustainability. Given the scarcity of natural resources and the high societal cost of externalities (e.g. air pollution, GHG emissions) circularity principles and design need to be considered. A more efficient use and recycling of raw materials would reduce the amount of waste usually produced by the construction industry. Overall, incorporating principles of sustainability, when producing zero energy renovation kits, will create opportunities for new jobs which would meet the objectives of the circular economy package (EC, 2016-b).

The development of these zero energy renovation kits will lead to new ways of working for industry. Companies will have to enhance coordination and cooperation across the value chain and jointly define standards and have aligned goals. The use of “lean” principles and methods could reduce completion times and costs. This will be a fundamental change in the construction industry which will enhance its modernisation.

Integration of buildings in to the EU energy system

The energy transition of the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, will definitely enable buildings to play a positive role in the EU energy system. In fact, this transition would lead to an increased production of energy savings, which is projected to be the first fuel of Europe in 2030 (JRC, 2015-b), and to some extent of renewable energy by buildings. The more energy efficient the EU building stock will be, the more important will the role of energy savings and renewables be in the EU energy mix and consequently the role of buildings in the EU energy system.

The increased share of renovated buildings to the net zero energy consumption level, the roll-out of smart meters and the increased penetration of heat pumps will facilitate the implementation of demand-response strategies. Reduced demand from buildings will translate into reductions in system peaks, thus a reduction in generation and grid infrastructure investments as the amount of energy to import, produce, transport and distribute energy will be reduced (ECOFYS, 2015-b). Furthermore, highly energy efficient buildings will allow for storage of heat and cold in the building mass, especially if phase-change materials are considered when developing the zero energy renovation kits. Consequently, heat and cold storage will allow district heating and cooling systems to avoid running at peak-load. Buildings will, in the near future, take up an active role in the energy system, shaping their role as micro energy hubs and unlocking the opportunities to offer new and tailored services (BPIE, 2016).

New market actors, outside the traditional building value-chain, are already offering new products and services to better manage energy consumption and energy production of new buildings. These new players in the building sector include the ICT sector (e.g. Google), the utility sector (e.g. E.on) and electric vehicle manufacturers (e.g. Tesla). Additional new actors are expected to appear in the near future. The increased efficiency and penetration of smart appliances and equipment connected to smart grids will allow for more energy savings. Timers and controls will determine the best time slots to consume energy. Appliances will be automatically turned off at peak load when energy prices are high to allow consumers to sell their energy production at high prices. Over time, EU citizens, who will enjoy increased comfort and efficiency in their living spaces, will also have a full control of their energy expenditures and will, in effect, become “prosumers”.

Digitalisation of the EU building stock

The development and deployment of digital technologies and processes will play a major role in the energy transition of the EU building stock to net zero energy consumption. Digital technologies will enable new functionalities along the entire value-chain, from the early data gathering phase to the integration and interoperability of buildings with the EU energy system. Digital technologies will help architects and designers to facilitate the adoption (or enhance the application) of many other innovations, such as industrialisation of renovation kits, automation and 3D printing, and should help in optimising the overall energy renovation process.

The integration of field data from Geographical Information Systems (GIS), drones and laser scans, combined with robotics and 3D printing will allow for analytics-optimised design, model input to simulation and rapid prototyping and performance analysis. This will certainly have a fundamental impact on the construction industry. Digital technologies will not only reduce project delays, but they will also enable the production of purpose-built shapes that cannot be produced by other methods. Productivity gains of up to 80% can be achieved for some applications, together with an important reduction of waste (WEF, 2016). Renovation time will be shrunk from weeks to days and customised components will be provided at much lower cost (WEF, 2016).

During the installation phase of net zero energy renovation kits, digitalisation will allow for real-time data sharing, better integration and coordination. Industry is already using drones and embedded sensors to enable real-time communication and to track machines and components during the construction process itself. 3D scanners will build digital models of existing buildings and will detect any deviation during the construction process. The use of big data and algorithms will generate new insights from the huge data pools created both on construction projects and during the operation phase of existing assets. New methods of simulation and virtual reality will help to identify interdependencies and overlaps during the design and engineering stages. This will enable a virtual experience of the building, even at the design stage. Mobile connectivity will allow industry to engage in real-time communication and provide contractors with additional on-site information. During the operation phase, digitalisation will allow for enhanced operations and monitoring. Digitalisation will build-up a continuous know-how, by enabling seamless flows of information across all stakeholders and different renovation phases by providing neutral and unbiased information.

Overall, digitalisation will significantly enhance collaboration among stakeholders. Each party can contribute information and/or extract information from the central model and, by providing a long term view of the overall process, offer owners greater benefits during commissioning and operational phases.

Big companies have already made the transition to the digital world, but most SMEs have little experience with digitalisation tools. Governmental support would be needed to ensure fair access of SMEs to these new technologies and to build the technical capacity that would allow the reshaping of skills for the markets which would be trigged by the industrialisation of energy renovation.

Conclusions and next steps

This publication is an analytical report on how to ensure a smooth energy transition of the EU building stock, from being an energy waster to being highly energy efficient and energy producer, leading to net zero energy consumption. The report estimates the current EU energy renovation market. The analysis shows that governmental support has been instrumental in getting the energy renovation market off the ground.

The report shows that if a 40% energy savings target for the EU for 2030 is adopted, the size of the current energy renovation market could increase by almost half. However, the identified energy renovation market is a largely component-based renovation market mainly financed by grants from public budgets. An ambitious energy savings target is needed to trigger private investments and increase the size of the energy renovation market. This will, in turn, enable the necessary move towards a more industrialised, dynamic and sustainably financed energy renovation market.

The first step towards this transformation, is to address the gaps and loopholes identified in the 14 existing EU instruments aiming to increase investment in reducing energy consumption in buildings and their related GHG emissions. The report suggests a specific recommendation for each of the identified gaps and loopholes. These recommendations, which are described in detail in Chapter II and summarised in the table included in the Executive Summary, should be further discussed and developed with stakeholders. The aim is to design solid foundations for the future in light of EU priorities in terms of jobs, growth and competitiveness as well as the Paris Climate Agreement (UNFCCC, 2015) and the Energy Union Strategy Framework (EC, 2015-a).

The energy transition of the EU building stock, from being an energy waster to being highly energy efficient and energy producer leading to net zero energy consumption, is an opportunity to unleash the 4th industrial revolution in Europe. The report proposes to build, with stakeholders from all sectors, a forward-looking policy framework for buildings based on the “Efficiency First” principle. The proposed framework should combine EU investments-related policies with climate and energy policies. This framework would lead to a streamlined and more coherent version of the existing EU instruments identified in Chapter II. The initial proposal included in this report is based on i) setting a 2050 binding carbon and energy savings target for buildings, ii) designing an overarching investment-climate-energy policy framework for buildings to set enabling conditions for achieving the binding 2050 carbon and energy savings target, iii) setting up an EU risk-sharing facility for de-risking energy renovation investments, iv) setting up an EU energy renovation facilitator to ease the implementation of the framework and, v) building technical capacity to foster innovation in technologies, business models, integration of buildings in to the EU energy system as well as the digitalisation of the EU building stock. EU industry and consumers will be the direct beneficiaries of such a framework.

The arguments and suggestions included in this report have been built on a number of assumptions. First and foremost, it is widely recognised today that meeting the Paris Climate commitment requires a breakthrough in mindsets and technologies. Furthermore, the scale of investments needed to transform the EU building stock calls for a strategic use of the limited public funding available to leverage private finance. Last but not least, the need to build technical capacity to implement this transformation must be put in place. Understandably, more detailed analysis is required to test these assumptions once there is a decision to go forward with an overarching, integrated and coherent long-term climate-energy-investment policy framework to ensure the energy transition of the EU building stock.

Discussion and consensus regarding the 2050 binding carbon and energy savings target for buildings

Member States have set an implicit, binding carbon savings target for buildings to meet their ESD targets – these ESD targets deserve more attention by the energy efficiency community. The implicit binding carbon savings targets are so far set until 2020. Member States are currently discussing their 2030 ESD targets (Figure 2.1). The stringency of the 2030 ESD targets are of high importance for buildings as 99% of their direct GHG emissions fall under ESD. Furthermore, two-thirds of the Member States have set, on a voluntary basis, an energy savings target for their building stock, for the overall economy or for both. The energy savings targets are indicative by nature as they have been set under the EU 2020 indicative energy savings target. The time periods and the exact nature of these national energy savings targets, as well as their stringency, vary widely among Member States (Table 2.5).

The coherence between the existing carbon and energy savings targets and the measures included in various Member States' reporting is questionable (see Chapter II). A deep-dive discussion is needed at the EU and Member States levels to ensure coherence between both targets and between the targets and the proposed measures. These discussions should be used as an opportunity to align the targets for buildings with the Paris Climate commitment (UNFCCC, 2015) and to launch the industrial renaissance of Europe.

Discussion and consensus regarding the proposed institutional setup

One of the critical factors in achieving the carbon and energy savings targets for buildings is to set the right governance structure. The proposal on the institutional setup of the EU risk-sharing facility and the EU energy renovation facilitator are complex policy options. The appropriate approach to the design and creation of both institutions requires high-level policy discussions. These discussions should involve, in a transparent manner, the EU institutions, Member States, regional and local authorities as well as stakeholders, as this new set-up will have an impact on existing EU and Member States support and policies for net zero energy renovation programmes.

Discussion and consensus on the 2050 roadmap for the EU building stock and its implementation

After the EU and its Member States, together with all relevant stakeholders, have reached consensus on all of the above topics and issues, a detailed implementation roadmap with milestones should be drawn up in order to give industry and investors sufficient confidence. Implementation of this roadmap should be supervised by the EU energy renovation facilitator and by using financial support provided through the proposed EU risk-sharing facility.

Annex I: Analytical framework for the EU decarbonisation scenarios

The decarbonisation scenarios EE27, EE30 and EE40 are based on the results of various models:

- as regards the impact of energy efficiency measures on the overall energy system, GHG emissions, investment needs and overall energy system costs: the PRIMES model (a partial-equilibrium model of the energy system) was used. For each scenario, PRIMES offers consistent projections (not forecasts) based on the reference scenario. It was used for setting the 2020 targets, the low-carbon economy and energy 2050 roadmaps and the 2030 framework for climate and energy;
- for the macro-economic impacts of the implementation of energy efficiency measures:
    - E3ME: a post-Keynesian model based on the assumption that investment in one sector does not automatically lead to a crowding effect on investment in other sectors was used. Energy efficiency measures are financed by ETS allowances;
    - GEM-E3: a general equilibrium model which assumes that capital markets operate in an optimal manner, so that additional investments in energy efficiency imply lower capital availability in other sectors was used. Governments use ETS revenues to lower employers' social security charges.

The projections analysed are those to 2030. Each scenario involves a strengthening of current energy efficiency policies, including the Energy Efficiency Directive, the Energy Performance of Buildings Directive (EC, 2010-a) and the measures under the Ecodesign (EC, 2009) and Labelling Directives (EC, 2010-b). For the transport sector, the measures considered are those included in the 2011 White Paper (EC, 2011-b).

The non-policy assumptions are similar to those made for the 2030 Communication. The model assumes GDP growth of 1.6% a year and population growth of 0.2% per year in 2020-2030. Degree days are kept constant at the 2005 level. GHG emissions reduction target was 40% and the share of renewables in the energy mix put at 27%.

Fossil-fuel prices are as used for the 2030 Communication, i.e. €93/boe for oil, €65/boe for gas and €24/boe for coal.

The scenarios are set in enabling conditions. In each case, the policy assumptions are those that are economically viable for each sector (see Table AI. 1).

The system cost is calculated using standard (un-lowered) private discount rates (8% for public transport, 9% for power generation, 12% for industry, trucks and inland navigation and 17.5% for passenger cars).

Table AI. 1 Policy and financial assumptions by scenario and sector

Policy assumptions	**EE27**	**EE30**	**EE40**
Buildings: - annual renovation rate	• 1.48% (2015-2020) • 1.84% (2021-2030)	• 1.61% (2015-2020) • 2.21% (2021-2030)	• 1.65% (2015-2020) • 2.42% (2021-2030)
- discount rate reduction	• from 12% to 10.5% (residential sector) • from 10% to 9.2% (non-residential sector)	• from 12% to 10% (residential sector) • from 10% to 9% (non-residential sector)	• from 12% to 10% (residential sector) • from 10% to 9% (non-residential sector)
- % of households connected to district heating in 2030	• 11%	• 12%	• 14%
Products:	Increased uptake of: • advanced technologies; • BAT in industry	Increased uptake of: • advanced technologies; • BAT in industry	Increased uptake of: • advanced technologies; • BAT in industry
Transport • passenger cars • LCVs	• 75gCO_2/km • 110 gCO_2/km	• 72gCO_2/km • 110 gCO_2/km	• 70gCO_2/km • 110 gCO_2/km
Grid	Measures limiting losses	Measures limiting losses	Measures limiting losses

Source: Securing energy efficiency to secure the energy union (JRC, 2015-b) based on the impact on Energy efficiency and its contribution to energy security (EC, 2015-b)

Annex II: Households energy taxes per energy consumption band

Households gas prices include three energy consumption bands:

- Band D1: Consumption < 20 GJ
- Band D2: 20 GJ < Consumption < 200 GJ
- Band D3: Consumption > 200 GJ

Households electricity prices include five energy consumption bands:

- Band DA: Consumption < 1 000 kWh
- Band DB: 1 000 kWh < Consumption < 2 500 kWh
- Band DC: 2 500 kWh < Consumption < 5 000 kWh
- Band DD: 5 000 kWh < Consumption < 15 000 kWh
- Band DE: Consumption > 15 000 kWh

Table AII-1: Households electricity and gas taxes per energy consumption band

€/kWh	Electricity taxes par consumption band					Gas taxes per consumption band		
	DA	DB	DC	DD	DE	D1	D2	D3
Belgium	0,0632	0,0537	0,0510	0,0474	0,0439	0,0205	0,025	0,0208
Bulgaria	0,0163	0,0160	0,0160	0,0160	0,0160	0,0072	0,013	0,0130
Czech Republic	0,0510	0,0358	0,0236	0,0203	0,0181	0,0158	0,0202	0,0190
Denmark	0,2159	0,2159	0,2102	0,1449	0,1449	0,0438	0,0591	0,0591
Germany	0,1749	0,1565	0,1519	0,1494	0,1426	0,0253	0,0276	0,0260
Estonia	0,0350	0,0340	0,0340	0,0340	0,0340	0,0093	0,0161	0,0139
Ireland	0,1311	0,0695	0,0463	0,0345	0,0246	0,0143	0,0209	0,0191
Greece	0,0584	0,0537	0,0544	0,0681	0,0816	0,0194	0,0231	0,0189
Spain	0,1132	0,0610	0,0507	0,0446	0,0428	0,0231	0,0347	0,0252
France	0,0638	0,0578	0,0568	0,0559	0,0560	0,0276	0,0255	0,0213
Croatia	0,0455	0,0329	0,0309	0,0298	0,0290	0,0110	0,0182	0,0174
Italy	0,0923	0,0741	0,0949	0,1224	0,1324	0,0326	0,0473	0,0452
Cyprus	0,0473	0,0376	0,0375	0,0374	0,0370	0,0148	0,0186	0,0185
Latvia	0,0554	0,0555	0,0554	0,0553	0,0550	0,0129	0,0152	0,0152
Lithuania	0,0385	0,0383	0,0380	0,0373	0,0362	0,0073	0,0108	0,0113
Luxembourg	0,0482	0,0447	0,0436	0,0425	0,0417	0,0079	0,015	0,0148
Hungary	0,0274	0,0252	0,0243	0,0237	0,0252	0,0417	0,047	0,0442
Malta	0,0154	0,0067	0,0060	0,0073	0,0178	0,0215	0,0307	0,0276
Netherlands			0,0605	0,1148	0,0697	0,0112	0,0186	0,0184
Austria	0,1485	0,0951	0,0744	0,0643	0,0537	0,0267	0,0408	0,0375
Poland	0,0382	0,0328	0,0312	0,0303	0,0299	0,0163	0,0227	0,0209
Portugal	0,2104	0,1247	0,1132	0,1063	0,0986	0,0189	0,0284	0,0275
Romania	0,0388	0,0385	0,0381	0,0378	0,0372	0,0174	0,0166	0,0174
Slovenia	0,1065	0,0686	0,0505	0,0394	0,0318	0,0668	0,0763	0,0713
Slovakia	0,0451	0,0323	0,0285	0,0252	0,0225	0,0046	0,0062	0,0056
Finland	0,0809	0,0613	0,0521	0,0483	0,0446	0,0205	0,025	0,0208
Sweden	0,0986	0,0715	0,0672	0,0606	0,0565	0,0072	0,013	0,0130
United Kingdom	0,0128	0,0117	0,0104	0,0096	0,0089	0,0158	0,0202	0,0190

Key point: Energy taxes do not encourage households to save energy because they are proportionally higher when the volume of energy consumed is lower.

Source: EUROSTAT, energy balances database

Annex III: Inconsistencies between energy efficiency classes in the market and minimum energy performance requirements

Ecodesign requirements are set at the Least Life Cycle Cost (LLCC) which is determined by the preparatory studies based on available data. This methodology is sub-optimal. By the time of the implementation of Ecodesign requirements, the market has already moved as illustrated below by the requirement set for domestic refrigerators.

The Commission Regulation No 643/2009 (EC, 2009-g) sets Ecodesign requirements for domestic refrigerators based on the Energy Efficiency Index (EEI). The three tiers considered by the regulation are as follows:

- 1st tier: EEI <55, eliminated from the EU market by 1 July 2010.
- 2nd tier: EEI <44, eliminated from the EU market by 1 July 2012.
- 3rd tier: EEI <42, eliminated from the EU market by 1 July 2014.

The Commission Delegated Regulation No 1060/2010 (EC, 2010-c) on labelling updated the previous energy classes and introduced three new energy classes A^{+}, A^{++}, A^{+++} (Table AII-1). The first tier introduced by the Commission Regulation No 643/2009 (EC, 2009-g) related to the Ecodesign implementing measure for household refrigerating appliance corresponds to energy class A as set by the Commission Delegated Regulation No 1060/2010. This makes energy classes B, C, D, E, F, G in 2010 irrelevant as the entry into force of the first tier, which is about eliminating all products below class A, was implemented that year.

Table AII-1: Energy Efficiency classes for domestic refrigerators

Energy Efficiency class	Energy Efficiency Index until 30 June 2014	Energy Efficiency index from 1 July 2014
A+++	EEI<22	EEI<22
A++	22<=EEI<33	22<=EEI<33
A+	33<=EEI<**44**	33<=EEI<**42**
A (Ecodesign First tier)	**44**<=EEI<55	**42**<=EEI<55
B	55<=EEI<75	55<=EEI<75
C	75<=EEI<95	75<=EEI<95
D	95<=EEI<110	95<=EEI<110
E	110<=EEI<125	110<=EEI<125
F	125<=EEI<150	125<=EEI<150
G	EEI=>150	EEI=>150

Key point: Class A corresponds to the first tier of Ecodesign which has been implemented the year the energy classes were adopted. This makes energy classes below class A irrelevant.

Source: Commission Delegated Regulation No 1060/2010 (EC, 2010-c)

Furthermore, by the time of the implementation of the first tier; elimination of products with efficiency class below energy class A in 2010, the market share of refrigerators with energy class B was at 2% and those with energy classes below were no longer sold in the EU market (Table AII-2). It is, therefore, unlikely that Ecodesign has driven the efficiency improvement as by the time of the implementation of any of the 2nd eco-design tier, elimination of class Ain 2014, market share of refrigerators with energy class A was at 2% (Table AII-2).

Table AII-2: Market share of refrigerators per energy class

Energy class	2004	2005	2006	2007	2008	2009	2010 (Ecodesign first tier)	2011	2012	2013	2014
C	6%	3%	2%	1%							
B	31%	25%	17%	11%	7%	4%	2%	1%			
A	55%	61%	66%	67%	64%	59%	50%	37%	18%	4%	2%
A^+	6%	9%	14%	20%	27%	32%	41%	52%	66%	75%	72%
A^{++}				1%	2%	4%	7%	9%	13%	17%	21%
A^{+++}								1%	2%	4%	4%

Key point: Ecodesign requirements should be set at the efficiency level of the best available technologies to foster technological innovation and enhance the competitiveness of the EU industry.

Source: Energy Efficiency of white goods in Europe: monitoring the market with sales data (TopTen, 2015)

Annex IV: Allowed verification tolerances for selected products

When performing market surveillance checks, the authorities of Member States are required to test one single unit per model. The tested model is considered to comply with the applicable requirements within the limits of the tolerances shown below. If, despite the tolerances below, the tested product does not comply with the applicable requirements, Member States authorities shall randomly select three additional units of the same model for testing. The model is considered to comply with the applicable requirements if for each measured parameter the average value for the three units comply with the applicable requirements with the tolerances below.

Table AIV-1: Allowed verification tolerances for heating, cooling, lighting and domestic refrigeration products

Product family	Expected savings by 2020	Measured parameter	Verification tolerance
Space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination of heater, temperature control and solar device	-Annual energy savings: 45 Mtoe -Annual CO_2 emission reductions: 110 MtCO2 -Annual nitrogen oxides emission reductions: 270 kt SO_x	Seasonal space heating energy efficiency	not more than 8% lower than the declared value at the rated heat output of the unit
		Water heating energy efficiency	not more than 8% lower than the declared value at the rated heat output of the unit
		Sound power level for heaters	Not more than 2 dB above the declared value
		Emissions of nitrogen oxides	Not more than 20% higher than the declared value
		Class of temperature control	Zero tolerance
		The collector efficiency of the solar collector	Not more than 5% lower than the declared value of the unit
		Standing loss of solar hot water storage tank	Not more than 5% higher than the declared value of the unit
		Auxiliary electricity consumption of solar devices	Not more than 5% higher than the declared value of the unit
Water heaters and hot water storage tanks	-Annual energy savings: 11Mtoe -Annual CO_2 emission reductions: 26 MtCO2 -Annual nitrogen oxides emission reductions: 130 kt SO_x	Daily electricity consumption	The measured values shall not be more than 5% higher than the value declared by the manufacturer
		Daily fuel consumption	
		Weekly fuel consumption with smart controls	
		Weekly fuel consumption without smart controls	
		Weekly electricity consumption with smart controls	
		Weekly electricity consumption without	

		smart controls	
		Standby power consumption sol-standby	
		Standing loss	
		Storage volume	The measured value shall not be more than 2% lower than the value declared by the manufacturer
		Collector aperture area	
		Mixed water at 40°C V40	The measured value shall not be more than 3% lower than the value declared by the manufacturer
		Pump power consumption sol-pump	
		Sound power level (indoor and/or outdoor)	The measured value shall not be more than 2 dB higher than the value declared by the manufacturer
		Emissions of nitrogen oxides	The measured value shall not be more than 20% higher than the value declared by the manufacturer.
Solid fuel boilers and packages of a solid fuel boiler, supplementary heaters, temperature controls and solar devices	-Annual energy savings of 0.4 Mtoe -Annual CO_2 emission reductions of 0.2 Mt -Annual Particulate Matter reductions of 10 kt. -Annual organic gaseous compounds reduction of 14 kt. -Annual carbon monoxide reduction of 130 kt.	Seasonal space heating energy efficiency	Determined value is not more than 4% lower than the declared value of the unit
		Emissions of particulate matter	Determined value is not more than 9 mg/m^3 higher than the declared value of the unit
		Emissions of organic gaseous compounds	Determined value is not more than 7 mg/m^3 higher than the declared value of the unit
		Emissions of carbon monoxide	Determined value is not more than 30 mg/m^3 higher than the declared value
		Emissions of nitrogen oxides	Determined value is not more than 30 mg/m^3 higher than the declared value of the unit
		Values and classes in energy label	They have to correspond to the technical documentation
		Energy efficiency index	Not more than 6% lower than the declared value of the unit
Local space heaters	-Annual energy savings of 3.8 Mtoe -Annual CO_2 emission reductions of 6.7 Mt -Annual SO_x emission reductions of 0.6 kton	Seasonal space heating energy efficiency for local electric space heaters	Cannot be worse than the declared value at the nominal heat output of the unit
		Seasonal space heating energy efficiency for liquid and gaseous fuel domestic local space heaters	Not more than 8% lower than the declared value
		Emissions of NO_x for liquid and gaseous fuel domestic local space heaters	Not more than 10% higher than the declared value
		Space heating energy efficiency for luminous local space heaters and tube local space heaters	Not more than 10% lower than the declared value
		Emissions of NO_x for luminous local space heaters and tube local space heaters	Not more than 10% higher than the declared value

		Seasonal space heating energy efficiency for solid fuel local space heaters	Not more than 5% lower than the declared value
		Emissions of particulate matter for solid fuel local space heaters	Shall not exceed the declared value by more than: -20 mg/m^3 at 13% O_2 for open and closed fronted solid fuel space heaters using solid fuel other than compressed wood in the form of pellets and cookers -10 mg/m^3 at 13% O_2 for closed fronted solid fuel local space heaters using compressed wood in the form of pellets
		Organic gaseous compounds of solid fuel space heaters (OGCs)	Shall not exceed the declared value by more than: -25 mgC/m^3 at 13% O_2 for closed fronted solid fuel local space heaters. -15 mgC/m^3 at 10% O_2 for closed fronted solid fuel local space heaters using compressed wood in the form of pellets
		Carbon monoxide (CO)	Shall not exceed the declared value by more than: -275 mg/m^3 at 13% O_2 for closed fronted solid fuel local space heaters. -60 mg/m^3 at 10% O_2 for closed fronted solid fuel local space heaters using compressed wood in the form of pellets
		Nitrogen oxides (NO_x)	Shall not exceed the declared value by more than 30 mg/m^3 expressed at 13% O_2
Air conditioners	-Annual electricity savings of 11 TWh	Seasonal energy efficiency ratio (SEER) and seasonal coefficient for performance (SCOP) for all room air conditioners	Not less than the declared value minus 8% at the declared capacity of the unit
		Off-mode and standby-mode conditions for single and double duct air conditioner	Do not exceed the limit values by more than 10%
		Energy efficiency ratio (EER) and coefficient of performance (COP) if applicable for single and double duct air conditioner	Is not less than the declared value minus 10%
		Sound power level	Measured value Shall not exceed more than 2 dB(A) above the declared value
Ventilation units	-Aggregate increase in savings by 1300 PJ (45%) to a level of 4130 PJ in 2025	Specific power input (SPI)	Measured value Shall be no more than 1.07 times the maximum declared value
		Thermal efficiency	Measured value shall be no less than 0.93 times the minimum declared value
		Specific fan power (SFP)	Measured value shall be no more than 1.07 times the maximum declared value

		Fan efficiency uni-directional ventilation unit, non-residential	Measured value shall be no less than 0.93 times the minimum declared value
		Sound power level for residential ventilation unit (RVU)	Measured value shall be no more than the maximum declared value plus 2 dB
		Sound power level for non-residential ventilation unit	The measured value shall be no more than the maximum declared value plus 5 dB.
Lighting products	-Annual energy savings of 39 TWh for non-directional household lamps -Annual electricity savings of 25 TWh for directional lamps	Maximum rated power	Average results of a sample batch of minimum 20 lamps do not vary by more than 10% of the declared values
		Lamp survival factor at 6000 h (LED only)	A maximum of two out of every 20 lamps in the test batch may fail before the required number of hours
		Number of switching cycles before failure	At least 19 of every 20 lamps in the batch have no failure after the required number of switching cycles is reached
		Starting time	The average starting time of the lamps in the test batch is no higher than the required starting time plus 10% and no lamp in the sample batch has a starting time longer than two times the required starting time
		Lamp warm-up time to 60% ϕ	The average warm-up time of the lamps in the test batch is not higher than the required warm-up time plus 10% and no lamp in the sample batch has a warm-up time that exceeds the required warm-up time multiplied by 1.5.
		Premature failure rate	A maximum of one out of every 20 lamps in the test batch fails before the required number of hours
		Colour rendering (Ra)	The average Ra of the lamps in the test batch is not lower than three points below the required value, and no lamp in the test batch has a Ra value that is more than 3.9 points below the required value
		Lumen maintenance at end of life and rated lifetime (LED only)	Lumen maintenance at end of life and the lifetime values obtained by extrapolation from the lamp survival factor and from the average lumen maintenance of the lamps in the test batch at 6000h are not lower than respectively the lumen maintenance and the rated lifetime values declared in the product information minus 10%
		Equivalence claims for retrofit lamps	The average results of the lamps in the test batch do not vary from the limit, threshold or declared values by more than 10%
		Beam angle	The average results of the lamps in the test batch do not vary from the declared beam angle by more than 25% and the beam

			angle value of each individual lamp in the test batch does not deviate by more than 25% of the rated value
		Peak intensity	The peak intensity of each individual lamp in the test batch is not less than 75% of the rated intensity of the model
		Other parameters (including energy efficiency index)	Average results of the lamps in the test batch do not vary from the limit, threshold or declared values by more than 10%
Household refrigerating appliances		Rated gross volume	The measured value shall not be less than the rated value by more than 3%
		Rated storage volume	The measured value shall not be less than the rated value by more than 3%.
		Freezing capacity	The measured value shall not be less than the rated value by more than 10%
		Energy Consumption	The measured value shall not be greater than the rated value (E_{24}) by more than 10%
		Power consumption of household refrigerating appliances with a storage volume below 10 litres	The measured value shall not be greater than the limit value by more than 0.10W at 95% confidence level
		Wine storage appliances	The value measured for the relative humidity shall not exceed the nominal range by more than 10%
		Airborne acoustical noise emissions	The measured value shall meet the rated value

Key point: The allowed verification tolerances can lead to savings losses if misused by manufacturers.

Source: Ecodesign implementing measures for heating, cooling, lighting and household refrigerating appliances

Annex V: Energiesprong: an innovative model to achieve net zero energy renovation

Energiesprong is a Dutch initiative aiming to create the market conditions for energy renovation towards net zero energy buildings. The aim of the initiative is to organise the demand side, facilitate supply chains, show real-life examples, disclose all relevant knowledge and promote innovative co-operations. The project has been designed with the aim to develop industrialised energy renovation using standardised off-site prefabricated elements. The objective is to decrease cost and reduce the time spent on-site. Energy renovation companies used 3D scans of houses to offer factory-produced renovation tailored to each house.

The overall objective of the initiative is to renovate 110,000 rental houses (social housing) in The Netherlands to net zero energy level over the period 2013-2020. Net zero energy means, annually a house does not consume more energy for heating, hot water, lights and appliances than it produces. In practice, energy produced by renewables is roughly equivalent to the annual average electricity consumption. Buildings targeted by Energiesprong are those constructed between the 1950s and 1970s, before the first building energy code was implemented in The Netherlands. The first pilot projects, in 2013, cost around EUR 130,000 per home, but three years later the cost has dropped to EUR 60,000. The ultimate objective is to be at EUR 40,000 once economies of scale are achieved.

The implementation of the project involved the following actors:

- Energiesprong: a non-profit development team, a quasi-autonomous agency, partly funded by the Dutch government, in charge of running the Energiesprong initiative. Energiesprong played the role of an Energy Renovation Facilitator. It brought together a wide range of stakeholders including the Ministry of Housing, Planning and Urban Development, the Ministry of Finances, and the social housing, private housing and commercial property sectors.

- WSW: A rated social bank, which lends the upfront capital. It provided EUR 6.6 Billion to underwrite a government-backed 30-year loan guarantee to social housing associations and generating a 5.25% financial return. The EUR 6.6 billion is equivalent to 30 years of households' energy expenditures.

- Social housing association: owners of the buildings, they take the financial risk by contracting the loan from the social bank. The loan is paid back via energy savings under the 30-year energy performance contract. The social housing association invests EUR 40-70k to fund the capital work and charge the tenants a combined "rent + energy plan" bill which is equivalent to the amount paid by the tenant for the rent and energy bills prior to the renovation. This amount is paid to the social housing association until the loan is repaid.

- Tenants: To launch the renovation project, all tenants in each block have to agree on the renovation project. Tenants are offered comfortable homes with attractive façades, solar panels and smart metering. Furthermore, to gain tenants' acceptance free bathrooms, fridges and Ikea kitchens, with electric cooking were included in the renovation package. Tenants are offered the possibility to choose the kitchen's colour and design.

- EnergyGO: is a private company with the expertise and knowledge to assess energy renovation concepts. EnergyGo is appointed by Energiesprong to streamline the process of contracting, realisation and monitoring of the individual projects. EnergyGo rates projects submitted by energy renovation companies based on their technical feasibility and the ambition level of energy savings targeted by each proposed solution.

- Energy renovation companies: selected by Energiesprong based on the assessment of the technical offer made by EnergyGO. Renovation companies are offered a 30-year maintenance contracts by the social housing, but in return they have to offer:
    - An insurance-backed energy performance guarantee (30 years).
    - A 10-day delivery timetable of all work (this has been reduced to three days).
    - Affordability, with the investment financed by energy savings.
    - Aesthetic attractiveness, improving the appearance of the house as well as the quality of life of residents.

The initiative includes monitoring of the real consumption of renovated buildings as well as the evaluation of users' satisfaction (by questionnaires) and the process of realisation (co-operations, design process, operation and maintenance, etc.). The aim of the monitoring is to compare the initial projected energy consumption of the building with the actual one and to better understand tenants' behaviour and how to reduce its related consumption.

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List of acronyms

ACE	Architects Council of Europe
AEAs	Annual Emission Allowances
AREA	Air Conditioning and Refrigeration European Association
BaP	Benzo[a]pyrene
CF	Cohesion Fund
CRF	Central Risk Function
CO	Carbon monoxide
2DS	2 Degrees Scenario
EAE	European Association for External Thermal Insulation Composite Systems
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECEC	European Council of Engineering Chambers
ECEEE	European Council for an Energy Efficient Economy
EEAG	Environmental protection and Energy Aid Guidelines
EED	Energy Efficiency Directive
EEEF	European Energy Efficiency Fund
EEI	Energy Efficiency Index
EHPA	European Heat Pump Association
EIB	European Investment Bank
EFIEES	European Federation of Intelligent Energy Efficiency Services
EFSI	European Fund for Strategic Investment
EHP	Euro-Heat & Pump
EHPA	Association of the European Heating Industry
ELENA	European Local Energy Assistance
EMF	European Mortgage Association
EPBD	Energy Performance Building Directive
EPEE	European Partnership for Energy and the Environment
EPF	European Property Federation
EPIA	European Photovoltaic Industry Association
ERDF	European Regional Development Fund
ERM	Enterprise Risk Management
ESD	Effort Sharing Decision
ESIF	European Structural and Investment Fund
ESMIG	European Smart Metering Industry Group
ES-SO	European Solar Shading Organisation
ETS	Emission Trading Scheme
EU	European Union
eu.bac	European Building Automation and Controls Association
EURELECTRIC	Union of the Electricity Industry
EURIMA	European Insulation Manufacturers Association
EuroACE	The European Alliance of Companies for Energy Efficiency in Buildings

Eurovent	European Committee of Air Handling and Refrigeration Equipment Industries
EVIA	European Ventilation Industry Association
GBER	General Block Exemption Regulation
GEM-E3	General Equilibrium Model for Energy-Economy-Environment interactions
GHG	Greenhouse gas
GIS	Geographical Information System
HICP	Harmonised Indices for Consumer Prices
ICT	Information and Communication Technologies
IEA	International Energy Agency
IFRS	International Financial Reporting Standards
IPCC	Inter-governmental Panel on Climate Change
IUT	International Union of Tenants
JASPERS	Joint Assistance to Support projects in European regions
JESSICA	Joint European Support for Sustainable Investments in City Areas
LLCC	Least Life Cycle Cost
LIFE	Environment and Climate Action Fund
E3ME	Energy-Economy-Environment Model for Europe
MMR	Mechanism for Monitoring and Reporting
$PM_{2.5}$	Particulate Matter
PRIMES	Price Induced Market Equilibrium System
PU Europe	Federation of European Rigid Polyurethane Foam Associations
SILC	Social Inclusion and Living Conditions
SBS	Structural Business Statistics
SME	Small and Medium Enterprises
S&L	Standards and Labelling
RED	Renewable Energy Directive
UIPI	International Union of Property Owners
US	United States
OECD	Organisation for Economic Co-operation and Development

Glossary

Asset rating: is a means of expressing the energy performance of a building where the energy performance is calculated based on detailed registration of building parts, surfaces and the technical installations in the building (IEA, 2010).

Building element: means a technical building system or a clearly delineated part of the building envelope (EC, 2010-a).

Building envelope: means the integrated elements of a building which, acting together, securely separate its interior from the outdoor environment (EC, 2010-a).

Capacity generation: is the maximum electrical output that an electricity can produce under specific conditions.

Efficiency First Principle: is a guiding principle introduced by the Energy Union Strategy Framework (EC, 2015-a) where it says that energy efficiency should be considered as an energy source in its own right. It aims to prioritise investments in energy savings (energy efficiency and demand-response).

End-use: includes heating, cooling, ventilation, lighting, hot water and services provided by various equipment, appliances and consumer electronics in buildings.

Energy performance contract: is a binding, legal agreement between a beneficiary and a provider of an energy measure or set of measures (energy efficiency improvement and/or energy production via renewable sources), verified and monitored during the whole term of the agreement, where investments in that measure or set of measures are paid for in relation to a mutually agreed level of guaranteed energy efficiency improvements or energy generation.

Energy renovation: consists of coordinated and well planned works to a building which lead to the improvement of the energy performance of the building.

EU Energy Renovation Facilitator: is a one-stop-shop, independent from existing EU institutions, especially dedicated to organising the demand and the supply of energy renovation. The aim is to identify and categorise risks and to facilitate their mitigation by allocating them to the most appropriate EU entity. The Energy Renovation Facilitator should not be mitigating any risk itself.

EU Risk Sharing Facility: is a bilateral loss-sharing agreement between local/national banks and an originator of assets. The originator could be the EU through one of its institutions such as the European Investment Bank. The local/national bank reimburses the originator for a portion of the principal losses incurred on a portfolio of eligible assets. The aim of the Risk Sharing Facility is to mitigate the financial risk of the energy renovation by providing loan guarantees for companies involved in the renovation and to finance local authorities to build technical capacity.

Fuel poverty: is the inability of low-income families to afford energy services which, usually due to the very low energy performance of the building, leads to uncomfortable homes both in wintertime and in summertime. The internal market regulation refers to fuel poverty as energy poverty.

Horizon 2020 programme: is an EU financial instrument implementing the Innovation Union which is the EU flagship 2020 initiative aimed at securing the global competitiveness of the EU.

LIEF: is the acronym for Long-term Industrial Energy Forecasting model. The model estimates future industrial energy consumption, taking into account the composition of production, energy prices and some policy initiatives.

Monte-Carlo simulation: this is an approach used to model the probability of different outcomes in a process that cannot be easily predicted due to the intervention of a random variable.

Net Zero Energy Consumption Building: is a highly energy efficient building, which satisfies the remaining energy needed to maintain a comfortable, healthy indoor environment from renewable energy sources produced locally. The average annual energy balance for all end-uses should be equal to zero. As a result, the concept of a *net zero energy building* only makes sense if the building is already very low energy demand for heating and cooling.

Operational rating: is a means of expressing the energy performance of a building where energy performance is based on metered consumption, which is normalised to standard conditions (IEA, 2010).

Prosumer: is an energy consumer who has the potential to be an energy producer, through self-generation of renewable energy, storage, energy savings and participation in demand-response (Client Earth, 2016)**.**

PRIMES model: is a tool which is used in the policy making process to simulate a market equilibrium for energy supply and demand. The model estimates the equilibrium by finding the prices of each form of energy such that the producers it identifies are best suited to supply, match the quantity of consumers wishing to access the energy. The equilibrium is static (within each time period) but repeated in a time-forward path, under dynamic relationships**.**

System cost: is the total sum of investment and operational costs of an energy system.

Technical building system: means technical equipment used for heating, cooling, lighting, ventilation and hot water (or for a combination of these), of a building or of a building element (EC, 2010-a).

Zero Energy Renovation Kit: is an integrated solution, which includes the envelope (enclosing walls and roof, insulation elements (including air tightness membranes) and windows), the technical building systems and elements, the appliances, the energy production systems (including battery storage, thermal mass etc.) which allow the delivery of a net Zero Energy Consumption Building. A Zero Energy Renovation Kit will vary according to construction periods, climate zones and building types.

References

ACEEE, 2008, *The size of the US energy efficiency market: generating a more complete picture* by Karen Ehrhardt-Martinez and John "Skip" Laitner,
http://aceee.org/research-report/e083

ARMINES, 2007, *Ecodesign Preparatory study for room air-conditioners*
http://www.eceee.org/ecodesign/products/airco_ventilation/Introduction_Lot10

BigEE, 2014, *Your guide to energy efficiency in buildings*
http://www.bigee.net/en/policy/guide/appliances/recommended/

BIOIS, 2013, *Energy performance certificates in buildings and their impact on transaction prices and rents in selected EU countries*
https://ec.europa.eu/energy/sites/ener/files/documents/20130619-energy_performance_certificates_in_buildings.pdf

BPIE, 2016, *Buildings as micro-energy hubs delivering climate solutions*
http://bpie.eu/wp-content/uploads/2016/05/Buildings-as-micro-energy-hubs-delivering-climate-solutions_Final.pdf

CA, 2016*, Implementing the Energy Performance of Buildings Directive (EPBD) – Featuring Country Reports*
http://www.epbd-ca.eu/ca-outcomes/2011-2015

CE, 2015*, Assessing the Employment and Social Impact of Energy Efficiency*
https://ec.europa.eu/energy/sites/ener/files/documents/CE_EE_Jobs_main%2018Nov2015.pdf

ClientEarth, 2016, *Prosumer rights: Options for an EU legal framework post-2020*
http://www.documents.clientearth.org/wp-content/uploads/library/2016-06-03-prosumer-rights-options-for-an-eu-legal-framework-post-2020-coll-en.pdf

CORDIS, 2015, *Community Research and Development Information Service*
http://cordis.europa.eu/projects/home_en.html

COSO, 2004, *Enterprise Risk Management Integrated Framework*
http://www.coso.org/ermupdate.html

CSTB, 2015, *Technical assessment of national/regional calculation methodologies for energy performance of buildings*
https://ec.europa.eu/energy/sites/ener/files/documents/EPB_calculations_in_EU.pdf

EC, 1997, *Resolution of the European Council of the Stability and Growth Pact*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31997Y0802%2801%29&from=EN

EC, 2003, *Directive 2003/87/EC on establishing a scheme for greenhouse gas emission allowance trading with the community and amending* Council Directive 96/61/EC
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0087&from=FR

EC, 2007, *Brussels European Council, Presidency conclusions on the 2020 energy and climate policy framework*
http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/93135.pdf

EC, 2009-a, *Directive 2009/29/EC amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme for the community*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0029&from=FR

EC, 2009-b, *Decision No 406/2009/EC on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009D0406&from=HR

EC, 2009-c, *Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently* repealing Directives 2001/77/EC and 2003/30/EC
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

EC, 2009-d, *Directive 2009/125/EC on stablishing a framework for the setting of ecodesign requirements for energy-related products*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0125&from=FR

EC, 2009-e, *Directive 2009/72/EC concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC*
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0055:0093:EN:PDF

EC, 2009-f, *Directive 2009/73/EC concerning common rules for the internal market in natural gas and repealing Directive 2003/57/EC*
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0094:0136:en:PDF

EC, 2009-g, *Commission regulation No 643/2009 implementing Directive 2005/32/EC with regard to eco-design requirements for household refrigerating appliances*
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:191:0053:0068:en:PDF

EC, 2010-a, *Directive 2010/31/EC on the energy performance of buildings*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN

EC, 2010-b, *Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0030&from=FR

EC, 2010-c, *Commission delegated regulation No 1060/2010 supplementing Directive 2010/30/EU with regard to energy labelling of household refrigerating appliances*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010R1060&from=EN

EC, 2012-a, *Directive 2012/27/EC on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0027&from=FR

EC, 2012-b, *Commission Delegated Regulation No 244/2012 on supplementing Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings by establishing a comparative methodology framework for calculating cost-optimal levels of minimum energy performance requirements for buildings and building elements* http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:081:0018:0036:en:PDF

EC, 2013-a, *Regulation No 525/2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0525&from=EN

EC, 2013-b, *Council Regulation No 1311/2013 laying down the Multiannual Financial Framework for 2014-2020*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R1311&from=EN

EC, 2014-a, *A New Start for Europe: My Agenda for Jobs, Growth, Fairness and Democratic Change Political guidelines. Opening Statement of Jean-Claude Juncker,*
https://ec.europa.eu/priorities/sites/beta-political/files/juncker-political-guidelines_en.pdf

EC, 2014-b, *Impact Assessment on Energy Efficiency and its contribution to Energy Security and the 2030 Framework for Climate and Energy Policy*
https://ec.europa.eu/energy/sites/ener/files/documents/2014_eec_ia_adopted_part1_0.pdf

EC, 2014-c, *European Council conclusions on the 2030 Climate and energy policy framework*
http://data.consilium.europa.eu/doc/document/ST-169-2014-INIT/en/pdf

EC, 2014-d, *Commission Regulation No 651/2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the treaty*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0651&from=EN

EC, 2014-e, *Guidelines from the Commission on State Aid for environmental protection and energy 2014-2020*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628%2801%29&from=EN

EC, 2014-f, Communication from the commission on an investment plan for Europe
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0903&from=EN

EC, 2015-a, *Energy Union Package, A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy*
http://eur-lex.europa.eu/resource.html?uri=cellar:1bd46c90-bdd4-11e4-bbe1-01aa75ed71a1.0001.03/DOC_1&format=PDF

EC, 2015-b, *The impact of Energy Performance Contracts on Governments Accounts*
http://ec.europa.eu/eurostat/documents/1015035/6934993/EUROSTAT-Guidance-Note-on-Energy-Performance-Contracts-August-2015.pdf/dc5255f7-a5b8-42e5-bc5d-887dbf9434c9

EC, 2015-c, *State of the Energy Union,*
http://eur-lex.europa.eu/resource.html?uri=cellar:ebdf266c-8eab-11e5-983e-01aa75ed71a1.0008.02/DOC_1&format=PDF

EC, 2015-d, Proposal for a regulation for setting a framework for energy efficiency labelling
http://eur-lex.europa.eu/resource.html?uri=cellar:e285ab78-2ba4-11e5-9f85-01aa75ed71a1.0007.02/DOC_1&format=PDF

EC, 2015-e, *Energy efficiency in public and residential buildings. Ex-post evaluation of Cohesion policy programmes 2007-2013, focusing on the European Regional Development Fund (ERDF) and the Cohesion Fund (CF)*
http://ec.europa.eu/regional_policy/sources/docgener/evaluation/pdf/expost2013/wp8_final_report.pdf

EC, 2016-a, *Draft delegated regulation with regard to the use of tolerances in verification procedures*
https://www.nve.no/Media/4007/tolerances_el-v3-2_delegert-forordning_sent.pdf

EC, 2016-b, Communication from the Commission on *an EU strategy for heating and cooling*
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0051&from=en

ECOFYS, 2012-a, *Economic benefits of the EU Eco-design Directive*
http://www.ecofys.com/files/files/ecofys_2012_economic_benefits_ecodesign.pdf

ECOFYS, 2012-b, Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive
http://www.energylabelevaluation.eu/tmce/Literature_report_Energy_Labelling_Ecodesign_2013-12-18_Ecofys.pdf

ECOFYS, 2015-a, *Assessment of cost-optimal calculations in the context of the EPBD*
https://ec.europa.eu/energy/sites/ener/files/documents/Assessment%20of%20cost%20optimal%20calculations%20in%20the%20context%20of%20the%20EPBD_Final.pdf

ECOFYS, 2015-b, *The role of energy efficient buildings in the EU future power system*
http://www.ecofys.com/files/files/ecofys-2015-role-of-energy-efficient-buildings-in-power-systems.pdf

ECOS, 2016, *How product testing practices contribute to the loss of energy savings, and how to prevent it,*
http://ecostandard.org/wp-content/uploads/ECOS-Paper-Product-testing-practices-and-energy-losses-200416.pdf

ECORYS, 2012, Study *"Lead Market Initiative -Assessing the impact of national recovery measures on construction in the EU-27"*

EEFIG, 2015, *Energy Efficiency the First Fuel of the EU Economy: How to drive new finance to Energy Efficiency Investment*
http://ec.europa.eu/energy/sites/ener/files/documents/Final%20Report%20EEFIG%20v%209.1%2024022015%20clean%20FINAL%20sent.pdf

EEA, 2013, *Achieving energy efficiency through behaviour change: what does it take?*
http://www.eea.europa.eu/publications/achieving-energy-efficiency-through-behaviour

EEA, 2015-a, *Air quality in Europe, 2015 Report*
http://www.eea.europa.eu/publications/air-quality-in-europe-2015

EEA, 2015-b, *Trends and projections in Europe 2015. Tracking progress towards Europe's climate and energy targets*
http://www.eea.europa.eu/publications/trends-and-projections-in-europe-2015

EEA, 2015-c, *Overview of reported national policies and measures of climate change mitigation in Europe in 2015*
http://www.eea.europa.eu/publications/overview-of-reported-national-policies

EEA, 2016, *UNFCCC database version 17 for GHG emissions*
http://www.eea.europa.eu/data-and-maps

ENERDATA, 2015, *ODYSSEE database, Decomposition analysis*
http://odyssee.enerdata.net/home/

EUROCONSTRUCT, 2014, *Summary report, The Construction sector in Europe*
http://euroconstruct.org/publications/publications.php

T. Fawcett & J. Rosenow, 2016, *The Member States' plans and achievements towards the implementation of Article 7 of the Energy Efficiency Directive*
https://www.researchgate.net/publication/299469153_The_Member_States'_plans_and_achievements_towards_the_implementation_of_Article_7_of_the_Energy_Efficiency_Directive

IEA, 2010, *Energy Performance Certification of Buildings*
http://www.iea.org/publications/freepublications/publication/buildings_certification.pdf

IEA, 2013-a*, Building Energy Efficiency Policies (BEEP) Database*
https://www.iea.org/beep/

IEA, 2013-b, *Modernising building energy codes to secure our global energy future*
http://www.iea.org/publications/freepublications/publication/PolicyPathwaysModernisingBuildingEnergyCodes.pdf

IEA, 2014, *Energy Efficiency Market Report*
http://www.iea.org/publications/freepublications/publication/EEMR2014.pdf

IEA, 2016, *Energy Technology Perspectives*
http://www.iea.org/etp/etp2016/

IFC, 2015, *Energy Performance Building Directive: Compliance study*
https://ec.europa.eu/energy/sites/ener/files/documents/MJ-04-15-968-EN-N.pdf

IPCC, 2014, *Climate Change 2014. Synthesis Report. Summary for Policymakers*
https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf

JRC, 2015-a: *Energy renovation: The Trump Card for the New Start for Europe*
http://publications.jrc.ec.europa.eu/repository/bitstream/JRC92284/eur26888_buildingreport_online_2015-03-25.pdf

JRC, 2015-b, *Securing Energy Efficiency to Secure the Energy Union: How Energy Efficiency meets the EU Climate and Energy Goals*
http://publications.jrc.ec.europa.eu/repository/bitstream/JRC97451/2015-12-09%20securing%20energy%20efficient%20to%20secure%20the%20energy%20%20union%20online.pdf

JRC, 2016, *Synthesis report on the assessment of Member States' building renovation strategies* *http://publications.jrc.ec.europa.eu/repository/bitstream/JRC97754/syntesis%20report%20building%20renovation%20strategies_online%20fin.pdf*

Hampton, 2009, *Fundamentals of Enterprise Risk Management.*

LTECV, 2015, L*oi n°2015-992 du 17 17 août 2015 relative à la transition énergétique pour la croissance verte*
https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000031044385&categorieLien=id

Meier, 1997, *Energy test procedures for appliances,* Energy and Buildings No 26 (1997)
OECD, 2012, Towards a Green Investment Policy Framework: The case of Low-Carbon, Climate Resilient Infrastructure.
http://www.oecd.org/env/cc/Towards%20a%20Green%20Investment%20Policy%20Framework_consultation%20draft%2018-06-2012.pdf

P. Quirion, 2013, *L'effet net sur l'emploi de la transition énergétique en France : Une analyse input-output du scenario Négawatt*
http://www2.centre-cired.fr/IMG/pdf/CIREDWP-201346.pdf

RICARDO-AEA, 2015*, Study evaluating the national policy measures and methodologies to implement Article 7 of the Energy Efficiency Directive*
http://www.cedelft.eu/publicatie/study_evaluating_the_national_policy_measures_and_methodologies_to_implement_article_7_of_the_energy_efficiency_directive/1620

Topten, 2015, *Energy Efficiency of white goods in Europe: monitoring the market with sales data*
http://www.topten.eu/uploads/File/WhiteGoods_in_Europe_June15.pdf

UNFCCC, 2015, *Paris Climate Agreement*
https://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf

VELUX, 2016, *Healthy Homes Barometer*
http://www.velux.com/article/2016/Energy-renovation-resonates-with-european-home-owners

VHK, 2015, *Ecodesign impact accounting*
https://ec.europa.eu/energy/sites/ener/files/documents/Ecodesign%20Impacts%20Accounting%20%20-%20final%2020151217.pdf

WEF, 2016, *Shaping the future of construction, A breakthrough in mind-set and technology*
http://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_full_report__.pdf

Wyns, 2016, *Streamlining for performance*
http://climatestrategies.org/wp-content/uploads/2014/10/CS-Blueprint-2030-Oct-2015-formatted.pdf

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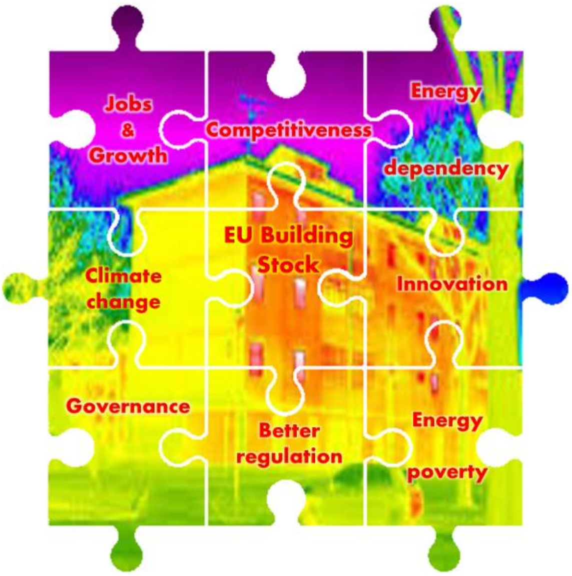
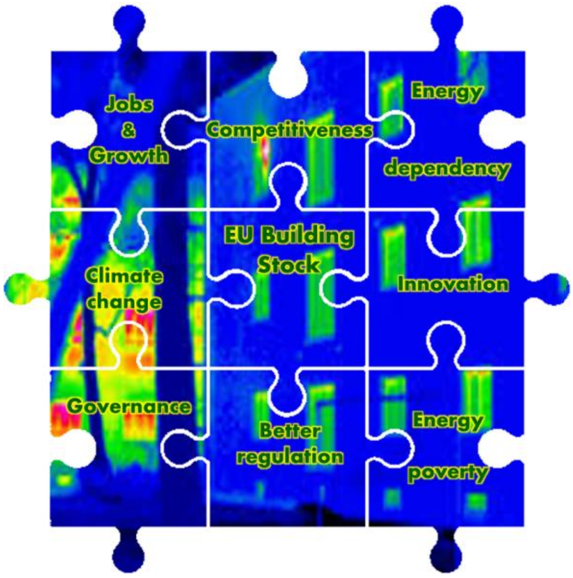


EU Building Stock Tomorrow?



-An emerging EU energy renovation market of €109 billion and 882,000 jobs.	***-An EU energy renovation industry leading the global transformation of buildings.***
-More than 40% of total EU final energy consumption and 46% of EU gas imports.	***-Net Zero (fossil) Energy Consumption buildings.***
-More than 40% of end-use sectors' direct CO_2 emissions.	*-Net Zero Carbon Emission buildings.*
-Unhealthy, leaky, polluting and high running costs buildings leading to fuel poverty.	*-Healthy, highly energy efficient buildings producing energy and empowering EU citizens.*
-Component-based energy renovation financed by grants.	*-Industrialised energy renovation and self-financed energy renovation market.*
-Fragmented provisions for buildings' energy/carbon savings among 14 EU policy instruments.	*-Efficiency First Framework combining investments-energy-climate provisions for buildings.*
-Fragmented EU institutions with unclear responsibilities.	*-EU Energy Renovation Facilitator and EU Risk Sharing Facility.*
-Fragmented stakeholders with unclear target and sub-optimum collaborations.	*-Aligned stakeholders around the clear target of Net Zero (fossil) Energy Consumption and Net Zero Carbon Emission buildings.*

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