Energy transition of Europe's building stock Implications for EU 2030 Sustainable Development Goals

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Energy transition of the EU building stock, from being an energy waster to being highly energy efficient and an energy producer, is a prerequisite for Europe's carbon neutrality, as well as for meeting Europe's Sustainable Development Goals (SDGs). Achieving these targets requires shifting the emerging energy renovation market from a market of step-by-step and shallow energy renovation financed by grants to a market of industrialized and holistic energy renovation leading to zero energy buildings financed by long-term loans. This paradigm shift is an opportunity for the construction industry to improve its productivity by industrializing the energy renovation process through the use of modern production technics and innovative technologies as well as business models. The industrialization of energy renovation will lead to cost reduction, making zero energy buildings affordable for all EU citizens, regardless of their income.

Buildings' role in Europe's decarbonisation strategy

Europe's buildings were responsible in 2015 for 40% of the Union's final energy consumption and for 37% of its CO_2 emissions. While identified more than a decade ago as a major potential for improvements, buildings' contribution to the EU energy consumption and greenhouse gas (GHG) emissions did not significantly change over the period 2010-2015. Consequently, buildings are considered one of the pillars of the EU decarbonisation strategy, and reducing the sector's energy demand and greenhouse gas (GHG) emissions has become a higher priority in the European Commission's latest policy proposals.

The European Commission's proposed *Clean Energy Package for all Europeans*, currently under negotiation at the European Parliament and the European Council, confirms the pivotal role of buildings in the decarbonisation of Europe's energy system. The 2030 energy saving targets scenarios, as assessed by the European Commission [1], project final energy demand to experience a sharp decrease in residential and tertiary buildings, compared to industry and transport sectors (See Figure 1).

Clearly, the more ambitious the energy saving target, that will be agreed in 2018, is, the more the decrease of final energy demand of residential and tertiary buildings will be. This is particularly true when comparing the expected decrease of final energy demand in ambitious scenarios to the decrease that would happen with the energy savings target of 27% as agreed by the European Council in 2014 [2] (See Figure 1). The projected decrease in the final energy demand of residential and tertiary buildings would

result from an increase of renovation rates after 2020, provided an increased ambition of energy savings target.

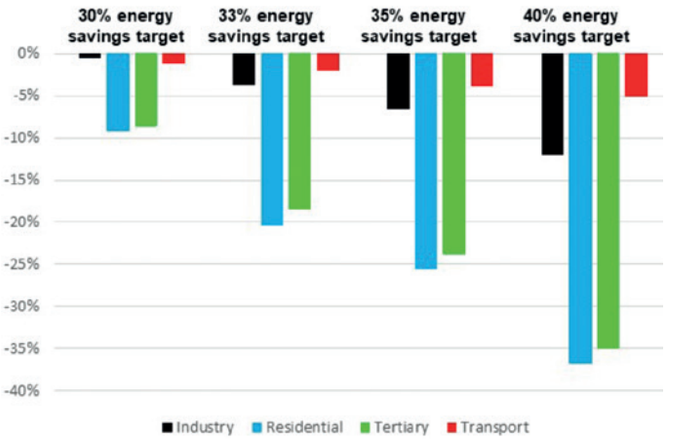

Figure 1: Percentage change in final energy demand per sector in the energy savings scenarios analysed by the European Commission in 2016 compared to the 27% energy savings target agreed by the Council in 2014.
Source: [3] based on PRIMES (1) modelling results.
Key point: Residential and tertiary buildings must deliver the highest reduction in final energy demand in each of the energy savings scenarios assessed by the European Commission.

Existing EU policy and financial frameworks to decarbonise the building stock

EU legislative instruments (besides dissemination, standardisation, recommendations, etc.) play a key role in Europe's decarbonisation strategy. Provisions to reduce buildings' energy consumption and hence GHG emissions are spread among at least 14 major EU-wide policy instruments (See Figure 2) [4].

Existing provisions range from those related to i) reducing GHG emissions of the overall building stock included in the ***Effort Sharing Decision (ESD)***, ii) renovating annually part of public buildings owned and occupied by central governments as required by the ***Energy Efficiency Directive (EED)***, iii) improving energy performance of each building individually and building components and elements as required by the ***Energy Performance of Buildings Directive (EPBD)***, iv) setting minimum energy performance requirements for appliances and equipments as required by the ***Eco-design Directive***, and iv) providing information to consumers about the energy consumption of the appliances sold in the EU market as required by the ***labelling directive***. The implementation of the provisions included in the ***Renewable Energy Directive (RED)*** should also contribute to the decarbonisation of Europe's buildings.

Furthermore, the EU provides financial support to the implementation of the existing provisions through the ***Multi-annual Financial Framework (MFF)*** and more recently through the ***European Investment Plan.*** The EU accounting rules and those related to the use of the ***State-Aids*** have also been revised to better support the decarbonisation of Europe's buildings. Other EU instruments, such as the ***Emission Trading Scheme (ETS)*** directive and the directives for setting rules for the ***Internal Market in Electricity (IME)*** and the ***Internal Market in Gas (IMG),*** also

(1) PRIMES is the EU wide energy model used by the European Commission for scenario construction and policy impact analysis.

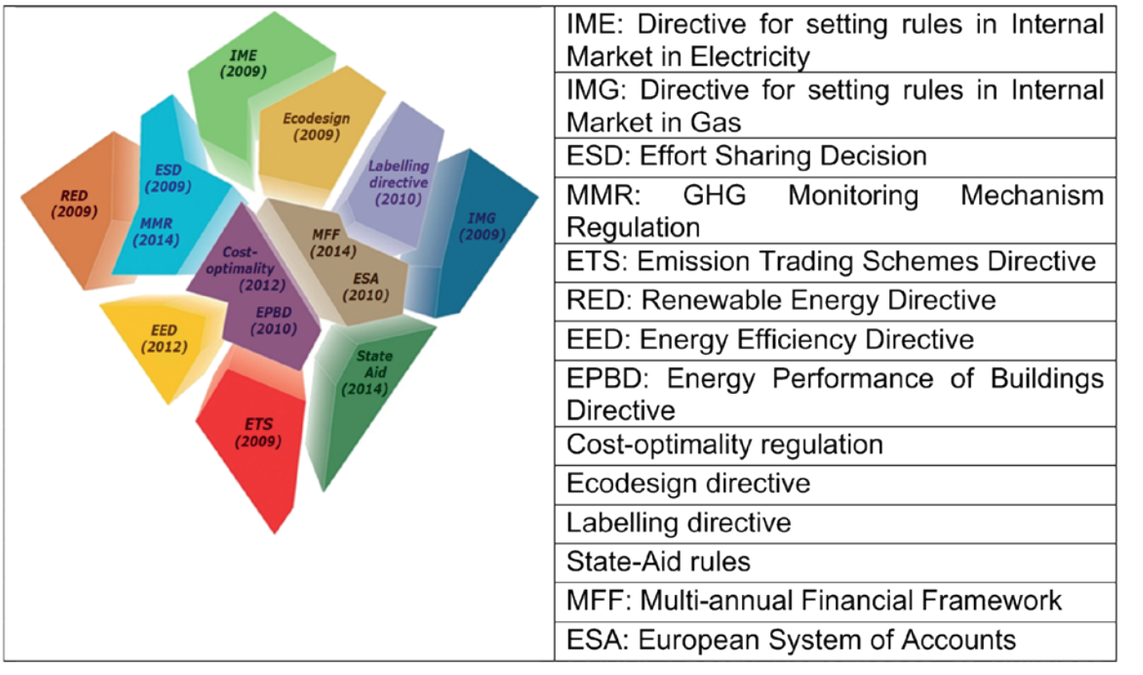

Figure 2: EU policy instruments aiming at reducing buildings' energy demand and GHG emissions.
Source: [4]
Key point: Europe's provisions to reduce buildings' energy demand and GHG emissions are comprehensive but fragmented across at least 14 EU policy instruments.

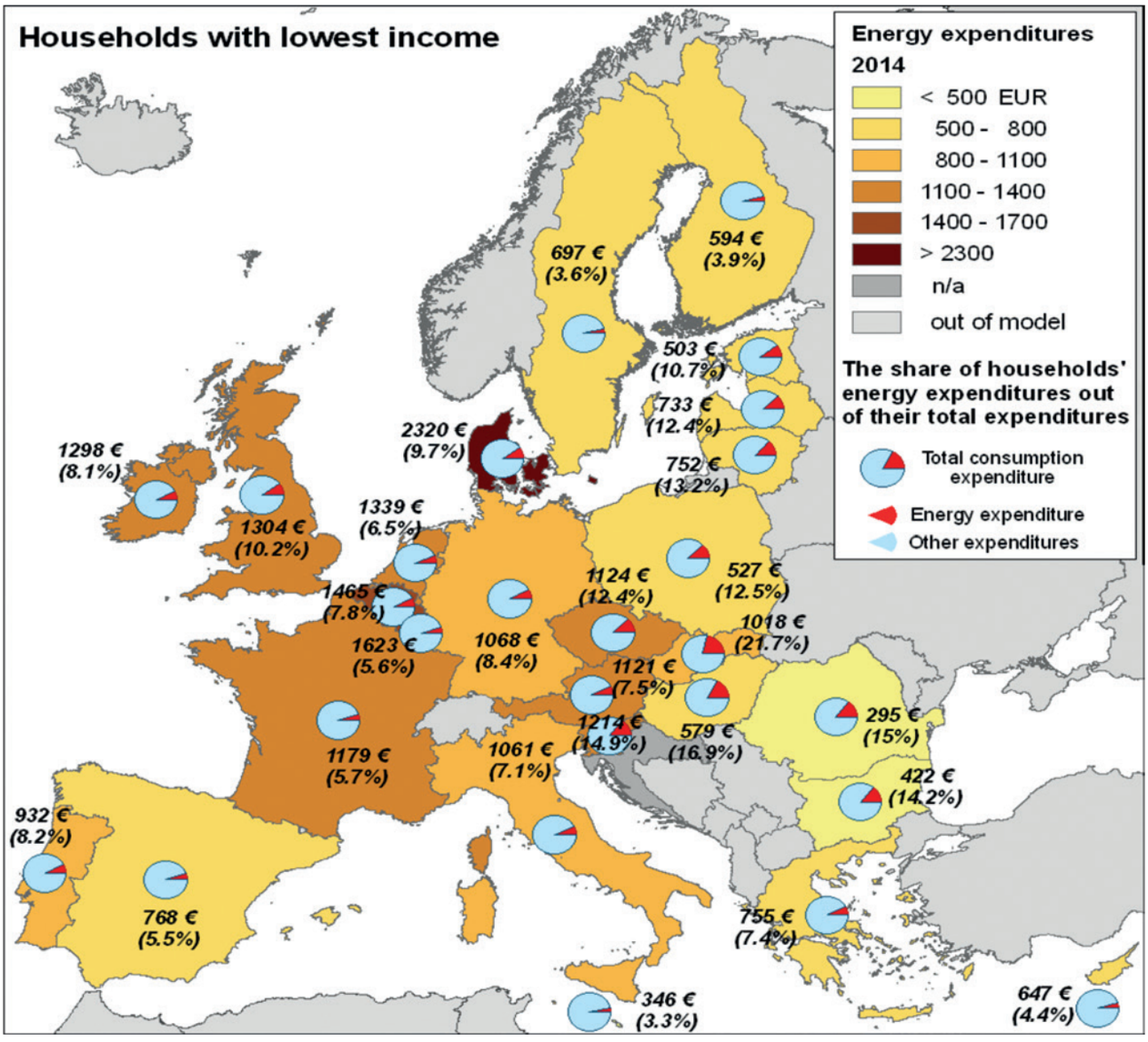

Figure 3: Low-income households' annual energy expenditures (heating, cooling, appliances and lighting) and the share of their energy expenditures out of total households' expenditures.
Source: [10] based on Eurostat data.
Key point: Energy expenditures do not necessarily follow climate patterns.

contribute to financing the decarbonisation of Europe's buildings. These instruments require Member States to allocate part of their carbon and energy taxes revenues to the transformation of their building stocks from being energy wasters to being highly energy efficient and energy producers through the integration of renewables.

Contribution of buildings' energy renovation to the EU economy

The building sector, which includes the construction of new buildings and the renovation of existing ones, is the single largest sector contributing to the EU GDP and employment. The sector had, in 2015, a turnover of EUR 1.366 billion in the EU 28, equivalent to more than 9% of the EU GDP. Almost 11 million persons were employed in the construction and/or the renovation of buildings in 2015. This was equivalent to 8% of total employment in the 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.

The financial and economic crisis hit hard on the market of new buildings in Europe, especially in Member States with over-supply of new buildings prior to the crisis. On the contrary, the renovation market is one of the sectors that benefited most 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 [5]. Governments have either extended existing measures or introduced new ones to meet their 2020 climate and energy targets. The financial and economic crisis was seen by some policy-makers as an opportunity to increase energy renovation of existing buildings, especially residential ones, and meeting two

contemporary goals. Often, European funds and/or loans have been engaged to ease the financial burden.

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 turnover. In the following years, the renovation market overtook the construction of new buildings to reach 57% out of the total in 2015 while it was 47%, in 2005. Energy renovation has been the game-changer in the market shift between the construction of new buildings and the renovation of existing ones. Governmental policies, either the ones related to the economic recovery or those related to the implementation of the EU 2020 climate and energy targets, played a major role in this market shift which has led to the rise of a vibrant energy renovation market. Consequently, the renovation market developed into a more reliable and steady form of the construction activity [6]. The dominance of the renovation market over the market of new buildings as a result of energy renovation is likely to continue in the coming years, given Europe's decarbonisation objectives and the limited need for new buildings in the European Union [4].

The EU energy renovation market was estimated at EUR 109 billion in 2015, with approximately 882,900 jobs created and/or sustained. 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. It is expected that Member States with ambitious energy renovation strategies will experience an increase of their energy renovation markets, with their small and medium enterprises becoming the main beneficiaries [4].

Contribution of buildings' energy renovation to Europe's energy justice

The overall Energy transition of Europe's buildings plays a key role for the building's energy systems, the improvement of dwelling conditions – and thus, also, in Europe's social and economic policy objectives. In recent years, policy makers made the fight against energy poverty one of their priority areas, as more than 50 million of EU citizens reported, in 2015, about their inability to keep their homes warm in winter. Energy poverty became a concern in all EU countries. However, the highest shares of the population facing energy poverty are observed in Member States with GDP per capita lower than the EU average.

Moreover, the share of households' energy expenditures out of their total expenditures contribute to the overburden of housing costs. Over the period 2008-2015, the annual rate increase of housing costs was at +1.23%, against +3.2% for households' electricity prices and +1.7% for households' gas prices [7]. The increase of households' energy prices is particularly disadvantageous for low-income households who spend almost the equivalent of one month out of their annual income to pay for their energy bill (See Figure 3) [10].

The European Commission's *Clean Energy Package for All Europeans* proposed, in recital 40 of the internal market directive for electricity [8], to define energy poverty as the "*Inability to afford basic energy services such as adequate warmth, cooling, lighting and the energy to power appliances, due to a combination of low income, high energy expenditure and poor energy efficiency of their homes*". The same directive requires Member States i) to define a set of criteria to measure energy poverty, ii) to monitor energy poverty, and iii) to report in their National Energy and Climate Action Plans (NECAPs) proposed under the Governance Regulation [9] on the evolution of energy poverty and the measures undertaken to prevent it.

Energy poverty is a multifaceted policy question with important impacts on health, exclusion and social justice and fairness. Measures used by Member States to fight energy poverty include ensuring customers are given information on alternatives to disconnection sufficiently in advance, providing financial support to low-income families to pay for their energy bills and/or to implement energy efficiency measures. Moreover, EU instruments require Member States to allocate part of their public investments in the energy transition to the renovation of dwellings occupied by low-income families. As energy costs of low-income households are partially covered by public expenditures, savings on energy bills by renovating buildings lead to savings in governmental expenditures, while ensuring access to modern energy services for all.

Financing buildings' energy transition

Energy transition of Europe's buildings benefits from EU finance through the European Structural and Investment Fund (ESIF) and the European Fund for Strategic Investment (EFSI). The former allocates €13 billion to energy renovation of residential and public buildings over the period 2014-2020 and the latter provides a guarantee and loans to third-party financing and national funds. The aim is to facilitate investments in bundled energy renovation projects. However, current financial regulations make combining EU funding difficult.

Member States, especially the most advanced ones in their energy renovation strategies, allocate an important part of their carbon revenues, households' energy taxes as well as part of their revenues from energy efficiency obligations to energy renovation. However, Member States' reporting under different EU provisions show that financial instruments are not deployed to their full potential and grants are the preferred instrument to finance energy renovation [4]. The use of grants leads to undertaking step-by-step energy renovation and implementing shallow efficiency measures, which individually are affordable, but – when summed-up to achieve deep renovation – make energy renovation costs high (up to €1.400 /m²).

Challenges of buildings' energy transition

The current, low renovation rates and the quality of energy renovation work jeopardise the energy transition of Europe's buildings, as well as the Commission's estimates of the savings potential from buildings. The Commission's scenarios are based on renovation rates at EU level of the

order of 1.5% of the building stock for the period 2015-2020 and between 1.7% and 3% for the period 2020-2030. Current renovation rates are in the most advanced countries, such as France and Germany, only around 1%. From a quality perspective, the emerging energy renovation market is a market of a step-by-step and shallow renovation leading at the best to low savings and, in the worst case, to lock the savings potential until the next renovation round [2].

The *Clean Energy Package for all Europeans* is unlikely to shift the emerging energy renovation market from shallow renovation to a market of overall and deep or even zero energy renovation. In fact, the package falls short in: i) outlining a bundling of the existing fragmented financial supports to energy renovation, ii) addressing the structural financing problem of allocating the future cash-flow between investors and owners of buildings, iii) building financial bridges between future savings and present costs, and iv) requiring deep/zero energy renovation to be undertaken when public finance is used.

Consequently, energy renovation enterprises are not encouraged to propose a more holistic energy renovation offer which would be so important for maximising the energy savings and reducing the overall cost of energy renovation. But the major fault of the step-by-step energy renovation approach is the missed opportunity to improve the productivity of the construction sector, which has rather stagnated over the last twenty years, compared to the one of manufacturing (See Figure 4). It is, therefore, unlikely that energy renovation enterprises would apply innovative technologies (Robotics, laser scanning, 3D printing, Building Information Modelling (BIM)…), and business models which would lead to improve their profitability whilst making energy renovation affordable for all, including low-income households.

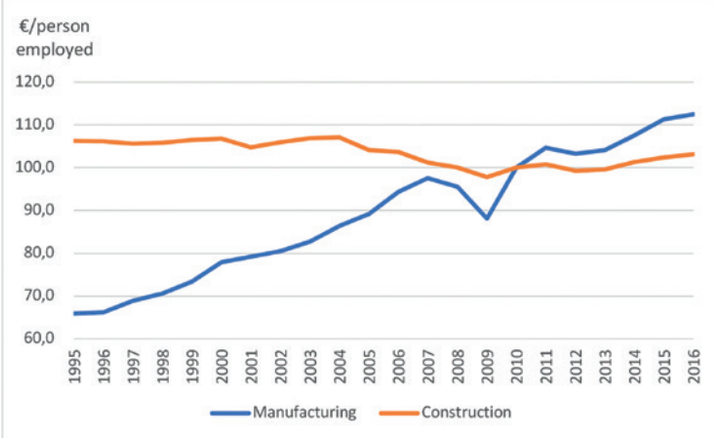

Figure 4: Productivity improvement overtime in the construction and manufacturing sectors (2010=100).
Source: OECD productivity database.
Key point: Productivity in manufacturing has nearly doubled while in the construction sector it remained almost flat over the period 1995-2016.

The way forward

Beyond reducing energy demand and GHG emissions from buildings, energy transition of Europe's buildings is an opportunity to ensure all European citizens, regardless of their income, live and work in comfortable, healthy, environmental friendly and non-polluting buildings, which provide their users with all modern services. Energy renovation should therefore be considered in a broader modernisation programme of Europe's aging building stock. The modernisation perspective will make Europe's buildings sustainable over their lifetime by tackling issues not considered when buildings undergo energy renovation only, such as embodied energy, the under-occupation of dwellings in some neighbourhoods while others face overcrowding and the adverse health and environmental impacts of some "energy efficiency-only" solutions.

The transformation of Europe's buildings from being energy wasters to being highly energy efficient and even energy producers (through the integration of renewable energy technologies) is also an economic and business opportunity. This is particularly true for small and medium enterprises, as they are major players in the building sector. Energy renovation enterprises should seize this opportunity to reshape skills, upgrade facilities and innovate (process and technologies) to offer cost-effective solutions based on recyclability, re-use and low environmental and health impacts over buildings' lifetime.

Making Europe's buildings carbon neutral, as agreed in the revised Energy Performance of Buildings Directive (EPBD), requires the construction 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 aiming at zero energy consumption. Innovation will have to occur along the overall value-chain of the building sector, from bundling existing public finance, developing holistic prefabricated zero energy renovation kits to transforming EU citizens from being passive consumers into being active prosumers. The transformation of the overall value-chain requires policy intervention and has the power to unleash the Fourth Industrial Revolution in Europe while reducing energy renovation costs.

Finally, meeting various EU priorities requires framing building's energy transition within Europe's Sustainable Goals (SDGs), as defined under the auspices of the United Nations. In fact, the impacts of a well-designed and effectively implemented energy renovation programmes go far beyond the goal on clean and affordable energy (goal 7) and the one on climate action (goal 11), as depicted in Table 1 (see below). Existing energy transition policy framework should be revised to include the societal and economic dimensions of the transformation of Europe's buildings from being energy wasters to being highly energy efficient and energy producers.

(2) On average, residential buildings undergo major renovation every 30 years, and tertiary buildings every 20 years.

Dimensions of buildings' energy transition	SDG1: No poverty	SDG 2: Zero hunger	SDG 3: Good health and well	SDG 4: Quality education	SDG 5: Gender equality	SDG 6: Clean water and sanitation	SDG 7: Affordable and clean energy	SDG 8: Decent work and economic growth	SDG 9: Industry, innovation and infrastructure	SDG 10: Reduced inequalities	SDG 11: Sustainable cities and communities	SDG 12: Responsible consumption and production	SDG 13: Climate action	SDG 14: Life below water	SDG 15: Life on land	SDG 16: Peace, justice and strong institutions	SDG 17: Partnerships for the goals
Reduced energy demand	X		X		X		X	X	X	X	X	X	X			X	X
Affordability of energy services	X		X		X		X			X	X					X	
Improved dwellings conditions	X		X		X	X	X	X	X	X	X		X		X	X	
Reduced adverse environmental impacts			X								X		X				
Reduced adverse health impacts	X		X		X						X						
Contribution to economic prosperity								X	X		X						
Increased employment and decent work								X	X		X						
Fostering innovation								X	X		X	X					

Table 1: Dimensions of buildings' energy transition and their contributions to the 2030 Sustainable Development Goals (SDGs).
Key point: Energy transition of Europe's buildings goes far beyond the energy and climate goals.

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