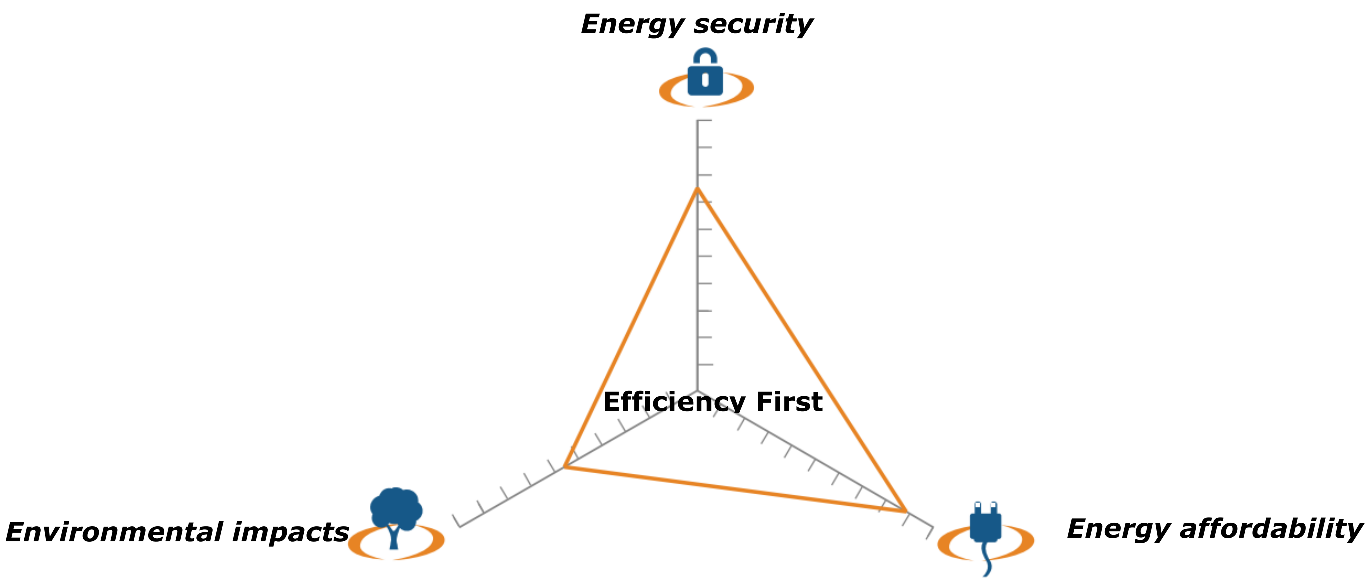
Clean Energy for All Europeans Package

Do the Commission's Impact Assessments Assign the Right Role to Energy Efficiency?



The EU Energy "Trilemma"

“Big results require big ambitions”

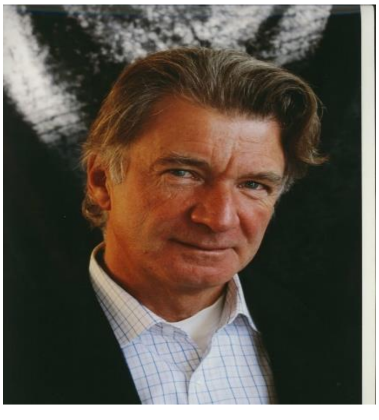
Heraclitus

Foreword

The Clean Energy for all Europeans package is the first opportunity for Europe to align its domestic energy and climate targets with the ratified Paris Climate Agreement. Unfortunately, Europe may well miss this opportunity as none of the Commission's scenarios is aligned with the Paris Climate Agreement. The 40% energy savings scenario, however, comes pretty close. As shown in this report, the analyses of the Commission's modelling results provide evidence that a 40% energy savings target by 2030 is more than feasible. I would hope that it will be seriously considered by the European Parliament and Council. The 40% savings target would put Europe on the Paris path, reduce the dependency on energy imports and hence improve our trade balance, help alleviate energy poverty and keep our industry globally competitive.

The argument of prohibitive costs, which may result from a higher energy savings target, used by the opponents to the 40% energy savings target is irrelevant. The Commission's modelling results provide the overall investments and costs including those related to energy services. The direct energy efficiency investments and costs for each sector are unknown, however, which makes a true assessment of the cost-effectiveness of energy efficiency measures impossible. Ideally the Commission should provide a detailed breakdown of the specific investments pertaining to the energy system. This would be the natural way forward to enable an evidence-based decision on the energy savings target. This being said, I cannot imagine Europe downsizing today its energy efficiency ambition because of a lack of precise information. Even without a more detailed analysis the arguments in favour of the 40% savings target seem overwhelming.

I welcome the objective of the OPENEXP report to provide additional insights into the Commission's modelling results. The report demonstrates that there are aspects of the respective energy efficiency scenarios that are not fully highlighted. These shortcomings make it more difficult for the Parliament as well as the Council to make informed decisions. The EU climate and energy targets should be based on robust and transparent scientific analyses and not on compromises behind closed doors. I welcome the proposed way forward towards a more transparent and participatory process proposed by this report. In these days, where science is put in doubt in other places of the world, Europe must seize the opportunity and lead the way by adopting an ambitious policy underpinned by science.



Anders Wijkman is co-president of the Club of Rome, Chairman of Climate-KIC, an eceee patron and was MEP (1999-2009).

Acknowledgements

This publication is an analytical report prepared by Yamina SAHEB from OpenExp. The report aims to contribute to the on-going debate in the European Council and in the European Parliament on the Clean Energy for All Europeans package proposed by the European Commission. The objective is to provide evidence-based scientific support to the European policy-making process and to contribute to a better assessment of various policy options.

The analyses included in this report are based on the impact assessment accompanying the Commission proposal to amend the Energy Efficiency Directive and the one accompanying the Commission proposal to amend the Energy Performance of Buildings Directive as well as the Technical reports on Member States results of the EUCO policy scenarios and those on macroeconomic results using E3ME and GEM-E3 models as well as the Commission's proposal to accelerate clean energy in buildings known as *"*Smart Finance for Smart Building initiative".

A workshop on the Clean Energy for All Europeans package was organised in Brussels in March 2017 for discussing the preliminary findings of the analysis. Participants at the workshop contributed valuable insights and feedback on the analyses included in this report. Additional feedback was provided by Edith BAYER, Rod JANSSEN, Charlotte JOHNSON, Adrian JOYCE and Sandor SZABO.

Special thanks go to Adrian JOYCE for editing the report and to Rod JANSSEN for his overall contribution to the project.

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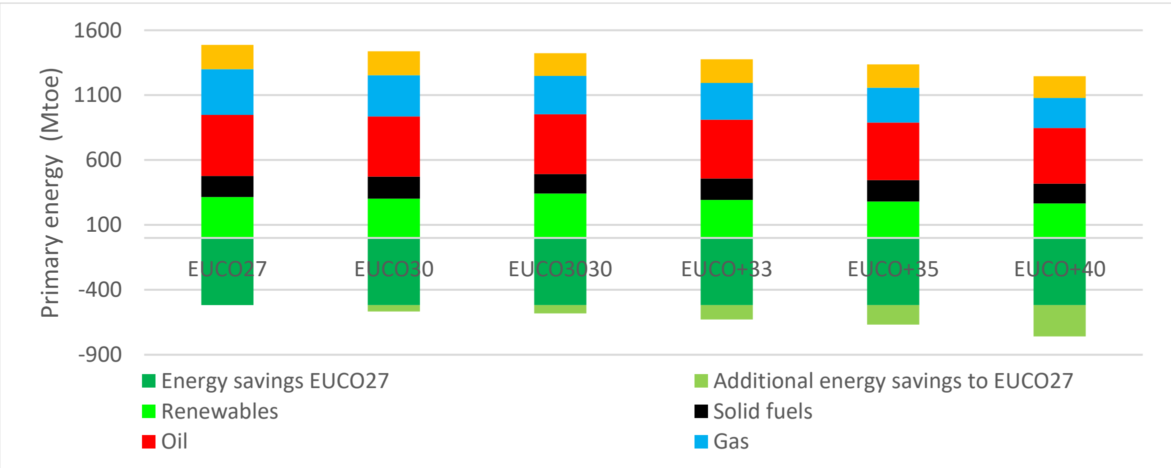
Executive Summary

The European Commission's Clean Energy for All Europeans Package, published in November 2016, includes the Commission's proposals for energy efficiency to play a meaningful role in the EU's obligations under the Paris Climate Agreement. The Commission's proposals are based on a combination of qualitative analyses and the modelling results of different energy savings scenarios. This report reviews the modelling assumptions and results included in the Commission's impact assessments related to the Energy Efficiency Directive (EED) and to the Energy Performance of Buildings Directive (EPBD). The aim is to provide additional insights to the European Parliament, the European Council and stakeholders. The overall objective is to gain a better understanding of the rationale behind the Commission's policy proposals. The following represents the main findings.

The Commission modelling results[1] show that 40% energy savings by 2030 is viable

Importantly, in line with the Energy Union Strategy Framework and its Efficiency First Principle[2], each of the policy scenarios modelled by the Commission projects energy savings to be the first fuel of Europe in 2030. As shown in Figure ES.1, energy savings are projected to be, in absolute terms, higher than any other fuel in each of the EUCO scenarios. Moreover, in the 40% energy savings scenario (EUCO+40) the sum of renewables and energy savings is projected to overtake the sum of nuclear and fossil fuels. This would reflect the expected acceleration of energy renovation of existing buildings and the increased penetration of renewables in power and heat generation.

Figure ES.1 EU 2030 primary energy mix in the Commission's scenarios



Key point: Energy savings[3] are projected to be the first fuel of Europe in 2030 in each of the Commission's scenarios.

Source: OpenExp based on the 2016 impact assessment related to the Energy Efficiency Directive

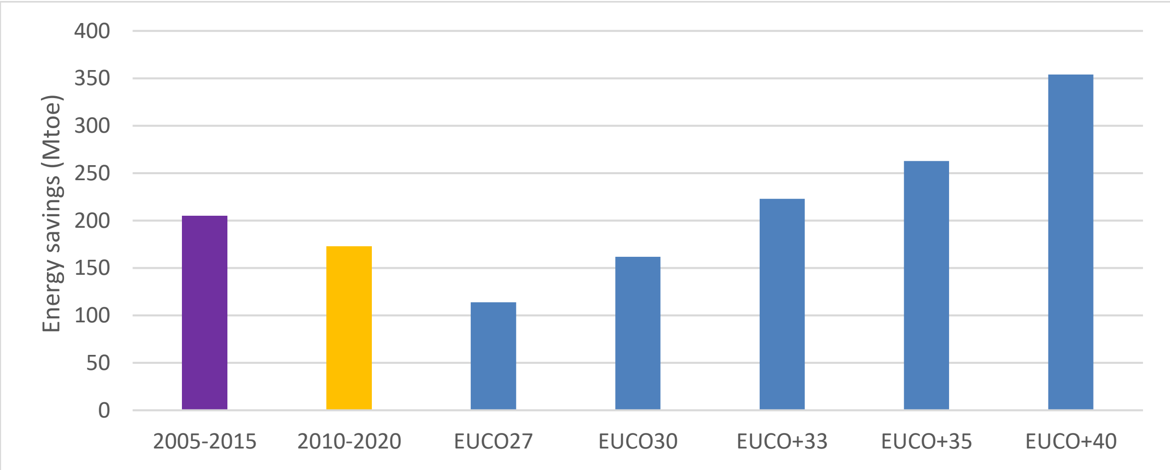
[1] The modelling results related to energy balances and discussed in this report are those considered in the Commission's 2016 impact assessment of the EED and included in The Technical Report on Member State Results of the EUCO policy scenarios

[2] Efficiency First Principle is a guiding principle introduced by the Energy Union Strategy Framework which states 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). More information on the Efficiency First Principle is available at: https://europeanclimate.org/efficiency-first-a-new-paradigm-for-the-european-energy-system/

[3] Energy savings are calculated as a difference between the 2007 baseline primary energy consumption for 2030 and the projected 2030 primary energy consumption in each of the EUCO scenarios.

The energy savings ambition for the next decade in the scenarios aiming at 27% and 30% energy savings (EUCO27, EUCO30) is lower than the one for the current decade. The projected energy savings in the EUCO27 and EUCO30 scenarios for the period 2020-2030 are, in absolute terms, lower than the savings achieved over the period 2005-2015[4] and the projected savings for the period 2010-2020 (Figure ES.2). This is significantly different in the 40% energy savings scenario where the expected energy savings for the period 2020-2030 would be double those expected for the period 2010-2020. This would reflect the expected doubling of renovation rates from 1.5% in the current period to 3.1% in the EUCO+40 in the next decade while the renovation rates increase only slightly in the scenarios aiming at 27% and 30% energy savings.

Figure ES.2 Energy savings in the period 2021-2030 (EUCO scenarios) and in the periods 2010-2020 and 2005-2015



Key point: Energy savings ambition for the next decade in EUCO27 and EUCO30 is lower than the one for the current decade.

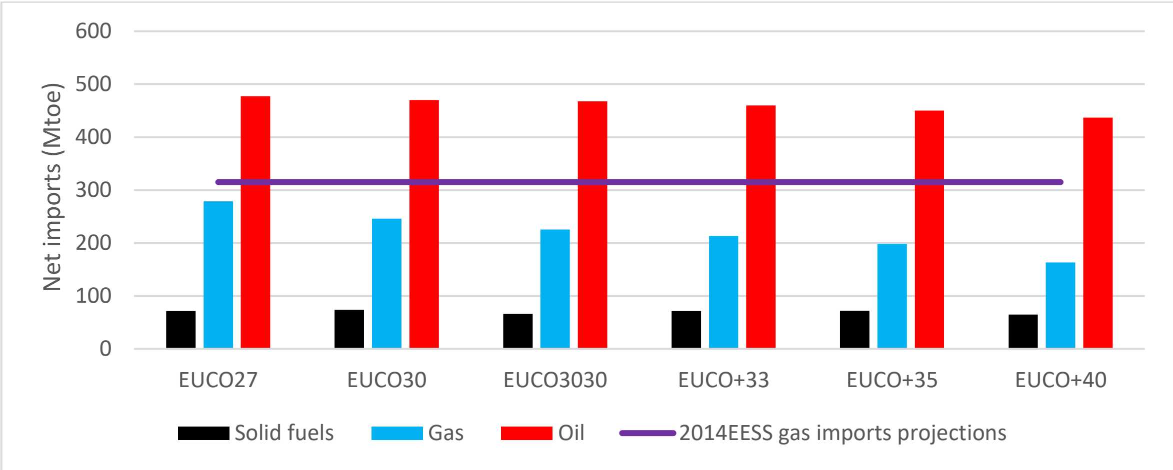
Source: Savings in EUCO scenarios and those in the period 2010-2020 are based on the 2016 impact assessment related to the Energy Efficiency Directive while savings in the period 2005-2015 are based on Eurostat data.

From an energy security perspective, the 40% energy savings scenario projects gas imports to be almost half of gas import projections in the 2014 European Energy Security Strategy (EESS). Each of the Commission's scenarios projects gas import needs to be lower than the 2030 projections for gas considered in the 2014 EESS (Figure ES.3). The more significant difference between the two projections is observed in the scenario aiming at 40% energy savings (EUCO+40). The reduction of gas imports in this scenario would result from the combined effect of the projected doubling of renovation rates and the more than doubling[5] of the number of household using electric heating. Moreover, the scenario aiming at 40% energy savings would bring a cumulative € 160 billion savings in gas import bills, over the period 2021-2030, in comparison with the scenario aiming at 27% energy savings.

[4] Energy savings referred to for the period 2005-2015 include savings due to the implementation of energy efficiency measures but also those savings resulting for reduced economic activity during this period.

[5] The projected number of household using electric heating in the EUCO+40 scenario is 53 million while the projected one in the EUCO27 is 22 million.

Figure ES.3 2030 Net imports projections of solid fuels, oil and gas in EUCO scenarios and 2030 gas projections in the 2014 EESS

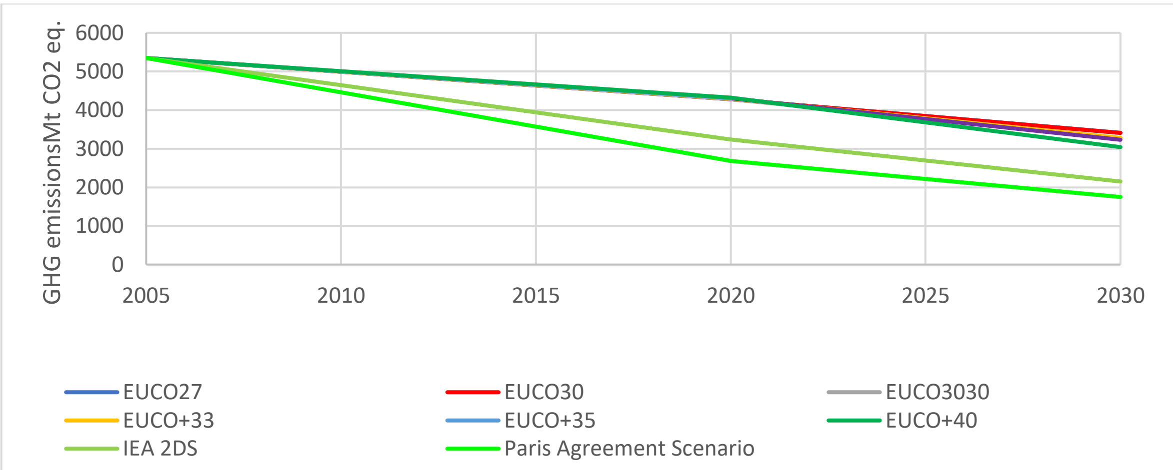


Key point: The Commission's EUCO scenarios project gas import to be lower than those considered in the 2014 European Energy Security Strategy.

Source: 2016 impact assessment related to the Energy Efficiency Directive and the European Energy Security Strategy

From an environmental perspective, none of the Commission's scenarios is aligned with the Paris Climate Agreement. The expected greenhouse gas (GHG) emissions reduction in the 40% energy savings scenario is the closest to the International Energy Agency's two-degrees scenario (IEA 2DS). However, they are still higher than the required ones under the Paris Climate Agreement (Figure ES.4). The highest share of emissions reduction is expected to take place in two sectors: a) power generation, due to increased share of renewables and b) in buildings, due to reduced heating and consequently gas demand, that would result from the renovation of the building envelope and the electrification of heating.

Figure ES.4 EU 2030 GHG emissions in the Commission's scenarios, IEA two-degrees scenario (IEA 2DS) and the Paris Climate Agreement scenario



Key point: EU 2030 GHG emissions in EUCO scenarios are higher than those of the Paris Climate Agreement scenario.

Source: GHG emissions in EUCO scenarios are based on 2016 impact assessment related to the Energy Efficiency Directive, those of the IEA 2DS are based on ETP 2016 and those related to the Paris Climate Agreement scenario are based on OpenExp estimates.

The GHG emissions reduction goes hand in hand with the increased energy savings ambition and the increased share of renewables despite the decrease of Emission Trading Scheme (ETS) carbon prices. Modelling results show that low carbon prices will not negatively impact GHG emissions reduction. This is in line with what the EU experienced in the period 2005-2014. The correlation observed, during the previous period, between GHG emissions reduction and the increased share of renewables and energy savings in the EU primary energy mix and the opposite correlation observed with ETS carbon prices are expected to occur in the period 2020-2030 (Table ES.1).

Table ES.1 2030 GHG emissions reduction, ETS carbon price, share of renewables and energy savings target in the Commission's scenarios

	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
ETS carbon price (€/t of CO_2 eq.)	42	27	27	20	14
Total GHG emissions reduction compared to 1990	-40,7%	-40,8%	-43,0%	-43,9%	-47,2%
GHG emissions reduction in ETS sectors compared to 2005	-43.1%	-43.1%	-44.3%	-44.2%	-48.3%
GHG emissions reduction in ESD sectors compared to 2005	-30.2%	-30.3%	-33.7%	-35.5%	-38.7%
Share of RE in gross final energy consumption	27%	27%	28%	28%	28%
Energy savings target	27%	30%	33%	35%	40%

Key point: Emissions reduction are expected to continue to be driven by an increased share of renewables and ambitious energy savings and not by the ETS carbon price.

Source: 2016 impact assessment related to the Energy Efficiency Directive

From a societal perspective, improving health of EU citizens and reducing energy poverty is more significant in the most ambitious energy savings scenario. The 40% energy savings scenario increases the number of life years in the population due to lower $PM_{2.5}$ by almost 17 million compared to the 27% energy savings scenario. Combined with reduced premature deaths due to reduced ozone pollution, this could translate to an average annual cost reduction of €43 billion[6]. In parallel, household energy expenditures are expected to increase only slightly as reduced energy bills would compensate, in the long term, for investments in energy efficiency measures. Moreover, real disposable incomes are expected to increase across all household groups including low-income. However, achieving these results requires tailored policy measures to ensure that ambitious energy renovation of existing buildings is undertaken, especially for buildings occupied by low-income families.

From a competitiveness perspective, energy related costs of energy intensive industries are expected to stay almost constant with increased levels of energy savings ambition. This could be explained by the combined decrease of electricity and ETS carbon prices, which would reduce energy purchases costs and auction payments, thereby outweighing the increase of capital costs necessary for investments. Consequently, this would ensure a slight decrease of the overall energy related costs of energy intensive industries (Table ES.2), in all scenarios compared to the EUCO27 scenario, and energy intensity of the industry sector improves considerably.

[6] The cost reduction referred to includes the reduction in monetary damage health due to PM and ozone concentration (estimated between 19.5 €bn/yr and 45 €bn/yr) and the air pollution control cost savings (estimated at 10.9 €bn/yr).

Table ES.2 Impacts of the Commission's scenarios on competitiveness of EU industry

	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
Ratio of energy related costs (inclusive of auction payments ETS) to value added for energy intensive industries	40.8%	40.1%	40.0%	39.8%	40.6%
ETS carbon price (€/t of CO2 eq.)	42	27	27	20	14
Auction Payments (annual average €bn '13)	6.8	4.5	4.2	3.1	2.1
Average price of electricity (€ '13/MWh)	164	161	162	161	163
Energy purchases costs (annual average €bn '13)	175.7	173.4	169.5	165.6	158.7
Capital costs (annual average €bn '13)	29.8	30.9	34.7	38.4	50.6
Total energy related costs (annual average €bn '13)	212.4	208.8	208.4	207.2	211.4

Key point: Ambitious energy savings scenarios are not expected to adversely impact the competitiveness of EU industry.

Source: 2016 impact assessment related to the Energy Efficiency Directive

From a macro-economic perspective, energy savings scenarios would contribute to keep the EU trade balance positive[7] **which in turn would drive growth and create jobs.** In fact, energy savings ambition correlates positively with the EU trade balances: ambitious energy savings scenarios show a greater demand for energy efficient products and lower demand for gas imports[8]. Investments in energy efficient technologies will therefore have a positive impact on the EU GDP except if efficiency investments are self-financed[9] which almost certainly will not be the case. Similarly, employment is expected to increase substantially with the projected increase of energy efficiency investments after 2020. Engineering and construction sectors would be the main beneficiaries of production and employment growth.

Energy renovation of existing buildings is the cornerstone of the Commission's scenarios

Renovation rates in the impact assessment related to the proposed changes to the EED are misaligned with those in the impact assessment related to the proposed changes to the EPBD. The resulting renovation rates from the EED modelling are much higher than the ones used as input for the EPBD modelling[10]. This inconsistency puts the EU at risk of not moderating its energy demand at the agreed level given the projected pivotal role for buildings in the EUCO scenarios (Figure ES.5). In fact, energy savings scenarios show greater changes in final energy demand in residential and tertiary sectors compared to industry and transport sectors in each of the EUCO scenarios. Moreover, the Commission considered in the EPBD modelling the option of obligating building owners to renovate their buildings to a given energy performance standard. The implementation of a such measure would increase over time the renovation rates. However, this option is not included in the Commission's proposed changes to the EPBD. Question remains about how to achieve the renovation rates resulting from the EED modelling and consequently how to achieve the projected savings.

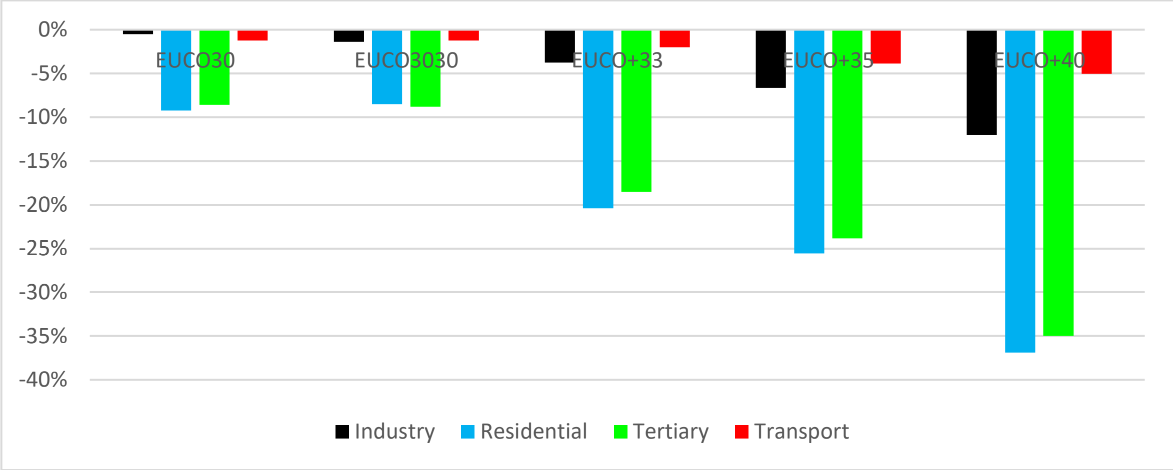
[7] It is worth noting that imports are projected to increase at a more rapid pace than exports.

[8] Currently, the trade balance of many Member States is negative exclusively because of fossil fuel imports.

[9] For the macro-economic modelling, the Commission considered four different options (self-financed, loan-based finance, no crowding out option, partial crowding out option).

[10] The EED modelling is based on a top-down approach using PRIMES model while the EPBD modelling is based on a bottom-up approach using the BEAM² model. The differences in the modelling approaches used for the EED and the EPBD do not justify the inconsistencies between the renovation rates resulting from the EED modelling and those used as input for the EPBD modelling.

Figure ES.5 Percentage change in final energy demand per sector compared to EUCO27 scenario



Key point: The building sector is expected to experience a sharp decrease of its final energy demand in 2030.

Source: OpenExp based on the [2016 impact assessment related to the Energy Efficiency Directive]

The Smart Finance for Smart Buildings (SFSB) initiative[11] **is a major step forward to mobilise private financing for energy renovation but still not sufficient to renovate Europe.** If effectively implemented, this non-legislative initiative would allow for:

i. financial de-risking through national financial platforms which would deploy attractive and accessible energy renovation loans leading to increased private investments in energy renovation;
ii. technical/technological de-risking through the local/regional one-stop-shops and the increase of Project Development Assistance (PDAs) which would facilitate bundling small projects into larger ones making them more attractive for banks and industrialised energy renovation solutions leading to economies of scale; and
iii. behavioral de-risking through the expected changes in the perception of energy efficiency investments which could result from the tailored information on energy renovation provided by various EU/national platforms to different market actors.

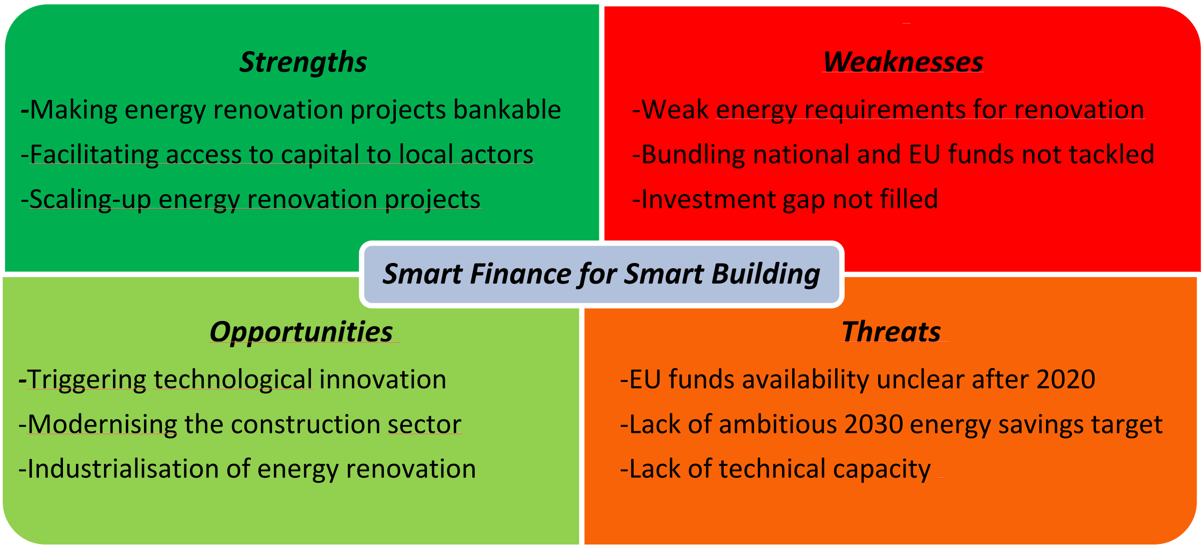
However, experience from the most advanced Member States in the renovation of their building stocks show that providing finance, PDAs and bundling small projects into larger ones is not always sufficient to trigger ambitious energy renovations at the scale needed. For the SFSB initiative to deliver on its expectations and for the EU to deliver on its energy renovation potential, the regulatory framework needs to be strengthened by requiring owners to undertake ambitious energy renovations of their buildings.

Uncertainties about the availability of EU funds in the period 2021-2030, which is the period where efficiency investments are expected to intensify, put the SFSB initiative at risk of failure. The financing platforms in the SFSB initiative are based on bundling public funding, in particular from the European Fund for Strategic Investment (EFSI) the European Regional Development Fund (ERDF) and the Cohesion Fund (CF), in order to mobilise private financing. However, the life-time of these

[11] The SFSB initiative is a non-legislative intervention designed to create an enabling framework to tackle market barriers to building renovation related to financing and to support the shift from current renovation practices based on shallow renovation financed by grants to large scale renovation projects financed by long-term loans paid back by energy savings.

three funds goes, for the time being, until 2020 and the EU public funding available in the period 2021-2030 remains unclear. This may increase the perceived risk of energy efficiency investments by investors (Figure ES.6). The two other funding mechanisms of energy renovation are ETS revenues, especially if carbon prices go up, and energy efficiency obligation schemes (EEOSs) under Article 7 of the EED if the proposed extension by the Commission is approved by the European Parliament and Council. Unfortunately, evidence shows that none of these instruments allow for financing ambitious energy renovations. ETS and EEOs revenues have, so far, mainly been used for financing low-hanging fruit measures. However, the proposed policy changes are unlikely to tackle the misalignment between the energy savings ambition and the policy instruments aiming at financing the implementation of energy efficiency measures.

Figure ES.6 SWOT analysis of the Smart Finance for Smart Buildings initiative



Key point: Effective implementation of the SFSB initiative requires policy intervention.

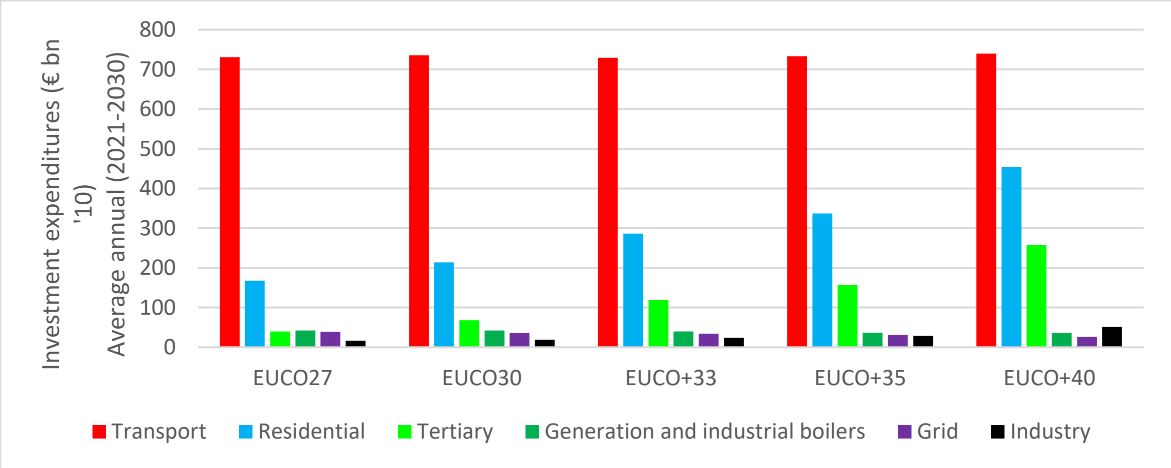
Source: OpenExp based on the Smart Finance for Smart Building initiative

Investment expenditures and costs related only to efficiency measures are unknown

The transport sector has the highest share of total[12] investment expenditures in the Commission's scenarios and the lowest contribution to energy savings. The share of total investment expenditures in the transport sector out of the total investment expenditures is projected to range from 70% in EUCO27 scenario to 47% in EUCO+40 scenario. The shares of total investment expenditures for residential and tertiary sectors are projected to increase in the most ambitious scenarios. The share of total investment expenditures in industry is kept constant, at 2% in EUCO27, EUCO30, EUCO+33 and EUCO+35 scenarios while it is projected to be at 3.3% in EUCO+40 scenario (Figure ES.7). This makes the total financing gap high because of the sector (transport) that contributes least to the energy transition (Figure ES.5) and the inclusion of energy services' investments in EUCO investment expenditures. The lack of information about the direct energy efficiency investment expenditures questions how the decision on the ambition level could be based on the cost-effectiveness of the policy options considered in the EUCO scenarios.

[12]Investments expenditures for transport include those related to mobility purposes (e.g. rolling stock).

Figure ES.7 Investment expenditures per sector in the Commission's scenarios

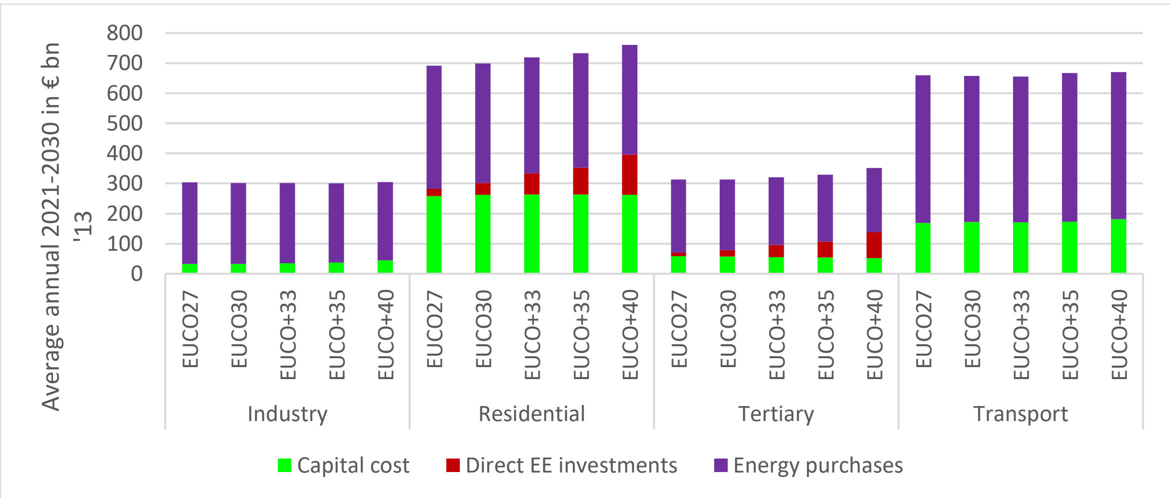


Key point: Transport sector has the highest total investment expenditures while it is the least contributing sector to energy demand reduction.

Source: [2016 impact assessment related to the Energy Efficiency Directive]

Total energy system costs per sector do not match with the expected energy savings from the implementation of energy efficiency measures. Total energy system costs of residential and transport sectors are projected to be almost equal (Figure ES.8) while the savings from the residential sector are much higher than those expected from the transport sector (Figure ES.5). Similarly, total energy system costs of tertiary and industry sectors are projected to be almost equal as well, especially in low ambitious scenarios (Figure ES.7) while the expected savings from these two sectors are quite different. The lack of information about the direct energy efficiency investment costs for the industry and the transport sectors do not allow assessing the cost-effectiveness of the planned measures in these two sectors. Furthermore, direct energy efficiency investment costs for residential and tertiary sectors resulting from the EED modelling cannot be compared to those resulting from the EPBD modelling given the differences in the renovation rates.

Figure ES.8 Energy system costs per component and per sector in the Commission's scenarios



Key point: Total energy system costs of the industry sector do not change across scenarios while those of the transport sector change only slightly.

Source: [2016 impact assessment related to the Energy Efficiency Directive]

The Commission's estimates of energy transition costs are high due to the private approach considered when estimating energy efficiency investments. The Commission's modelling assumes that individuals will take the decision to renovate their homes, buy efficient cars and efficient products. Thus, a private discount rate of 10%[13] was used when estimating total energy system costs. The guarantee/risk sharing mechanism proposed in the SFSB does not seem to be considered in these calculations since EU/EIB guarantee uses a much lower discount rate of around 4%. It is also unclear about how the effects of economies of scale on reducing technological/technical costs of energy renovation, through the expected industrialisation, which may result from large scale projects, were considered in the modelling.

The analysis of the impact assessments leaves many unanswered questions. As the approval process for the clean energy package continues in both Parliament and Council, it would be good, if a new modelling exercise is undertaken by the Commission and the following recommendations considered to allow for an evidence-based decision about the ambition level of the energy savings target:

Sensitivity analysis of different discount rate levels is needed to better assess the cost of different policy options. The debate about the discount rate to use requires an accurate comparison of energy system costs at various levels of discount rate. Similar sensitivity analysis was included in the Commission's impact assessment related to the Renewable Energy Directive (RED). A well-balanced and citizen-centred energy transition would be better based on cost-benefit analyses of different policy options at different discount rates instead of the least-cost approach considered by the Commission. Policy intervention, such as the guarantee mechanism included in the SFSB initiative will certainly be needed. This policy intervention must be reflected in the Commission's modelling to ensure a smooth transition of the EU energy system to a sustainable one.

Precise information on the direct energy efficiency investments and costs is needed to allow for an accurate assessment of the cost-effectiveness of energy efficiency measures. Imbedding direct energy efficiency investments and costs in the overall investments and costs which include also those related to energy services, as currently provided by the Commission's modelling results, may lead the Parliament and the Council to lower the ambition level for the energy savings target because of a financing gap not necessarily due to efficiency measures. It is, therefore, important to provide a detailed breakdown of energy system costs and investments.

Co-building impact assessments with stakeholders to enhance transparency and increase the robustness of policy proposals. The governance regulation is an opportunity to change mind-sets and move towards a more participatory process in policy design. Impact assessments should be opened for stakeholder input prior to the selection of the preferred option by the Commission. This would require full transparency about the assumptions, the modelling methodology and a breakdown of results into relevant components (e.g. energy efficiency investment per sector). Moreover, the use of open source models instead of privately owned models would help in building trust in the modelling process and in the results produced.

[13] The discount rate used by the Commission is lower than the one used in 2014. However, it is higher compared to the 4% discount rate recommended in the Commission's better regulation tool box.

Introduction

The Clean Energy for All Europeans package released by the European Commission on November 30th, 2016 includes proposals related to energy efficiency to amend both the Energy Efficiency Directive (EED) and the Energy Performance of Buildings Directive (EPBD). Each proposal is accompanied by an impact assessment that presents different policy options and the expected impacts of each policy option in terms of energy security, climate change, air pollution and health impacts, energy affordability, competitiveness, jobs and growth.

This publication is an analytical report that aims to contribute to making both the EED and the EPBD related impact assessments easy to understand by non-energy experts. The overall objective of this report is to support the on-going debate at the European Council and in the European Parliament on the efficiency files included in the Clean Energy for All Europeans package. The report provides evidence-based scientific support for the selection of the most suitable 2030 energy efficiency target and it brings, to the attention of decision-makers, key issues that require specific attention.

The structure of the report is as follows:

- Chapter I analyses the expected contribution of energy efficiency to EU priority areas of energy security, climate change, air pollution and health impacts, energy affordability, competitiveness, jobs and growth. The analyses are based on the policy scenarios considered by the Commission in the 2016 separate impact assessments accompanying the proposed amendments to the EED and the EPBD. It shows that in line with the Energy Union Strategy Framework, the Commission projects energy savings to be the first fuel of Europe in 2030. However, the analyses highlight inconsistencies with gas projections considered for the energy security strategy as well as inconsistencies with the Paris Climate Agreement and within the efficiency files (e.g. renovation rates resulting from the EED modelling and those considering as input for the EPBD modelling).

- Chapter II looks at, and undertakes, a cost-benefit analysis for the different policy scenarios included in the EED impact assessment. The analysis highlights discrepancies between the projected savings per sector, their related total investment expenditures and total energy system costs. The Chapter discusses the financing gap resulting from the over-estimated energy system costs due to the use of a high discount rate in the Commission's modelling. It recommends conducting a sensitivity analysis of the impact of different discount rates on the energy system costs to better inform decision-makers.

- Chapter III discusses the Commission's proposal on how to finance the energy transition with a specific focus on financing energy renovation of the building stock in the EU. The analyses are based on the Commission's initiative entitled *"Smart Finance for Smart Buildings" (SFSB)* which provides a de-risking framework for financing until 2020. The Chapter shows that SFSB is at risk of failure if the regulatory framework is not strengthened.

- Chapter IV provides the conclusions of the report

Chapter I: Contribution of energy efficiency to EU priority areas

Highlights

- In line with the Efficiency First principle, energy savings are projected to be the first fuel in Europe in 2030 across all the Commissions' scenarios. Similarly, renewables are projected to be the first fuel in power generation in 2030. The scenario with a 40% energy savings target may ensure EU energy independence in the longer term as, already in 2030, the sum of energy savings and renewables overtake the sum of fossil fuels and nuclear altogether.
- None of the Commission's scenarios is aligned with the Paris Climate Agreement requirements. However, the projected GHG emissions reduction in the scenario with 40% energy savings target are consistent with those resulting from the IEA two-degrees scenario, but are still far from the expected GHG emissions reduction for Europe to meet its Paris Climate Agreement commitment.
- The highest cuts in energy demand are projected to take place in the residential and tertiary sectors while the industry sector is projected to achieve the lowest reductions in energy demand. These projected energy demand reductions in residential and tertiary sectors would be driven by the renovation of existing buildings. However, the renovation rates used in the EPBD modelling are much lower than those resulting from the EED modelling.
- The demand for electricity is projected to slow down as ambition for energy savings increases, despite the projected increase in electrification for heating and transport. This would lead to a decrease of electricity prices and would have a positive impact on the competitiveness of EU industry and energy affordability.
- The increased ambition for the energy savings target is expected to reduce health impacts that arise from pollution leading to a decrease in costs related to health care. Similarly, the Commission's scenarios have positive impacts at EU level on jobs and growth, especially in the construction and engineering sectors as the scenarios target mainly residential and tertiary sectors.
- The Commission's modelling show negative impacts on GDP and employment in some Member States. Analyses of these impacts require disclosing the assumptions behind the macro-economic modelling. This would allow a better understanding of the impacts on jobs and growth resulting from the use of the general equilibrium macro-economic model (GEM-E3). Policy intervention might be needed to address specific national economic contexts.

This Chapter provides analysis of the impacts of the Commission's energy savings scenarios in terms of energy security, climate change, air pollution and health impacts, energy affordability, competitiveness, jobs and growth. This assessment required the Commission to combine a set of energy and economic models and different modelling approaches (Box 1.1).

The scenarios analysed in this Chapter are those included in the impact assessment accompanying the proposed amendments to the EED. Regarding the building sector, analyses of the scenarios considered in the impact assessment accompanying the proposed amendments to the EPBD are also included. In total, 11 scenarios were considered by the Commission, out of which seven relate to the proposed amendments to the EED and four relate to the proposed changes to the EPBD.

The Chapter is illustrated with graphs and tables based on the modelling results included in the above-mentioned reports and the technical report on Member State results of the EUCO policy scenarios.

The scenarios considered in the impact assessment for the proposed amendments of the EED include:

1. **REF2016:** is the 2016 EU reference scenario. It is based on currently implemented policies. REF2016 scenario does not achieve the agreed 2030 targets of at least 40 GHG emissions reduction, at least 27% target of renewables' share in final energy consumption and at least 27% energy savings target as compared to the 2007 baseline for 2030.
2. **EUCO27:** is the baseline scenario used across all impacts assessments included in the "Clean Energy for All Europeans" package. It aims at 27% energy savings target as compared to the 2007 baseline for 2030. This scenario meets the agreed 2030 climate and energy targets.
3. **EUCO30:** is based on the European Council guidance of having in mind a 30% energy savings target as compared to the 2007 baseline for 2030. The EUCO30 scenario meets the agreed 2030 climate and energy targets.
   NOTE: The EED amendments proposed by the Commission are based on this scenario.
4. **EUCO3030:** is a sensitivity scenario in line with the European Parliament position for the renewables target and the European Council guidance for the energy savings target. It assesses the combined effect of a 30% energy savings target as compared to the 2007 baseline for 2030 and a 30% target for the renewables' share in final energy consumption. The EUCO3030 scenario slightly overshoots the 2030 targets.
5. E**UCO+33:** explores a higher ambition for energy efficiency with a 33% energy savings target as compared to the 2007 baseline for 2030. The EUCO+33 scenario slightly overshoots the agreed 2030 climate and energy targets.
6. **EUCO+35:** explores a higher ambition for energy efficiency with a 35% energy savings target as compared to the 2007 baseline for 2030. The EUCO+35 scenario slightly overshoots the agreed 2030 climate and energy targets.
7. **EUCO+40:** is in line with the European Parliaments' call for a 40% energy savings target as compared to the 2007 baseline for 2030. The EUCO+40 scenario overshoots the agreed 2030 climate and energy targets and brings Europe's GHG emissions reduction targets

closer to the International Energy Agency two-degrees scenario (IEA 2DS). However, still far from the carbon budget for Europe under the Paris Climate Agreement.

The scenarios considered for the amendments of the EPBD include:

1. **Reference scenario:** which assumes that the EPBD, in combination with other EU policy and financial instruments, is delivering on its objectives. No policy changes are therefore considered in this scenario.
2. **Option I:** is a scenario based on enhanced implementation and further guidance on some of the existing provisions. In this scenario, the Commission would provide guidance to Member States on the cost-optimality calculation methodology. The aim for the Commission is to address the gaps between the calculated energy demand of existing buildings and actual consumption.
3. **Option II:** is a scenario based on enhanced implementation, including targeted amendments for strengthening current provisions. The changes considered under this scenario include:
    i. Setting milestones for the decarbonisation of the building stock by 2050.
    ii. Clarifying some provisions in the cost-optimality calculation methodology.
    iii. Improving the efficiency of technical building systems by documenting their initial performance and maintaining their operational performance over time.
    iv. Reinforcing the quality of Energy Performance Certificates (EPCs).
    v. Including provisions for a smartness indicator.
    vi. Including provisions for electro-mobility.

    Note: The EPBD amendments proposed by the Commission are based on this scenario.
4. **Option III:** is a scenario based on enhanced implementation towards further harmonisation and higher ambition. The changes considered under this scenario include:
    i. Setting milestones for the decarbonisation of the building stock by 2050.
    ii. Obligating building owners to renovate their buildings to a given energy performance standard.
    iii. Clarifying provisions in the cost-optimality calculation methodology, including additional benefits and going beyond cost-optimality.
    iv. Improving the efficiency of technical building systems by documenting their initial performance and maintaining their operational performance over time.
    v. Reinforcing the quality of EPCs and harmonising templates for EPCs based on a common list of indicators.
    vi. Including provisions on a smartness indicator.
    vii. Including provisions on Electro-mobility.

Box 1.1 Analytical framework

The following models were used by the Commission in its impact assessments of the EED and the EPBD:

1. **PRIMES** (Price-Induced Market Equilibrium System). A model that simulates the European energy system and markets on a country-by-country basis and across Europe for the entire energy system. The core-model is bottom-up and completed by various sub-modules. The model was partially

developed with EU research funding but is owned by a consortium led by the Energy-Economy-Environment Laboratory at the National Technical University of Athens (NTUA), which does not offer experts access to the model.

The PRIMES model was used to provide projections of detailed energy balances, both for demand and supply, CO_2 emissions, investments in demand and supply, energy technology penetration, prices and costs. The projections are provided over the period from 2015 to 2050 in 5-year intervals per Member State and for the EU28.

2. **GAINS** (Greenhouse gas and Air Pollution Information and Simulation). A model that is an integrated assessment model of air pollutants and greenhouse gas emissions and their interactions. The underlying algorithms are the property of the International Institute of Applied System Analysis (IIASA). The model is [accessible online for experts' use].

   The GAINS model was used for the assessment of the non-CO2 emission projections and air pollution impacts on human health from fine particulate matter and ground-level ozone.
3. **E3ME** (Energy-Environment-Economy Model for Europe) is a macro-economic model based on a post-Keynesian approach. The model assumes that investments in one sector do not automatically lead to a crowding-out effect on investments in other sectors. E3ME considers that energy efficiency measures are financed by ETS allowances.

   The model was partially developed with EU research funding but is the property of a consortium led by Cambridge Econometrics, which does not offer experts access to the model.

   E3ME was used to estimate the macro-economic impacts in terms of trade balances, jobs and growth at the EU and Member State levels. These estimates are provided for two options: no crowding-out and partial crowding-out. The model was used for both the EED and the EPBD impact assessments.
4. **GEM-E3** (General Equilibrium Model for Energy, Economy and Environment interactions) is a macro-economic model that assumes that capital markets operate in an optimal manner. This means additional investments in energy efficiency measures imply less capital available for other sectors. The model assumes that energy efficiency measures are financed by individuals.

   The model was partially developed with EU research funding but is a property of a consortium led by the Energy-Economy-Environment Laboratory at the National Technical University of Athens (NTUA) which does not offer experts access to the model.

   GEM-E3 was used to estimate the macro-economic impacts in terms of trade balances, jobs and growth at the EU and Member State levels. These estimates were made for two options: self-financing (no additional borrowing is possible) and loan-based financing (firms and households can borrow in capital markets without facing increasing unit costs of funding) of efficiency measures. The model was used only for the EED impact assessment.
5. **POLES** (Prospective Outlook on Long-term Energy Systems) model is a global partial equilibrium model simulating the entire energy system, both supply and demand. The model is based on a hybrid concept (bottom-up and top-down).

   The model was developed and is run by the Joint Research Centre of the European Commission. However, it does not offer experts access to the model.

   The POLES model was used to estimate the impacts of energy efficiency scenarios on international fuel prices (oil, gas and coal).
6. **IEEM (**Industrial Energy Efficiency Model) is a bottom-up model for the industrial sector that assesses the impact of eco-design measures, the continuation of energy efficiency obligation schemes and a better access to finance for industry.

   The model was developed and run by ICF International, which does not offer expert access to the model.

   Estimates made with IEEM were only used for comparison with the PRIMES results for industry.
7. **BEAM²** (Built Environment Analysis Model) is a bottom-up model based on building physics that

applies policy options to the building stock inventory, which is described in a disaggregated manner.

The model was developed and is run by ECOFYS, which does not offer experts access.

BEAM^2 was used to estimate final energy consumption per end-use (EPBD scope), technology and age band. It also estimates investments needs. BEAM^2 results (energy demand and investments) were used as inputs to estimate, in conjunction with the E3ME model, the macro-economic impacts of the scenarios considered for the EPBD amendments.

Key point: Each of the models, described above, plays an integral role in how the Commission assesses the impact of different policy scenarios. Yet, none of the models used by the Commission is an Open Source model and only one model gives experts access.

Impacts of the Commission's scenarios on EU energy security

Energy security is defined by the European Commission as the "uninterrupted availability of energy products at a price which is affordable for all consumers (private and industrial), while respecting environmental concerns and looking towards sustainable development" (EC, 2000). A country's energy security status is the combined result of several factors including i) the diversity of energy sources in its energy mix; ii) the extent to which it depends on imports to meet its energy needs; and iii) the diversity of its energy suppliers, which determines how vulnerable it is to political decisions taken in other countries. The more diverse a country's domestic energy sources (i), the lower its dependency on imported fuels (ii) and the more diverse its suppliers (iii), the less vulnerable it is to shocks affecting a specific energy source because of supply disruption, decisions taken elsewhere and price volatility (EC, 2013). Effective implementation of energy efficiency measures has a direct impact on EU energy security by reducing the overall energy demand and by increasing the share of energy savings in the EU primary energy mix (JRC, 2015-a). Consequently, as the use of indigenous energy sources increases the level of imports decreases, especially for the fuels consumed in the sectors targeted by policy measures as shown in the following sections.

EU energy mix per fuel

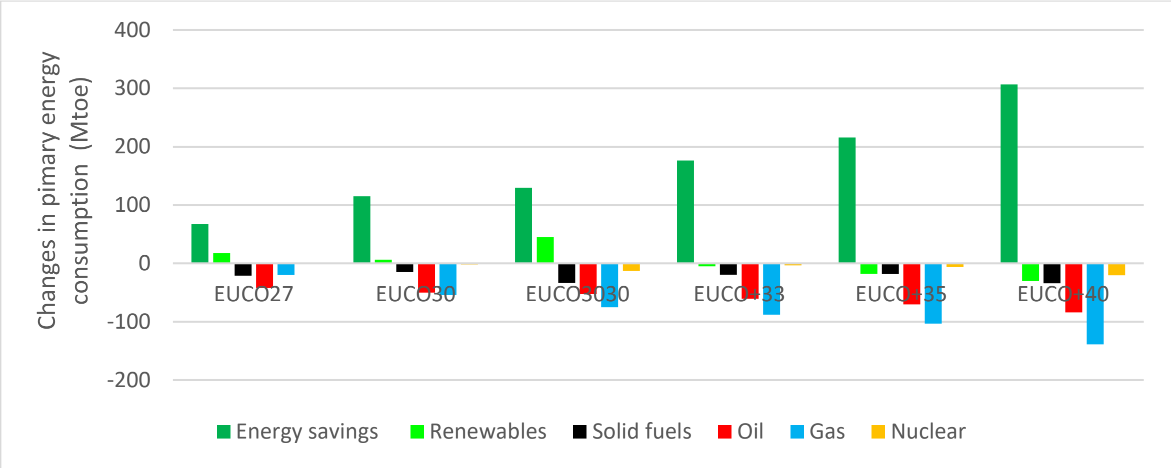
The projected intensification of energy efficiency policies after 2020 would reduce the growth of primary energy consumption in absolute terms, as compared to the reference scenario, by (4.7%) in EUCO27, (8.0%) in EUCO30, (9.1%) in EUCO3030, (12.3%) in EUCO+33, (15.0%) in EUCO+35 and (21.4%) in EUCO+40. This reduction in primary energy consumption is due to the projected increase of energy savings[14], as compared to the reference scenario, by (14.9%) in EUCO27, (25.4%) in EUCO30, (28.8%) in EUCO3030, (39.1%) in EUCO+33, (47.8%) in EUCO+35 and (68.0%) in EUCO+40. In scenarios with more than 27% energy savings, the main savings, as compared to the reference scenario, would occur in gas (Figure 1.1).

Energy savings are projected to be, in absolute terms, higher than any other fuel in each of the EUCO scenarios. If effectively implemented, energy efficiency measures considered in the EUCO scenarios would, therefore, make energy savings the "first fuel" of Europe in 2030 which is in line with the Energy Union Strategy Framework (EC, 2015-a). Importantly, in the scenario with 40% energy

[14] Energy savings are calculated as a difference between the 2007 baseline primary energy consumption for 2030 and the projected 2030 primary energy consumption in each of the EUCO scenarios.

savings, in absolute terms, the sum of energy savings and renewables is projected to overtake the sum of nuclear and fossil fuels altogether. This may lead in the long run to EU energy independence. Oil is projected to be Europe's second fuel in 2030 in absolute terms, followed by renewable energies and gas.

Figure 1.1 Changes in primary energy consumption compared to the reference scenario per fuel in EUCO scenarios



Key point: In scenarios with more than 27% energy savings, the highest savings would occur in gas consumption.

Source: OpenExp based on 2016 impact assessment related to the Energy Efficiency Directive

Compared with the reference scenario, oil demand is projected to decrease in absolute terms by (8.3%) in EUCO27, (9.7%) in EUCO30, (10.3%) in EUCO3030, (11.8%) in the EUCO+33, (13.8%) in EUCO+35 and (16.3%) in EUCO+40 reflecting the expected increased stringency of CO_2 standards for cars and vans.

In the scenario with 27% energy savings, gas is the fossil fuel which is expected to experience the lowest drop compared to the reference scenario (5.4%). While, in scenarios with more than 27% energy saving, gas is the fossil fuel that is expected to see the biggest drop reflecting the decrease in heating demand due to the expected higher building renovation rates and the increase in electrification of heating. As compared with the reference scenario, gas demand falls, in absolute terms by (5.4%) in EUCO27, (14.6%) in EUCO30, (20.3%) in EUCO3030, (23.7%) in EUCO+33, (27.8%) in EUCO+35 and (37.5%) in EUCO+40.

Nuclear is the energy source that should not see a big drop in absolute terms except in scenarios with high ambition for both renewables and efficiency. This is explained in the impact assessment related to the Renewable Energy Directive by the assumption that most existing nuclear power plants will be maintained and the oldest ones will be replaced by new ones (EC, 2016-b). As compared with the reference scenario, nuclear demand falls, in absolute terms, by (0.2%) in EUCO27, (1.0%) in EUCO30, (6.7%) in EUCO3030, (1.9%) in EUCO+33, (3.3%) in EUCO+35 and (11.1%) in EUCO+40.

Solid fuels are expected to experience the highest drop in fossil fuels consumption in the EUCO27 scenario compared to the reference scenario with a decrease of consumption estimated at (11.4%).

This is probably due to the increased share of renewables in this scenario compared to the reference scenario and not to the implementation of energy efficiency measures, as EUCO scenarios do not target end-use sectors consuming solid fuels. Moreover, the impact assessment states "*lower ETS prices allow* maintaining consumption *of solid fuels as the scenarios become more ambitious*". However, PRIMES modelling results show a decrease, as compared to the reference scenario, of 18.4% in EUCO+40 scenario (with an ETS carbon price at €14/$tCO_{2\,eq.}$) against a decrease of (11.4%) in EUCO27 (with an ETS carbon price at 42€/$tCO_{2eq.}$). Solid fuels consumption is projected to be, in absolute terms, at 151 Mtoe in EUCO+40 against 164 Mtoe in EUCO27 and 185 Mtoe in the reference scenario. As compared with the reference scenario, solid fuels demand falls, in absolute terms, by (11.4%) in EUCO+40, (8.0%) in EUCO30, (18.1%) in EUCO3030, (10.4%) in EUCO+33, (10%) in EUCO+35 and (18.4%) in EUCO+40.

Renewables are modelled as a share of the total energy consumption. Consequently, the modelling results show a decrease, in absolute terms, of renewables' consumption when total energy consumption falls. This negative interaction between the increased stringency of energy savings target and renewables, could be eliminated if, when modelling ambitious energy savings scenarios, the resulting absolute quantity of renewables in the baseline scenario (EUCO27) is considered instead of modelling renewables as a share of total energy consumption. Compared with the reference scenario, renewables increase, in absolute terms, by (5.8%) in EUCO27, (2.1%) in EUCO30 and (15.0%) in EUCO3030 while they are projected to decrease by (1.7%) in EUCO+33, (5.9%) in EUCO+35 and (10.2%) in EUCO+40.

The changes in the primary energy consumption, compared to the reference scenario, described above have a direct impact on net imports of fossil fuels. Gas imports will experience the most pronounced reductions (Table 1.1) as a result of the projected increase of renovation rates of existing buildings and the electrification of heating (see next section). Net imports of oil do not vary strongly across the scenarios while solid fuel imports vary only slightly (Table 1.1).

In each EUCO scenario, net imports of gas are projected to be lower than the gas projections considered for the 2014 European Energy Security Strategy[15] (EC, 2014). Importantly, in the scenario aiming at 40% energy savings (EUCO+40), gas imports would only be about half of the gas projections considered for the EESS (Table 1.1). Overall, EUCO scenarios allow keeping EU energy dependency in 2030 at almost the current level (52%.)

Table 1.1 2030 Net imports projections of solid fuels, oil and gas in EUCO scenarios and 2030 gas projections in the 2014 EESS

Net imports in EUCO scenarios	EUCO27	EUCO30	EUCO3030	EUCO+33	EUCO+35	EUCO+40
-Solid fuels (Mtoe)	71	74	66	72	72	65
-Gas (Mtoe)	279	246	225	213	198	164
-Oil (Mtoe)	478	470	467	460	450	437
2014 EESS gas imports (Mtoe)	315	315	315	315	315	315

Key point: Gas imports in EUCO scenarios are projected to be lower than those considered in the 2014 European Energy Security Strategy.

Source: 2016 impact assessment related to the Energy Efficiency Directive and the European Energy Security Strategy

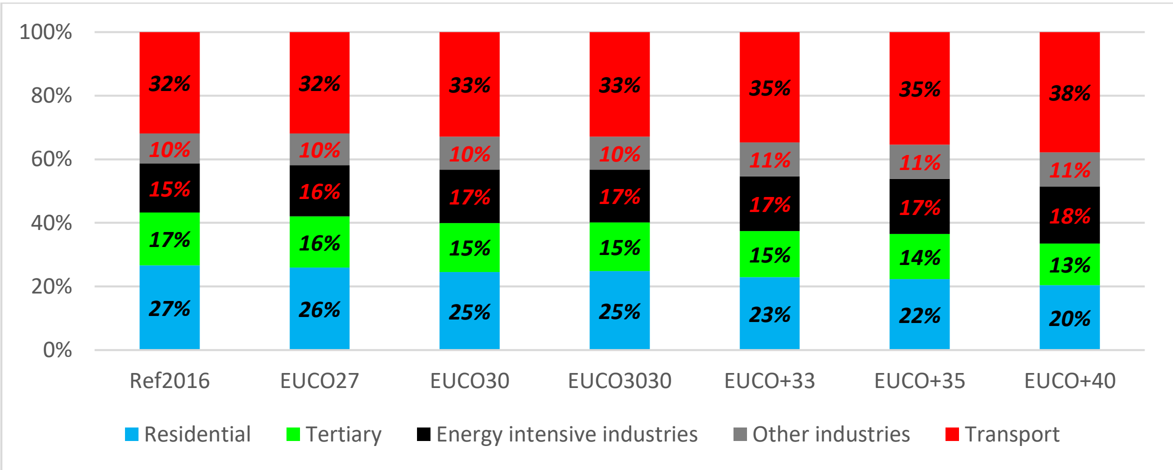
[15] The strategy was based on 2013 reference scenario.

EU energy mix per sector

End-use sectors

The Commission's modelling results show that end-use sectors' respective shares of final energy demand in 2030 will be different from the current shares. In 2015, the buildings sector (residential and tertiary) had the highest share of final energy demand with 39% out of the EU total final energy demand, followed by the transport sector with 33% and the industry sector with 25%. Compared to 2015, the major shift of the shares will be between the building and the transport sectors. The more ambitious the energy savings target, the lower would be the share of buildings' final energy demand out of the total, leading to an increased share of the final energy demand of the transport sector. In the scenario aiming at 40% energy savings, the share of final energy demand of the transport sector is projected to reach 38%, against 33% for the buildings sector (Figure 1.2). Industry's share will remain the smallest one and will experience only a slight increase (Figure 1.2).

Figure 1.2 2030 End-use sectors' shares of final energy demand in the Commission's scenarios



Key point: The building sector is the only sector expected to experience a sharp decrease of its final energy consumption in 2030.

Source: OpenExp calculations based 2016 impact assessment related to the Energy Efficiency Directive

a) Buildings

The building sector is projected to experience a sharp decrease of its final energy demand. Compared with the reference scenario, the fall in absolute final energy demand of residential and tertiary buildings is projected to be almost equal in scenarios with low ambition (EUCO27, EUCO30 and EUCO3030) while the decrease of final energy demand of residential buildings is projected to be higher than the one of tertiary buildings in the more ambitious scenarios. Further investigation is needed to understand these differences.

Final energy demand of residential buildings is projected to fall, compared to the reference scenario, by (7.1%) in EUCO27, (15.7%) in EUCO30, (15.0%) in EUCO3030, (26.1%) in EUCO+33, (30.9%) in EUCO+35 and (41.4%) in EUCO+40. While final energy demand of tertiary buildings is projected to fall, compared to the reference scenario, by (7.1%) in EUCO27, (15.1%) in EUCO30, (15.3%) in EUCO3030, (24.3%) in EUCO+33, (29.1%) in EUCO+35 and (39.6%) in EUCO+40.

The expected changes in the final energy demand of residential and tertiary buildings described above would result from an increase of renovation rates, after 2020, with the increased ambition of energy savings (Table 1.2).

Table 1.2 Renovation rates and electrification of heating in the EED impact assessment

	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
Renovation rates 2015-2020	1.5%				
Renovation rates 2021-2030	1.7%	2.1%	2.7%	2.9%	3.1%
Number of household with electric heating (millions)	22	30	48	48	53

Key point: The acceleration of energy renovation is expected to take place in the period 2021-2030.

Source: 2016 impact assessment related to the Energy Efficiency Directive

Overall, the measures assumed for the buildings sector aim at reducing heating demand and shifting to electric heating systems (Table 1.2). This explains the drop-in gas demand and, consequently, the drop-in gas imports described in the previous section. However, the assumptions considered by the Commission for buildings raise several questions:

1. Policy measures which would lead to the increase of rates and depth of energy renovation resulting from PRIMES modelling are not described in the EED impact assessment nor in the EPBD one. Achieving the energy savings target of the EED preferred option is, therefore, questionable, as existing provisions in both the EED and the EPBD have, for the time being, failed in increasing the rate and the depth of energy renovation.
2. Renovation rates considered for the preferred option (EUCO30) in the EED impact assessment (Table 1.2) are higher than those used for the preferred option (Option II) in the EPBD impact assessment (Table 1.3). This makes comparative analyses of the impacts of the EPBD preferred option and the EED preferred option not possible. Furthermore, achieving the expected reductions in final energy demand of buildings would, in theory, require higher rates for building envelope renovation compared to heating systems exchange rates. However, assumptions used for the EPBD impact assessment assumes the opposite, higher replacement rates for heating systems compared to the renovation rates of the envelope (Table 1.3).

Table 1.3 Renovation assumptions used as input for modelling the impact of the EPBD changes

2015-2030	Option I	Option II	Option III
Residential buildings (envelope renovation rates)	0.61% -1%	0.61% - 1.6%	
Tertiary buildings (envelope renovation rates)	0.7% -1.14%	0.7% -1.7%	
Heating systems exchange rates	3.6%-4.2%		

Key point: The low renovation rates considered in the EPBD preferred option question the achievement of the energy savings target of the EED preferred option.

Source: 2016 impact assessment related to the EPBD

3. The assumed impact of Article 7 on the ambition level of energy renovation, modelled as Energy Efficiency Values (EEVs)[16], and the underlying national policies implemented by Member States is questionable. In fact, based on Member States' notifications, Energy Efficiency Obligation Schemes (EEOSs) and the alternative measures implemented under Article 7, usually, target cheap measures with short pay-back time. If effectively implemented and well combined with other instruments, measures under Article 7 allow at the best upgrading heating systems and some building elements (RICARDO, 2016). The Commission assumes that the proposed long term perspective (continuation of Article 7) would encourage designing more long-term measures aiming at ambitious energy renovation. However, evidence to support this assumption is lacking.
4. The *Smart Finance for Smart Buildings* initiative (EC, 2016c) includes setting-up a guarantee mechanism for renovation projects. This would translate into low discount rates (4%) leading to low energy system costs which may make energy renovation financeable through existing funds (see Chapter II and III). This policy measure does not seem to be considered in the EED impact assessment as the Commission used a discount rate of 10% which artificially increases the overall energy system costs. Thus, misleading policy-makers about the cost-effectiveness of the scenarios aiming at ambitious energy savings.
5. The increased stringency of eco-design requirements is difficult to assess as the PRIMES model considers equipment in an aggregated manner. No details have, therefore, been provided in the impact assessment about the efficiency level considered per product category.

b) Transport

The transport sector is not projected to experience high decrease of its final energy demand. Compared with the reference scenario, the absolute final energy demand of the transport sector is projected to fall in 2030 by (4.5%) in EUCO27, (5.7%) in EUCO30 and in EUCO3030, (6.4%) in EUCO+33, (8.2%) in EUCO+35 by (9.3%) in EUCO+40. The expected low decrease in final energy consumption for transport, which uses mainly oil, explains the low impact of the Commission's scenarios on the reduction of oil imports described in the previous section.

Changes in the transport sectors final energy consumption are expected to be driven by the increased stringency of CO_2 standards for cars and Light Commercial Vehicles (LCVs) and Heavy Good Vehicles (HGVs) (Table 1.4) and the increased electrification of transport. The CO_2 standard considered for cars by the Commission in the scenario aiming at 40% energy savings is in the same order of magnitude as the one estimated for the IEA-2DS while those considered for low ambition scenarios are much higher. This raise questions about the expected role of the transport sector in the energy transition.

Other assumptions discussed in the impact assessment for transport include fair and efficient pricing for sustainable transport, eco-driving, collaborative intelligent transport systems, promotion of public procurement through the Clean Vehicles Directive, review of market access rules for road transport, support for multimodal travel information, promotion of intermodal and urban transport

16 Energy Efficiency Values are defined as shadow values of virtual energy savings constraints. EEVs are measured in €/toe saved.

and the alignment of national tax rates for petrol and gas oil used as motor fuels on the basis of energy content and CO_2 emissions. Most of these measures are already in place and contributing to reduce transport's energy consumption. However, the impacts of these measures are unknown, as they cannot be quantified with PRIMES model.

Table 1.4 Assumptions used for modelling the transport sector in the EED impact assessment

	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
2025 CO_2 standard for cars/LCVs	85/135/	80/130	80/130	77/118	74/106
2030 CO_2 standard for cars/LCVs	75/120	70/110	70/110	67/106	64/97
Annual average efficiency improvement for HGVs	0.7%				1.6%
Total stock of electrically chargeable cars and LCVs (millions)	34.2	39.8	39.9	45.8	55.5

Key point: The CO_2 standard in the 40% energy savings target is aligned with the IEA 2DS.

Source: 2016 impact assessment related to the Energy Efficiency Directive

c) Industry

The industry sector, especially energy intensives industries, is expected to experience the lowest changes in final energy consumption. Compared with the reference scenario, the absolute final energy consumption of energy intensive industries is not projected to change in the EUCO27 while it is expected to fall by (0.6%) in EUCO2030, (1.8%) in EUCO3030, (4.0%) in EUCO+33, (7.0%) in EUCO+35 and (11.0%) in EUCO+40.

Regarding other industries, compared with the reference scenario, final energy consumption is projected to fall by (1.0%) in EUCO27, EUCO30 and EUCO3030, (4.0%) in EUCO+33, (7.0%) in EUCO+35 and (14.0%) in EUCO+40. These low changes in final energy consumption may explain the low drop in solid fuels consumption described in the section above.

Changes in final energy consumption in the industry sector are expected, in PRIMES model, to be driven by the impact of ecodesign on the increased energy performance of industrial motors. However, the bottom-up model, IEEM, shows a low contribution of eco-design to the reduction in final energy consumption (6%), compared to the savings from the implementation of Article 7 of the EED (52%) and the savings from improved access to finance (41%). Further investigation would be needed to better understand the impact of efficiency measures in reducing energy demand of the industry sector.

In the more ambitious energy savings scenarios, the impact assessment assumes the application of Best Available Techniques and more advanced Best Available Techniques in the industry sector. However, no figures are associated with these two assumptions. Defining Best Available Techniques would help in understanding the expected measures that the industry sector would have to implement to reduce its final energy consumption.

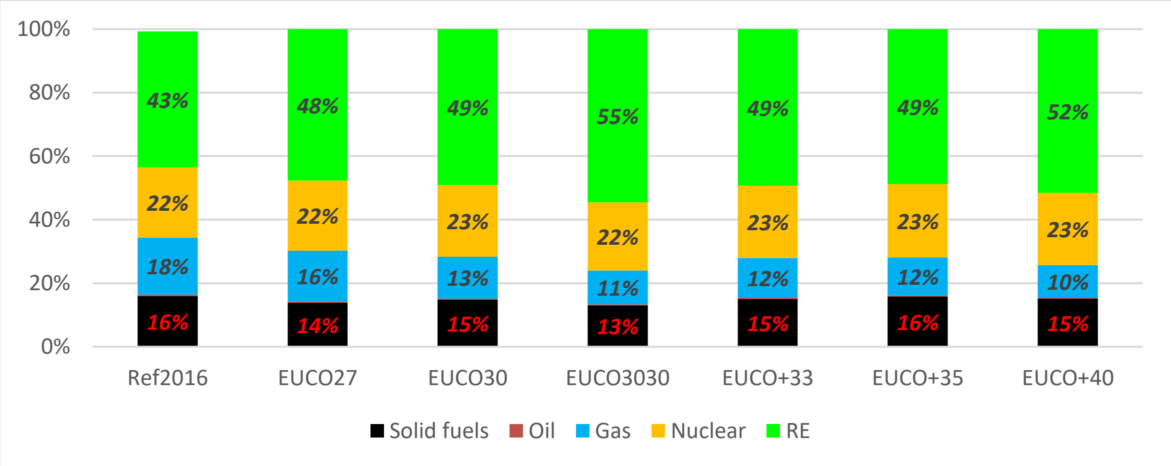
Power generation

Despite the expected increase of electrification of transport and heating, the growth in the demand for electricity is expected to slow down. The EED impact assessment assumes this decrease will be driven by the efficiency improvement of domestic appliances and industrial motors that would result from the implementation of eco-design measures combined with automation, such as active controls for lighting, motors and cooling products. Consequently, the need to expand power generation capacity is reduced in absolute terms as compared with the reference scenario by (0.1%) in EUCO27, (3.0%) in EUCO30, (4.6%) in EUCO3030, (5.3%) in EUCO+33, (8.0%) in EUCO+35 and (14.0%) in EUCO+40. This would lead to a decrease of electricity prices which would have a positive impact on the competitiveness of EU industry and energy affordability (see following sections).

Also, the strategy of decarbonising power generation makes renewable energies the first fuel in electricity generation in each of the Commission's scenarios by increasing their share from 43% in the reference scenario to (48.0%) in EUCO27, (49.0%) in EUCO30, EUCO+33 and EUCO+35 and (52.0%) in EUCO+40. The highest share of renewables in power generation is projected to be reached in EUCO3030, which overshoots the 2030 renewable target, with (55.0%) (Figure 1.3).

Among renewable energy sources, wind power is projected to have the highest share (between (19.6%) in EUCO2727 and (20.6%) in EUCO+40), followed by hydro with (10.8%) in EUCO27 and (12.5%) in EUCO+40. Nuclear is projected as the second fuel for power generation with (22%) in EUCO27, EUCO3030, EUCO+33 and EUCO+35 and (21%) in EUCO+40.

Figure 1.3 2030 Primary energy mix of power generation in the Commission's scenarios



Key point: Renewable energies are projected to be the first fuel of power generation in 2030 in each of the Commission's scenarios.

Source: OpenExp based on PRIMES modelling results included in the [2016 impact assessment related to the Energy Efficiency Directive]

Based on PRIMES modelling results, ETS prices do not seem to drive higher demand for solid fuels. In fact, the scenario with 40% energy savings (which implies the lowest ETS carbon price (€14/tCO_{2eq})) is also the scenario with the lowest quantity of solid fuels and the lowest share of solid fuels in the primary energy mix for power generation. The share of gas in power generation is projected to decrease in all scenarios with the lowest arising in the scenario aiming at 40% energy savings due to the renovation of existing buildings.

Impacts of the Commission’s scenarios on climate change

GHG emissions reduction in both the EUCO27 and the EUCO30 scenarios are in line with the Council’s decision of at least 40% GHG emissions reduction target in 2030 compared to 1990. This target is based on the two-degrees objective of global temperature increase agreed prior to the Paris Climate Agreement. However, the ratification of the Paris Climate Agreement makes the two-degrees objective essentially obsolete as Europe agreed with other nations to work towards *“holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels*” (UNFCCC, 2015). There is, therefore, no doubt about the need for Europe to revise its climate and, consequently its energy targets, when the contribution of each country/region to the Paris Climate Agreement will be published in 2018, which is also the expected year for the adoption of the “Clean Energy for All Europeans” package. Question remains about the missed opportunity to make the EU energy targets closer to the expected Paris Climate Agreement requirements for Europe.

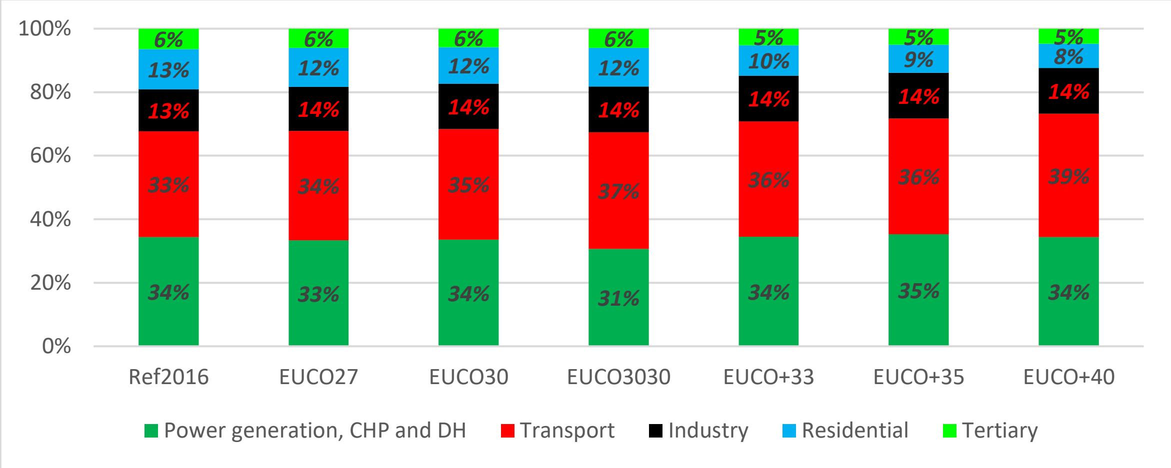
GHG emissions reduction in the EUCO3030, EUCO+33, EUCO+35 and EUCO+40 scenarios overshoot the agreed target of at least 40% GHG emissions reduction in 2030 compared to 1990 with (3%) in EUCO+33, (4%) in EUCO+35 and (7%) in EUCO+40. However, the scenario with 40% energy savings target is the only one that is aligned with the IEA 2DS projections for Europe in 2030. Although the modelling methodologies and the assumptions behind the PRIMES model and the IEA-Energy Technology Perspectives (ETP) model are not fully comparable, the up-coming IEA-well below two-degrees scenario confirms that the projected 2030 GHG emissions reduction in Europe will not be enough to meet the EU obligations under the Paris Climate Agreement.

At the sectoral level, the Commission’s strategy to mainly target the building sector (residential and tertiary) in its energy savings scenarios is well reflected in GHG emissions reduction, especially in the scenarios aiming at ambitious energy savings. As compared to the reference scenario, the highest emissions reduction is expected to take place in power generation in EUCO27 (22.8%), EUCO30 (24.8%) and the EUCO3030 (36.6%) while the highest GHG emissions reduction would take place in the residential sector in the EUCO+33 (37.3%), EUCO+35 (42.5%) and EUCO+40 (55%) followed by the tertiary sector in the EUCO+33 (31.9%), EUCO+35 (36.6%) and EUCO+40(46%).

The industry sector is projected to achieve the lowest emissions reduction with 4.8% in both the EUCO27 and the EUCO30 scenarios, followed by the transport sector with (6.2%) in the EUCO27 and (7.7%) in the EUCO30 scenario. In the 40% energy savings scenario, GHG emissions reduction in industry are expected to be reduced by (18%) as compared to the reference scenario while those of the transport sector are expected to decrease by only (12%). This would reduce, in 2030, the share of buildings GHG emissions to (13%) out of the total while the share of the transport sector would reach (39%) and the share of the industry sector would be kept constant across EUCO scenarios (Figure 1.4). Overall, the expected high GHG emissions reduction in the building sector, as compared to the reference scenario, make the contribution of the sectors under the Effort Sharing Decision (ESD)[17] to the overall energy related GHG emissions reductions much higher than the contribution of the sectors covered under the ETS[18] in the most ambitious scenarios.

[17] ESD sectors include buildings, transport, non-industry intensive industries and agriculture
[18] ETS sectors include power generation and energy intensive industries

Figure 1.4 2030 sectoral shares of GHG emissions in the Commission's scenarios

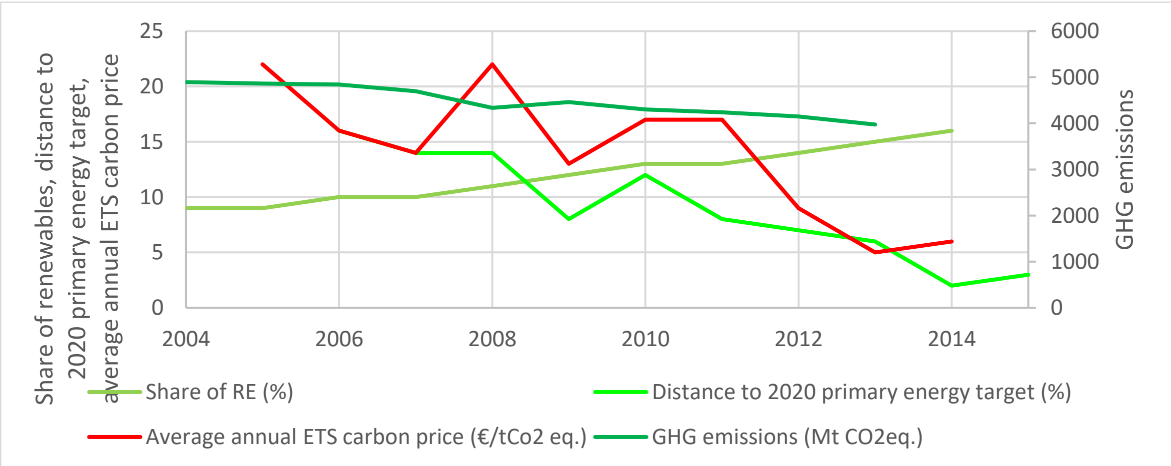


Key point: Residential and tertiary sectors are projected to be the least contributors to total EU GHG emissions in 2030.

Source: OpenExp based on PRIMES modelling results included in the 2016 impact assessment related to the Energy Efficiency Directive

The correlation observed, during the previous period, between GHG emissions reduction and the increased share of renewables and energy savings in the EU primary energy mix and the opposite correlation observed with ETS carbon prices (Figure 1.5) are expected to occur in the period 2020-2030 (Table 1.5). GHG emissions reduction go hand in hand with the increased share of renewables and the stringency of the energy savings target despite the decrease of ETS carbon prices. Further investigation is needed to better understand the role of climate policies versus energy policies in reducing GHG emissions.

Figure 1.5 Evolution of GHG emissions, renewables share, distance to 2020 primary energy savings target and ETS prices in the period 2004-2014



Key point: GHG emissions reduction correlates well with the increased share of renewables and the increased reduction in primary energy consumption and inversely with ETS carbon prices.

Source: EUROSTAT for the share of renewables, the distance to 2020 primary energy target and GHG emissions and OpenExp calculations for average annual ETS carbon prices based on monthly data provided by investing.com.

Table 1.4 GHG emissions reduction, renewables share, primary energy savings and ETS prices in the Commission's scenarios

	EUCO27	EUCO30	EUCO3030	EUCO+33	EUCO+35	EUCO+40
Total GHG emissions ($MtCO_2eq.$)	3412	3409	3272	3281	3231	3042
ETS price (€/tCO_2 eq.)	42	27	27	27	20	14
Renewables share	27%	27%	30%	28%	28%	28%
Energy savings target	27%	30%	30%	33%	35%	40%

Key point: GHG emissions reduction are expected to be driven by the renewables and energy savings target and not by the EU ETS.

Source: PRIMES modelling results/assumptions included in 2016 impact assessment related to the Energy Efficiency Directive

Impacts of the Commission's scenarios on citizens' health

For the first time, the impacts of the Commission's scenarios on citizen's health has been estimated using the GAINS model (see box 1.1). This model estimates the number of life years gained due to reduced emissions of various pollutants ($PM_{2.5}$, SO_2, NO_X) as well as the avoided premature deaths resulting from ozone pollution. The reduction in mortality and morbidity can also be valued economically (see Chapter II). Unfortunately, the impact assessment report does not provide the modelling estimates of the health impacts in the reference scenario (with current policies) nor in the baseline scenario (EUCO27). The only information available is the resulting comparison of the health impacts between the EUCO27 and the other EUCO scenarios. However, the EUCO3030 scenario, which aims at 30% energy savings and 30% renewables share, was not included in this analysis.

From a citizen's health perspective, the modelling results, included in the EED impact assessment report, show a positive correlation between health impacts and the increased stringency of energy savings target. Compared to the EUCO27 scenario, the number of life years gained due to less $PM_{2.5}$ would reach 16.9 million in the EUCO40 against 2.5 million in the EUCO30 (Table 1.6). Similarly, the number of avoided premature deaths per year from low-level ozone would reach 662 in the EUCO40 against 114 in the EUCO30 (Table 1.6).

Table 1.6 Changes in health damage in EUCO scenarios as compared to EUCO27 in 2030

	EUCO30	EUCO+33	EUCO+35	EUCO+40
Million life years gained due to less PM2.5	2.5	8.7	11	16.9
Avoided premature deaths due to low level ozone (cases per year)	114	337	438	662

Key point: The more ambitious the energy savings target, the more significant the impact of reduced energy consumption on citizen's health.

Source: GAINS modelling results included in 2016 impact assessment related to the Energy Efficiency Directive

Impacts of the Commission's scenarios on energy affordability

The impact of the Commission's scenarios on energy affordability is estimated in terms of:

- the share of energy related cost (excluding transport) in household expenditures using the PRIMES model; and

- real disposable income and consumer expenditures using the macro-economic models E3ME (no crowding out option only) and GEM-E3 (both loan-based and self-financing options)

Estimates of the share of energy related costs in household expenditures are based on total energy system costs which include energy purchases costs, capital costs and direct energy efficiency investment costs. The expected implementation of energy efficiency measures in residential buildings should lead to a shift from operational (energy purchases costs) to capital expenditure (capital costs and direct energy efficiency investments costs) (Chapter II). However, this shift will, in the short term, slightly increase the share of energy costs in household expenditures (Table 1.7).

Table 1.7 Share of energy costs (excluding transport) in household expenditures in 2030

	Ref2016	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
Share of energy costs in household expenditure (%)	6.9	7.1	7.4	7.8	8.0	8.5

Key point: The more ambitious the energy savings target, the more significant the share of energy related costs in household expenditures.

Source: PRIMES modelling results included in the 2016 impact assessment related to the Energy Efficiency Directive

The impacts of the Commission's scenarios on real disposable income is expected to be positive and to increase with the increased ambition of energy savings, except in the case of the self-financing option, which is unlikely to happen, (Table1.8). Similarly, consumer expenditures are projected to increase particularly in the no crowding-out option of the E3ME model, which is also unlikely to happen. The EED impact assessment states that this positive impact is due to higher employment levels and higher GDP.

Table 1.8 Expected changes in real disposable income in the Commission's scenarios in 2030

Real disposable income in Ref2016 and EUCO27 and % change from EUCO27	Ref2016 (€)	EUCO27 (€)	EUCO30 (%)	EUCO+33 (%)	EUCO+35 (%)	EUCO+40 (%)
E3ME (no crowding-out)	11,371.4	11,446.7	0.16	1.00	1.42	2.88
GEM-E3 (loan-based)	11,334.2	11,368.6	0.25	0.30	0.23	0.18
GEM-E3 (self-financing)	11,334.2	11,319.6	-0.14	-1.00	-1.36	-1.84

Key point: EUCO scenarios have a positive impact on the real disposable income in the loan-based option which is the most realistic one.

Source: E3ME and GEM-E3 modelling results included in the 2016 impact assessment related to the Energy Efficiency Directive

For the first time, the impacts of the Commission's scenarios on the real disposable income has been assessed across different socio-economic groups. This assessment was made using only the E3ME model, which is based on the post-Keynesian theory, and the results of this assessment are provided only for two scenarios (EUCO30 and EUCO+33). The modelling results show better impacts on lowest quintile than on the 5th quintile (Table 1.9)[19] which might be due to the impact of energy renovation on lowering the share of energy related cost in household expenditures in the case of low-income families. Achieving such an impact would mean all homes occupied by low-income families are renovated to the zero-energy consumption level. Unfortunately, the proposed changes to the EED and the EPBD do not include such a requirement.

[19] These results should be taken with caution as this is the first attempt to estimate the impacts of the efficiency scenarios per socio-economic groups. Further refinement is needed to better consider the policy measures.

Table 1.9 Percentage change in real disposable income by socio-economic group

% change compared to EUCO27		All households	Lowest quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
No crowding-out	EUCO30	0.10	0.16	0.18	0.15	0.12	0.03
	EUCO+33	0.71	1.05	0.99	0.85	0.68	0.44
Partial crowding-out	EUCO30	0.10	0.15	0.17	0.15	0.12	0.03
	EUCO+33	0.62	0.93	0.87	0.75	0.61	0.37

Key point: Low-income households are expected to experience a higher disposable income with stringent energy savings targets.

Source: E3ME modelling results included in the [2016 impact assessment related to the Energy Efficiency Directive]

Impacts of the Commission's scenarios on EU competitiveness

Impacts of the Commission's scenarios on EU competitiveness has been estimated in terms of:

- Balance of trade for the overall economy using the macro-economic models E3ME (no-crowding out option) and GEM-E3 (loan-based option);
- Impacts on EU industry using the PRIMES model; and
- Impacts on international fuel prices using the POLES model.

The impact of the Commission's scenarios on EU trade balance is expected to be positive across all scenarios by both macro-economic models (E3ME and GEM-E3) (Table 1.10) leading to an improvement in EU competitiveness. On one hand, total EU imports will increase as the expected reduction of fossil fuels imports, described in the previous section, should be largely offset by the increased imports of energy efficient equipment, products and other goods. On the other hand, total EU exports will also increase as the expected low energy costs, should improve the competitiveness of sectors supplying the market with energy efficient products (e.g. engineering). Thus, leading to an increase of the competitiveness of the EU industry. Exports would also be driven by overall GDP improvements. Compared to the reference scenario, the EUCO27 and EUCO30 scenarios present a slight decrease in both imports and exports in the loan-based option while all other scenarios present an increase of both imports and exports.

Table 1.10 2030 Projected EU trade balance in the Commission's scenarios

€bn, 2013		REF2016	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
Extra EU-imports	E3ME (no crowding out)	2,916.8	2,920.8	2,929.0	2,959.2	2,986.6	3,059.7
	GEM-E3 (loan based)	2,986.2	2,979.3	2,988.1	2,998.5	3,008.9	3,037.1
Extra EU-exports	E3ME (no crowding out)	3,720.4	3,722.2	3,722.4	3,727.4	3,730.6	3,741.7
	GEM-E3 (loan based)	3,395.7	3,379.9	3,388.1	3,395.9	3,405.4	3,434.1
Trade balance	E3ME (no crowding out)	803.6	801.4	793.4	768.2	744.0	682.0
	GEM-E3 (loan based)	409.5	400.6	400.0	397.4	396.5	397.0

Key point: The EU balance of trade is projected to be positive across all EUCO scenarios.

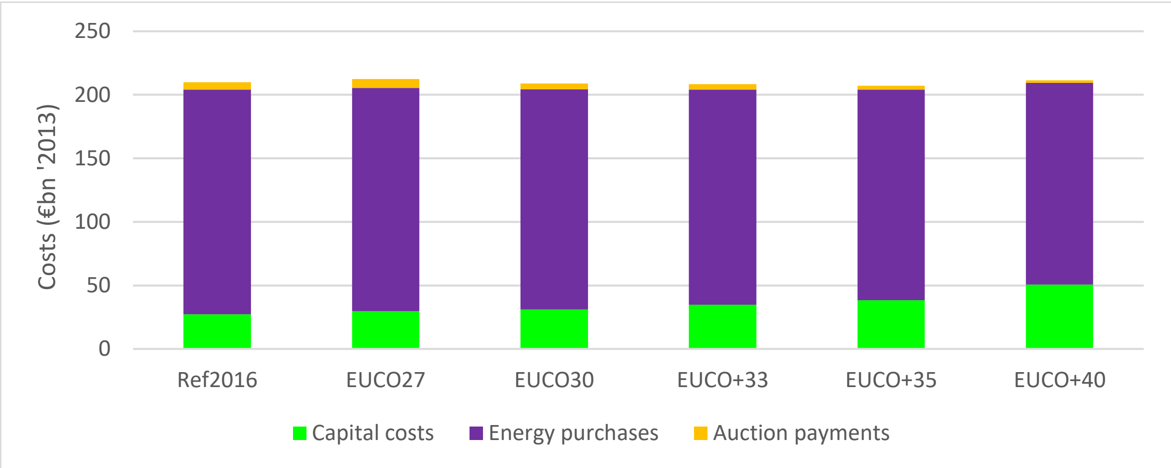
Source: OpenExp based on E3ME and GEM-E3 modelling results included in the [2016 impact assessment related to the Energy Efficiency Directive]

The impact of the Commission's scenarios on the competitiveness of energy-intensive industries is expected to be positive. Energy-intensive industries are not targeted by efficiency measures as they are already regulated under the EU-ETS. There is, therefore, no direct energy efficiency investments to be made by these industries (see Chapter II) to meet the efficiency target. At the same time, these industries will benefit from the impact of efficiency scenarios on:

- ETS prices which should be lower when the energy savings target is higher. Thus, leading to lower auction payments by energy-intensive industries;
- Electricity prices, which decrease slightly, compared to the reference scenario, when the energy savings target is higher. Thus, leading to lower energy purchases costs for end-use sectors.
- International fuel prices, which decrease slightly when the energy savings target is higher, thus contributing to lower energy purchases costs.

The only expected increase in expenditures for energy intensive industries relate to capital costs which could be due to the replacement of energy using products. However, this increase is projected by PRIMES model to be largely offset by the decrease of auction payments and energy purchases costs (Figure 1.6). As a result, the ratio of energy related costs to value added for energy intensive industries is projected by the PRIMES model to decrease slightly. As compared to the reference scenario total energy costs decrease in all scenarios except in the EUCO27 and the EUCO+40 where a slight increase is observed in both scenarios. As compared to EUCO27, total energy costs decrease in all other scenarios (Figure 1.6).

Figure 1.6 Breakdown of total energy costs for energy-intensive industries in the Commission's scenarios



Key point: The projected increase in capital costs should be largely offset by the projected decrease in energy purchases costs and auction payments.

Source: PRIMES modelling results included in the 2016 impact assessment related to the Energy Efficiency Directive

The impact of the Commission's scenarios on international fossil fuel prices is expected to be positive for energy importing countries. The projected decrease of energy consumption in the EU that would result from the implementation of energy efficiency measures, especially those targeting the building sector, would reduce gas demand at international level and consequently gas prices. The more stringent the energy savings target, the more significant the reduced international gas price (Table 1.11). The impact of the Commission's scenarios on international oil prices is limited as oil is mainly consumed in the transport sector, which is, as shown in the previous section, almost unaffected by the Commission's scenarios. Similarly, the impact of the Commission's scenarios on international coal prices is extremely limited as coal is mainly consumed by industry, which is not targeted by efficiency measures.

Table 1.11 Average international fuel prices compared to EUCO27 in the period 2020-2030

Average (2020-2030) change compared to EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
International oil prices	-0.3%	-0.6%	-1.0%	-1.4%
International gas prices	-1.1%	-2.3%	-3.0%	-4.3%
International coal prices	0.02%	0.01%	0.01%	-0.03%

Key point: International gas prices are projected to be the most affected by the Commission's scenarios due to energy renovation

Source: POLES modelling results included in the 2016 impact assessment related to the Energy Efficiency Directive

Impacts of the Commission's scenarios on growth and jobs

The impacts of the Commission's scenarios on growth and jobs has been estimated using the macro-economic models E3ME and GEM-E3. For a better assessment of the macro-economic impacts, two financing options have been considered for each model. Modelling results related to the post-Keynesian model (E3ME) are provided for the no crowding-out and the partial crowding-out options. Similarly, modelling results related to the general-equilibrium model (GEM-E3) are provided for the load-based and the self-financing options.

The Commission's scenarios show positive impacts on EU GDP (Table 1.12) and on employment at EU level (Table 1.13) except in the self-financing option using GEM-E3 model. Given that the self-financing option is unlikely to happen in the real world, EU GDP and EU employment are likely to increase with the ambition of the energy savings target. The more realistic option is the one that would combine partial crowding-out and loan-based financing. Unfortunately, impacts on EU GDP and EU employment for this combination has not been modelled.

Table 1.12 GDP impacts in the Commission's scenarios at EU level in 2030

	REF2016 (€bn/13)	EUCO27 (€bn/13)	EUCO30	EUCO+33	EUCO+35	EUCO+40
E3ME (no crowding out)	17,928	18,045	0.39%	1.45%	2.08%	4.08%
E3ME (partial crowding out)	17,928	18,045	0.39%	1.3%	1.58%	2.21%
GEM-E3 (loan-based)	16,955	16,962	0.26%	0.21%	0.16%	0.06%
GEM-E3 (self-financing)	16,955	16,907	-0.22%	-0.79%	-1.35%	-2.12%

Table 1.13 Employment impacts in the Commission's scenarios at EU level in 2030

	REF2016 (m jobs)	EUCO27 (m jobs)	EUCO30	EUCO+33	EUCO+35	EUCO+40
E3ME (no crowding out)	233.1	233.5	0.17%	0.68%	1.04%	2.08%
E3ME (partial crowding out)	233.1	233.5	0.17%	0.63%	0.85%	1.40%
GEM-E3 (loan-based)	216.4	216.6	0.20%	0.28%	0.36%	0.56%
GEM-E3 (self-financing)	216.4	216.0	-0.18%	-0.51%	-0.84%	-1.36%

Key point: GDP and employment impacts increase with the ambition of the savings target except in the self-financing option which is unlikely to happen in the real world.

Source: E3ME and GEM-E3 modelling results included in the 2016 impact assessment related to the Energy Efficiency Directive

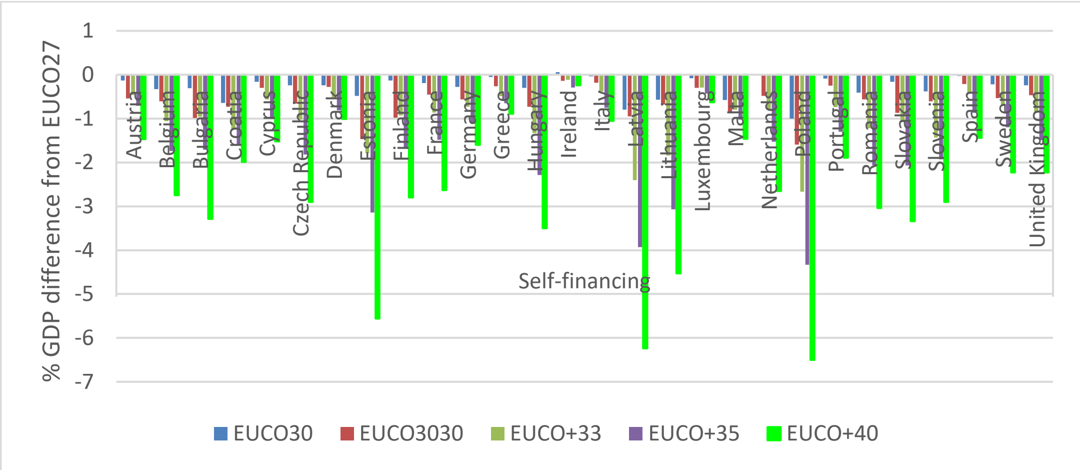
Using the E3ME model, the positive picture described above at the EU level is confirmed at the Member State level for both GDP and employment. In all Member States, efficiency scenarios create more economic activity leading to an increase of national GDP and the number of people employed. The more ambitious the energy savings target, the higher the impact at national level (Figure 1.7 and 1.8). However, using the GEM-E3 model, the picture is bit more nuanced. Some Member States, mainly those with GDP per capita lower than the EU average, are projected to experience negative impacts in terms of GDP and employment even in the loan-based option (Figure 1.7 and 1.8).

The high range of changes for both GDP and employment effects using GEM-E3 confirm the need for setting-up a "public financing scheme" that would facilitate the access to funding by providing preferential loans for energy efficiency investments (in general, but more specifically for buildings given their pivotal role in the EUCO scenarios). This could be a public fund directly, or risk mitigation fund to reduce the costs of loans, or public private partnership (PPP) form to ease the burdens to access to low interest loans (it could be secured by mortgage on the buildings). However, some of these results are questionable. In the GDP changes one could accept that the sectors disadvantaged by the implementation of energy efficiency (incumbent energy plants) can lose more in short term than the long-term benefits in other sectors. However, it is quite different in the employment: in the energy sector employment is much less measured in person/GDP than other affected sectors (like construction, machinery etc.), so the negative values in the more ambitious scenarios are quite surprising. This should be a core discussion point in the policy dialogue over the energy efficiency targets. In this respect, the modelling results of E3ME in both options (the partial/no crowding out) should also be further discussed as their results contradict those of the GEM-E3 model in each of the EUCO scenarios.

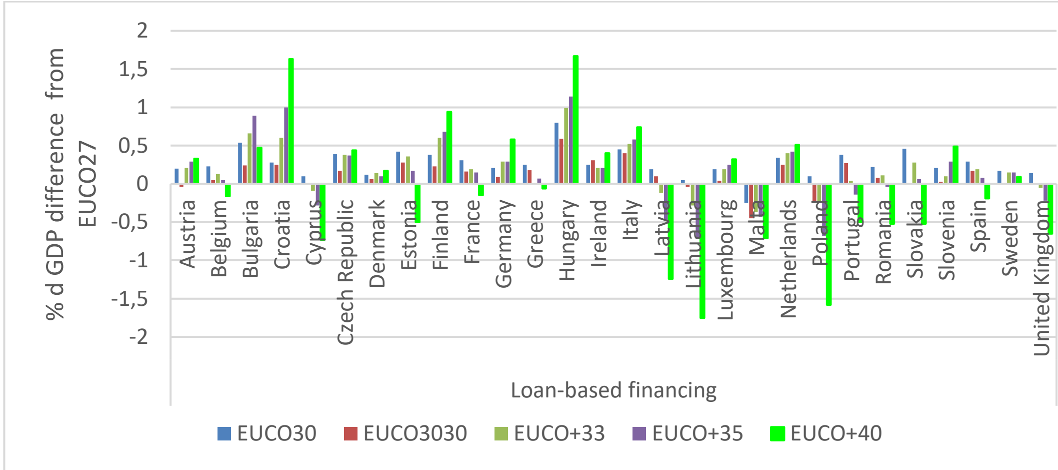
Looking to the employment effects at sectoral level, both models show an increase in construction, engineering and basic manufacturing sub-sectors. This is due to the specific focus of the Commission's scenarios on energy renovation. These sectors are projected to further increase their output with more ambitious energy savings targets, especially for those sectors not facing international competition. Utilities and extraction industries are projected to experience a decrease of their activities, especially when using the GEM-E3 model, which singles out the power sector from other utilities. On the contrary, the E3ME modelling results show a positive impact on utilities as the model includes the employment impact due to renewables in the power sector, which is not singled out from other utilities.

Overall, the Commission's scenarios provide evidence of the positive impact of energy efficiency on the priority areas for the EU (energy security, climate change, air pollution and health impacts, energy affordability, jobs, growth and EU competitiveness). The modelling results show that the more ambitious the energy savings target, the more significant the contribution of energy efficiency is to address the EU energy trilemma (see front cover). The next Chapter analyses the modelling results and the methodology used to assess the costs of the Commission's scenarios. Where the positive impacts described in this Chapter have been monetised, these benefits are compared to the costs.

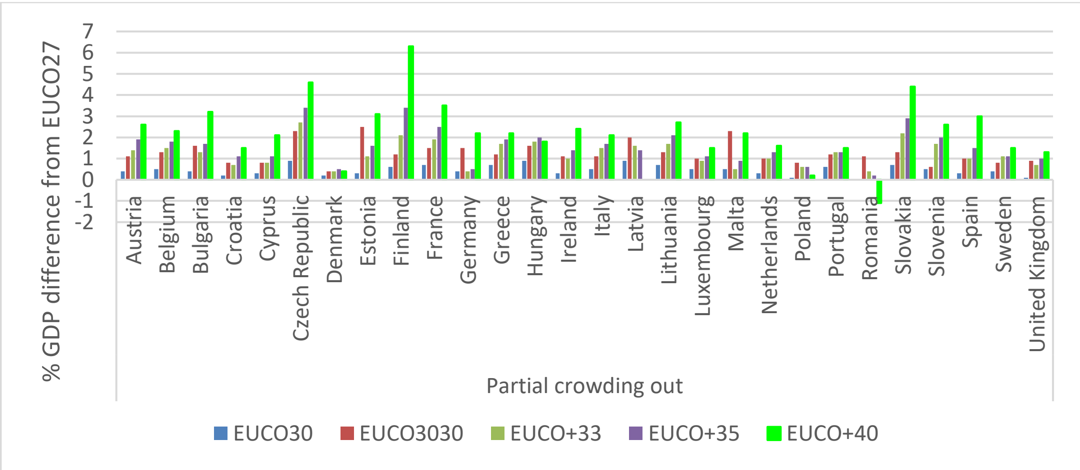
Figure 1.7 GDP impacts in the Commission's scenarios at Member State level in 2030 using GEM-E3 and E3ME macro-economic models



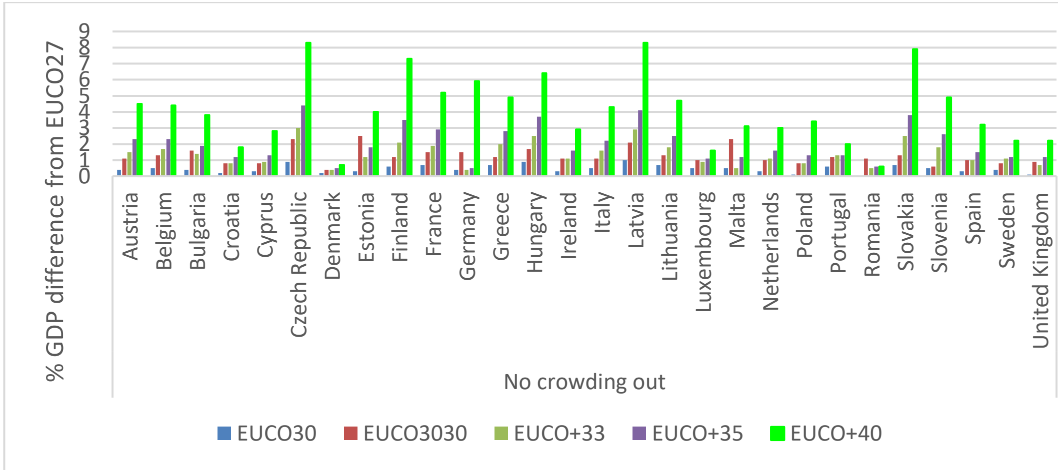
GEM-E3 (self-financing option)



GEM-E3 (loan-based option)



E3ME model (partial crowding-out option)

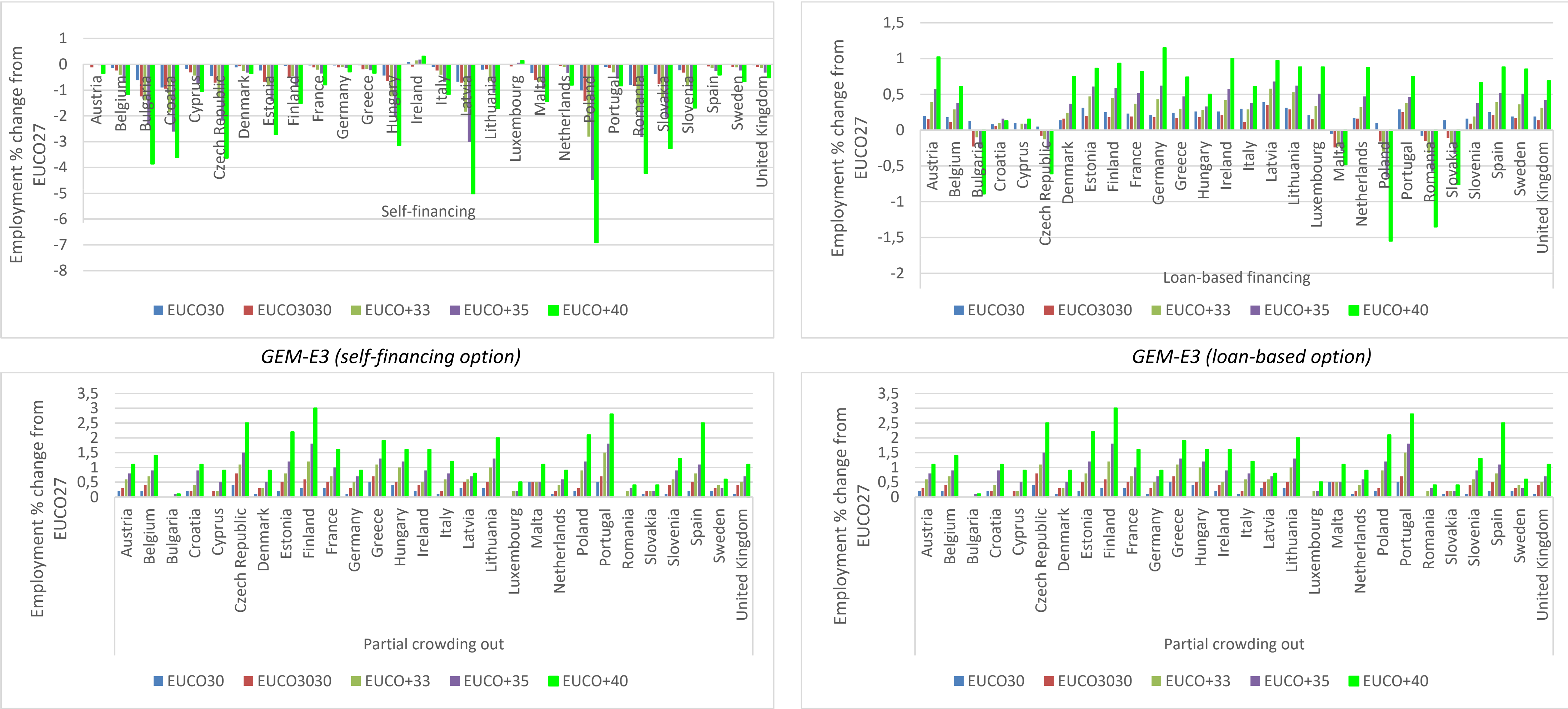


E3ME model (no crowding-out option)

Key point: Assumptions used to estimate GDP impacts should be disclosed to understand the discrepancies of the results

Source: E3ME and GEM-E3 modelling results included in the 2016 impact assessment related to the Energy Efficiency Directive

Figure 1.8 Employment impacts in the Commission's scenarios at Member State level in 2030 using GEM-E3 and E3ME macro-economic models



GEM-E3 (self-financing option)

GEM-E3 (loan-based option)

E3ME model (partial crowding-out option)

E3ME model (no crowding-out option)

Key point: Assumptions used to estimate employment impacts should be disclosed to understand the discrepancies of the results

Source: E3ME and GEM-E3 modelling results included in the 2016 impact assessment related to the Energy Efficiency Directive

Chapter II: Investment needs and costs of the Commission's scenarios

Highlights

- The Commission's modelling results provide overall investment expenditures including those related to transport energy services. Investment expenditures related only to the implementation of energy efficiency measures are unknown. This makes the assessment of the cost-effectiveness of energy efficiency scenarios challenging.

- Total investment expenditures per sector do not match with the expected sectoral savings. The transport sector is projected to have the highest share of total investment expenditures (these investments include those related to energy services) while this sector has the lowest contribution to energy cuts. Its contribution is projected to range from 75% in the reference scenario to 47% in EUCO+40 while the share of industry sector is kept almost constant across all scenarios and the one of residential and tertiary sectors are projected to increase with increased energy savings ambition.

- The Commission modelling assumes a discount rate of 10%. This results in high total energy systems costs which increases the financing gap of the EUCO scenarios. The expected low discount rate of 4% due to the implementation of the SFSB initiative does not seem to be considered in the Commission's modelling. It is also unclear if the impact of the SFSB initiative on reducing the technological costs has been considered or not.

- Energy system costs do not match with the expected savings from energy efficiency measures. Capital costs related to the cost of energy-using products are almost 66 times higher than direct energy efficiency investments in insulation in the reference scenario and almost double in the EUCO+40 scenario while the expected energy savings from the insulation of residential buildings are higher than those from energy-using products.

- With the estimated financing gap, savings from fossil fuel import bills and reductions in pollution control costs and health impact costs do not offset the direct energy efficiency investment costs in any of the EUCO scenarios. Sensitivity analysis of the impact of different discount rate levels on the financing gap is needed to better assess the cost of the energy system and the financing gap. This would allow for an evidence-based selection of the energy savings target.

Chapter I presented an assessment of the impacts of the Commission's scenarios in terms of energy security, climate change, air pollution and health impacts, energy affordability, competitiveness, jobs and growth. The analyses show that efficiency scenarios have positive impacts on each of the EU priority areas. Furthermore, the modelling results show that the more ambitious the energy savings target, the more significant the positive impact of the implementation of energy efficiency measures is on each of the EU priority areas.

This Chapter analyses the investment needs and costs of the energy system based on the Commission's modelling results. The costs are compared to the benefits analysed in the previous Chapter where they have been monetised. The costs of the scenarios were estimated with the PRIMES model while the monetised benefits were estimated with the PRIMES model for reduced imports bills and with the GAINS model for health benefits.

The Commission's modelling assumes that the direct beneficiaries of energy efficiency measures (individual agents and firms) are the ones who would invest in the energy transition. Based on this assumption, energy efficiency investments would be financed primarily by savings from households, equity from companies, loans provided by retail banks to consumers and large-scale green bonds issued in capital markets. Public finance would be used to overcome market barriers, which would trigger the expected private investments.

The broader societal positive impacts that would result from the implementation of energy efficiency measures such as reduced energy dependency and energy poverty, air pollution and health impacts, as well as the improvement of the EU GDP leading to the creation of more jobs are not factored in to the Commission's impact assessment in terms of reduced costs. **Consequently, the proposed energy savings target is based on the least cost scenario instead of cost-benefit analysis.**

Furthermore, the modelling results provided by the Commission do not allow stakeholders to undertake such analyses, although this is highly recommended by the better regulation agenda when it comes to the selection of the best policy options to consider for the future of Europe. Moreover, estimates of the cost of the energy transition are based on private discount rates of 10%, slightly lowered to reflect the on-going implementation of energy efficiency measures and the easy access to finance through the variety of existing financial instruments, but still too high to trigger private investments.

The Commission's modelling projects investment expenditures and energy system costs across all scenarios as follows:

1. Investment expenditures are expressed as net of financing and other costs. The PRIMES model provides the average annual investment expenditures for each end-use sector (residential, tertiary, industry and transport) as well as the average annual investment expenditures for each of the supply side sectors (grid, generation and industrial boilers).
2. Total energy system costs reflect the entire financial flows including the cost of finance. The PRIMES model provides the breakdown into capital costs, direct energy efficiency investment costs and energy purchases costs for the demand side sectors only. However, direct energy efficiency investment costs are provided only for residential and tertiary sectors. Energy system costs of the supply side are included in energy purchases costs.

The following sections analyse investment expenditures and total energy system costs included in the EED impact assessment. None of them could be compared to the ones provided in the EPBD impact assessment because of the differences in the renovation rates considered for each instrument (see Chapter I). The Chapter ends with an attempt at a cost-benefit analysis of the Commission's scenarios.

Scale of investment needs

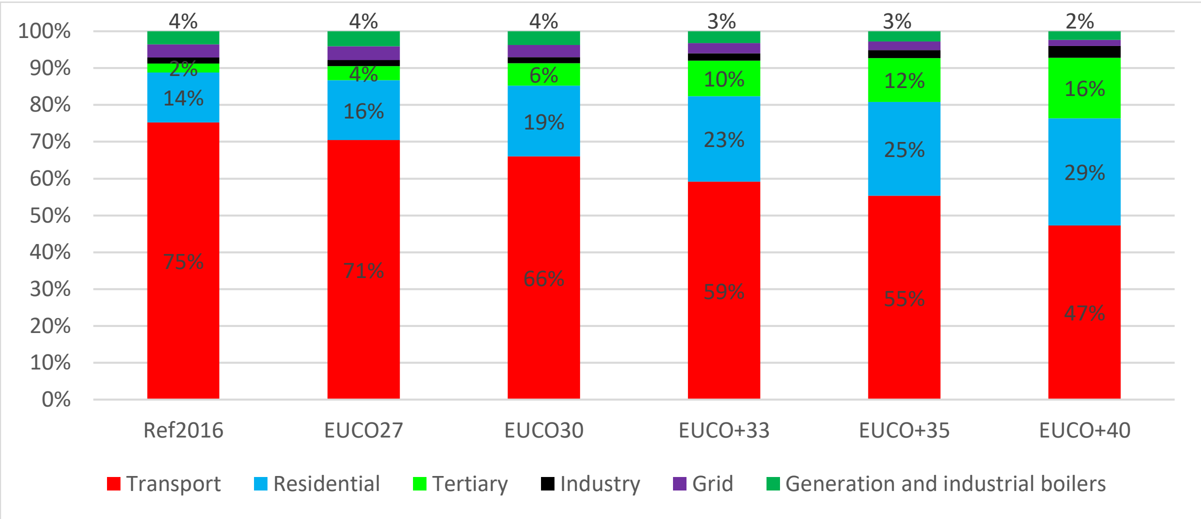
The PRIMES model provides an estimate of the average investment expenditures across all scenarios. These investment expenditures are net of financing and other costs. The model allows for a breakdown of investment expenditures per sector. Total investment expenditures in the reference scenario are those needed for the currently adopted policies, while investment expenditures in the EUCO scenarios are those necessary to meet the agreed three 2030 targets and beyond for what regards energy efficiency in the scenarios aiming at more than 27% energy savings. However, these investment expenditures include those related to the implementation of energy efficiency measures as well as those related to energy services.

Achieving the projected cuts in energy demand and CO_2 emissions, described in the previous Chapter, would result in additional annual investment expenditures, compared to the reference scenario, of €98 billion in EUCO27, €177 billion in EUCO30, €294 billion in EUCO+33, €294 billion in EUCO+33 and €627 billion in EUCO+40. Across all scenarios, more than 90% of the investment expenditures would occur in the end-use sectors (transport, residential, tertiary, and to some extent industry). In these sectors, investment expenditures are expected to increase with the increase ambition of the energy savings target while the opposite is projected to take place in the supply side sectors (grids, generation and industrial boilers) as less energy would be needed (see Chapter I).

Investment expenditures of the transport sector include those related to energy services. This may explain why the transport sector has the highest share of total investment expenditures while this sector has the lowest contribution to energy savings (see Chapter I). The ambition of energy savings target might well be lowered because of a sector (transport) which has the lowest contribution to the energy transition and the lack of precise information on investment expenditures related only to the implementation of energy efficiency measures. The Commission's modelling should provide investment expenditures related to the implementation of energy efficiency measures separately from other investment expenditures. This is particularly needed in the current context as the Commission's preferred energy savings target is based on the least-cost option and not on the cost-benefit analysis of each scenario.

The share of the transport sector's total investment expenditures across all scenarios is kept the highest one but decreases with the increase of energy savings ambition due to the increased share of investment expenditures of the residential and tertiary sectors (Figure 2.1). In the reference scenario, the share of the transport sector's total investment expenditures reaches (75%) out of the total investment expenditures while the share of total investment expenditures of the residential sector is projected to reach almost (15%) out of the total investment expenditures and the one of the tertiary sector to reach (3%). In the EUCO+40, the share of the transport sector's total investment expenditures is projected to be at 47% out of the total investment expenditures, followed by the residential sector with 29% and the tertiary sector with 16% out of the total investment expenditures. The industry sectors' share of total investment expenditures is the lowest one, it ranges from 2% in EUCO27, EUCO30, EUCO+33 and EUCO+35 to 3% in EUCO+40.

Figure 2.1 Share of total investment expenditures per sector in the Commission's scenarios



Key point: Transport sector has the highest share of investment expenditures across all scenarios.

Source: PRIMES modelling results included in the [2016 impact assessment related to the Energy Efficiency Directive]

The residential and tertiary sectors are projected to experience the highest increase in investment expenditures with an increased ambition in the energy savings target. This reflects the focus of the Commission's scenarios on reducing energy demand and, more specifically, heating demand through energy renovation of existing buildings (see Chapter I). Investment expenditures in the tertiary sector are projected to be 11 times higher in the EUCO+40 compared to the reference scenario, allowing for 40% reduction in final energy demand of tertiary buildings. In the residential sector, achieving the projected 41% reduction in final energy demand in EUCO+40, compared to the reference scenario, would require four times more investments. Detailed assumptions on costs and efficiency measures are needed to understand the differences in the cost-effectiveness of efficiency measures in these two sub-sectors.

The impact assessment assumes a high contribution from the private sector (mainly households) to the transformation of the EU energy system. However, given the scale of the investment needs described, the financial capacity of EU households is doubtful, especially in Member States with GDP per capita lower than the EU average. Without tailored policies to reduce the financial, technological and technical costs of the energy transition, the EU may fall short of meeting its energy targets and consequently its priorities in terms of jobs, growth and fairness.

Energy system costs:

The PRIMES model provides an estimate of the total energy system costs for end-use sectors (residential, tertiary, industry and transport) across all scenarios while total energy system costs of supply-side sectors are embedded with the energy purchases costs component. These costs are calculated from an end-user perspective, using a private discount rate lowered to 10%. For each end-use sector, a breakdown of the energy system costs into the three components below is provided:

- **Capital costs for energy using equipment:** It includes the financing cost of debt and equity. The higher the interest rate considered, the higher the capital cost is and the less attractive the investment is for investors (JRC, 2015-a-b; ECOFYS, 2015-a-b). Capital costs considered for transport relates to energy services.
- **Direct energy efficiency investment costs,** which represents the technology cost. The PRIMES model considers only the cost related to investment in the insulation of existing buildings. Direct efficiency investment costs is considered equal to zero for industry and transport sectors.
- **Energy purchases costs,** which include energy cost and the capital cost for investment in power and gas infrastructure, refineries and fossil fuel extraction.

The overall energy system costs resulting from PRIMES for the period 2021-2030 range from an annual average of €1,943 billion in the EUCO27 to €2,077 billion in the EUCO+40. This would correspond to 12.37% of the EU GDP in the scenario with 27% energy savings target and to 13.18% of the EU GDP in the 40% energy savings target. As compared to the reference scenario, PRIMES model projects an increase of the total energy system costs in EUCO27 of (0.8%), in EUCO30 of (1.2%), in EUCO+33 of (2.5%), in the EUCO+35 of (4.5%) and in the EUCO+40 of (7.7%).

The PRIMES model projects a decrease of energy purchase costs compared to the reference scenario ranging from € 33 billion in the EUCO27 to € 120 billion in the EUCO+40 scenario and an increase of capital costs and direct energy efficiency investment costs (Table 2.1). However, the projected savings in energy purchases costs do not offset the projected increase in capital costs and direct energy efficiency investment costs.

Table 2.1 Additional energy system costs in EUCO scenarios compared to the reference scenario

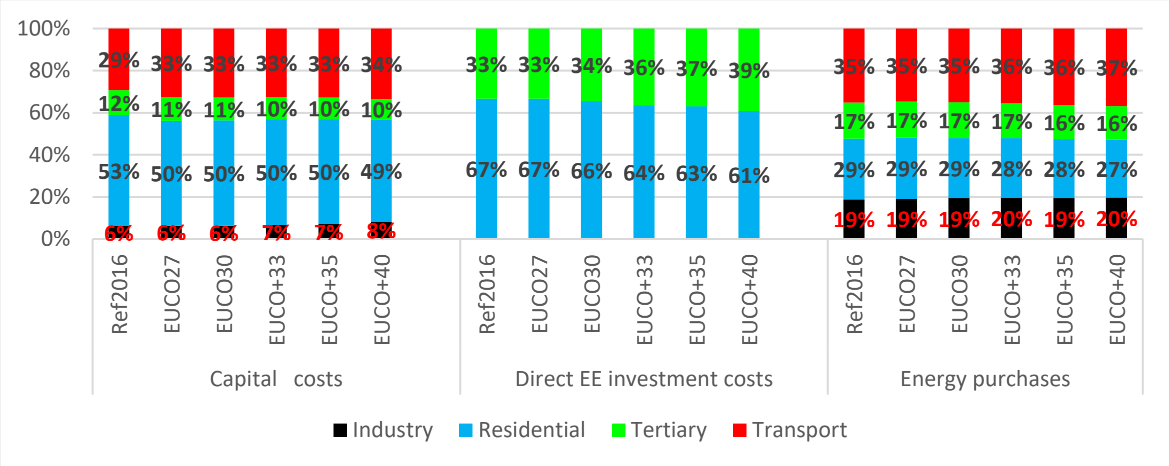
Average annual (2021-2030) €bn '13	EUCO27	EUCO30	EUCO+33	EUCO+35	EUCO+40
Capital costs	+19	+25	+25	+28	+40
Direct energy efficiency investments cost	+30	+55	+104	+137	+214
Energy purchases costs	-33	-61	-85	-88	-120
Additional energy system costs	+16	+19	+44	+74	+134

Key point: The reduction in energy purchases costs does not offset the additional capital costs and direct energy efficiency investment costs.

Source: OpenExp based on PRIMES results included in the 2016 impact assessment related to the Energy Efficiency Directive

Looking to total system costs at sectoral level, the PRIMES model does not provide direct energy efficiency investment costs for the industry and the transport sectors. Consequently, cost-effectiveness of energy efficiency measures in these two sectors cannot be assessed. These costs are included in the capital costs. The transport sector is projected to have the highest share of energy purchases costs across all scenarios. The residential sector is projected to have the highest share of capital costs – these costs include those related to energy using equipment – followed by the transport and tertiary sectors. The industry sector is projected to have the lowest share of capital costs while the tertiary sector is projected to have the lowest share of energy purchases costs.

Figure 2.2 Share of energy system costs per sector and component in the Commission's scenarios



Key point: More than 50% of total energy system costs is due to the building sector (residential and tertiary).

Source: OpenExp based on PRIMES results included in the [2016 impact assessment related to the Energy Efficiency Directive]

Cost-benefit analysis of the Commission's scenarios

Cost-benefit analysis is a common practice in public policies. The aim is to assess the opportunity cost of the proposed policies and measures. In the case of energy efficiency policies, the aim should be to better estimate the potential gain from the most ambitious energy savings scenarios compared to the less ambitious ones. DG REGIO (EC, 2014-b) developed a methodology to allow for this type of analysis and the Commission's better regulation toolbox (EC, 2015-b) includes some elements of this methodology. The EC methodology allows calculating the social opportunity costs to be valued, given that the return on investment is considered as a good measure of the proposals' contribution to long-term social welfare (EC, 2014-b). It recommends adopting a long-term perspective, setting a proper time horizon and adopting appropriate discount rates to calculate the present value of future costs and benefits (EC, 2014-b). The appropriate discount rates referred to in the EC methodology are known as societal discount rates, which, usually, do not exceed 4%.

Conducting a proper cost-benefit analysis of the Commission's scenarios is, unfortunately, not possible given the lack of availability of input data used by PRIMES and the lack of abreakdown of the results. Therefore, for this report, the only input data used for cost-benefit analysis (to avoid the risk of confusing readers) are those related to the average annual direct energy efficiency investments, the average annual fossil fuels import bill savings and the cost savings resulting from reduced air pollution and health impacts considered in each of the Commission's scenarios.

As demonstrated in Chapter I, primary energy demand is projected to fall, as compared with the reference scenario, by (4.7%) in EUCO27, (8.0%) in EUCO30, (9.1%) in EUCO3030, (12.3%) in EUCO+33, (15.0%) in EUCO+35 and (21.4%) in EUCO+40 by. Thus, fossil fuel imports are reduced, and the corresponding import bills as well. Similarly, the pollution levels are reduced leading to reduction in the corresponding health damage costs (Table 2.2).

Table 2.2 Costs/benefits analysis of the Commission's scenarios

€ billion	EUCO30	EUCO+33	EUCO+35	EUCO40
Annual average Import bills savings compared to EUCO27	-6.96	-14.73	-19.93	-28.75
Annual average reduction in pollution control costs and health damage costs compared to EUCO27	-6.4	-21.8	-28.25	-43.15
Total average annual costs savings from imports bills and health damage compared to EUCO27	-13.36	-36.53	-48.18	-71.9
Annual average direct energy efficiency investment costs compared to EUCO27	+25	+73	+106	+184

Key point: Direct energy efficiency investment costs are not offset by costs savings from imports bills and health damage.

Source: OpenExp based on PRIMES and GAINS modelling results included in 2016 impact assessment related to the Energy Efficiency Directive

The sum of the savings on fossil-fuel import bills and those due to reductions in pollution control costs and health impact costs are projected to be almost half of the additional direct energy efficiency investment costs[20] across all scenarios. This shows that even if mechanisms were put in place to allocate savings from fossil-fuel import bills and savings from pollution control costs and health impact costs to invest in insulation of existing buildings, there will still be a financial gap. However, this gap might well be lowered if the discount rate in the Commission's modelling matches the Commission's "better regulation toolbox", the Commission's cost-benefit methodology and the SFSB initiative.

The on-going debate in the European Parliament on the ambition level of the energy savings target would benefit from the inclusion of proper cost-benefit analyses in the Commission's impact assessment which should be based on the overall finance that might be used for energy efficiency including ETS and EEOSs revenues. It would allow the most appropriate energy savings target, from a long-term perspective, to be adopted, instead of selecting the least-cost scenario. Furthermore, the PRIMES results should provide a breakdown of the energy system costs in terms of investment costs and financing costs for each sector. As shown in the previous sections, PRIMES results include the capital costs due to infrastructure and auction payments in the energy purchase costs and those of energy services in the capital costs of the transport sector. Therefore, the resulting cost savings cannot be used to conduct cost-benefit analysis. Analysis of increased capital costs cannot be used either, as the information provided does not allow to separate the cost of energy efficiency investments from the cost of financing.

[20] The comparison is made only with the direct energy efficiency investment costs because the proposed energy transition strategy is based mainly on the insulation of buildings. Furthermore, direct energy efficiency investment cost is the only energy system cost clearly defined in the EED impact assessment.

Chapter III: Analysis of the Smart Finance for Smart Buildings Initiative

Highlights

- The Smart Finance for Smart Buildings (SFSB) initiative is a non-legislative proposal aiming at unlocking private finance. The initiative is structured around three, comparably important, pillars: 1) financial de-risking through a more effective use of public funding; 2) technological/technical de-risking through the aggregation of projects and assistance for project development; and 3) behavioural de-risking by providing information to investors to reduce the perceived risks of energy renovation projects.

- The implementation of the SFSB includes three instruments:

  - ✓ A risk sharing facility, which will be implemented at national level through national investment platforms. The risk sharing facility aims at reducing the financial costs through a guarantee mechanism which would lower interest rates for loans dedicated to energy renovation. The national investment platforms would be fed by merging existing EU funds (European Structural and Investments Funds (ESIF) and the European Funds for Strategic Investments (EFSI)).
  - ✓ An energy renovation facilitator, which will be implemented at local/regional level through one-stop-shops. The energy renovation facilitators aim at reducing the technological/technical costs of energy renovation by developing project pipelines of bankable projects and bundling small projects into larger ones. Thus, allowing for economies of scale and making energy renovation more attractive for industrialised solutions.
  - ✓ Various platforms to provide information to investors on energy renovation. The aim is to initiate and accelerate the transformation of the energy renovation market where fundamentals such as the lower probability of default in the case of energy efficiency related loans or the increased value of assets due to higher energy performance of investments are progressively considered and reflected in the pricing of the financing products offered by banks. The overall objective is to reduce the perceived risk by investors about energy renovation projects.

- The SFSB initiative is a major step forward. However, the full potential of this initiative will not be achieved if the regulatory framework is not strengthened and building owners are not required to renovate their buildings at a certain level of energy performance. Also, the availability of EU Funds in the period 2021-2030 must be defined at a scale that matches the projected intensification of energy renovation work.

Analyses of the impacts of the Commission's scenarios on EU priority areas, presented in Chapter I, showed that the more ambitious the energy savings target is, the more significant the positive impact of the EUCO scenarios on each of the EU priority areas is. However, as shown in Chapter II, the selection of evidence-based targets is not obvious given the lack of precise information on energy efficiency investment expenditures. Chapter II also highlighted the need for more detailed data to conduct proper cost-benefit analysis with the aim to better inform policy-makers about the most suitable target and about the financing gap.

This Chapter analyses the "Smart Finance for Smart Building, SFSB" initiative included in the Clean Energy for all Europeans package (Annex on "accelerating clean energy in buildings"). The Commission's focus on financing energy transition of the EU building stock from being an energy waster to being highly energy efficient and energy producer is justified by the projected leading role of the building sector in reducing energy demand.

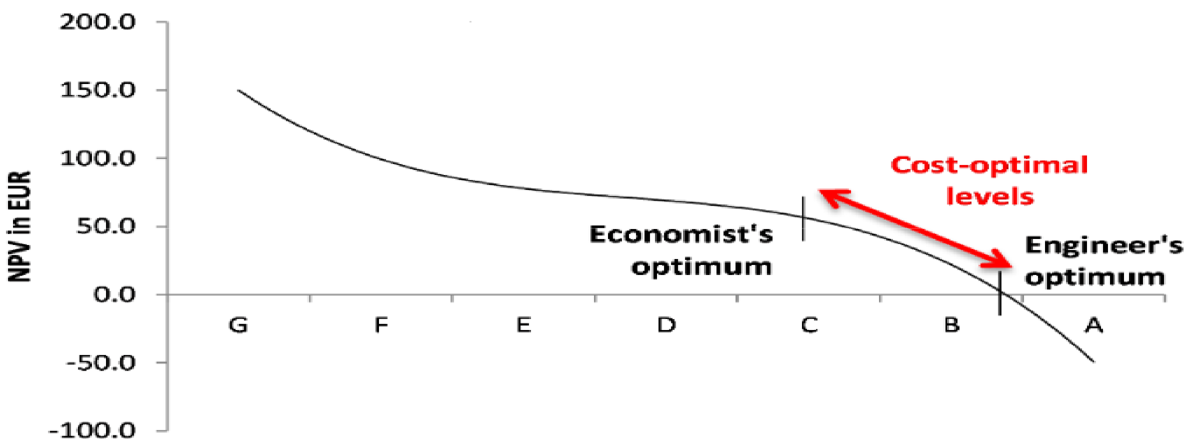
The following sections analyse the expected outcomes from the SFSB initiative based on existing literature and lessons learnt from the implementation of individual components of the initiative at Member States level. Detailed analyses of several energy renovation projects supported by the EU are included in the Clean Energy for All Europeans package (EC, 2016-e).

The SFSB initiative is an integral part of the Clean Energy for all Europeans package. It aims at mobilising private financing to accelerate, already now, the energy transition of the EU building stock from being an energy waster to being highly energy efficient and energy producer by removing the identified barriers. The initiative is based on lessons learnt at EU and Member States levels when overcoming the challenges of energy renovation. The objective is to unlock private finance and to create over-time a self-sustained energy renovation market that is ready for a longer-term perspective.

The SFSB initiative builds on existing EU financing strands and instruments that support energy efficiency and deployment of small-scale renewables, such as the European Structural and Investment Funds (ESIF) which allocates around €18 billion for energy efficiency (out of which €13 billion are allocated to buildings) over the period 2014-2020 and the European Fund for Strategic Investments (EFSI), where energy efficiency projects represent more than 10% of the EFSI guarantee usage so far. However, the SFSB initiative does not, for the time being, provide information about how EU financing instruments will be mobilised in the next period 2021-2030 at a scale that matches the intensification of energy renovation work that is projected. Furthermore, as shown in the previous Chapter, the impacts of the SFSB initiative do not seem to be considered in the Commission's modelling. In fact, the Commission used a discount rate of 10% in the EUCO scenarios, while the SFSB activities will deploy energy renovation loans with much lower interest rates. It is also unclear, given the lack of detailed data on investments and costs, if the impact of the SFSB initiative on reducing technological costs has been considered in the Commission's modelling.

Overall, the SFSB initiative is a major step forward. Moreover, to mobilise financing at the scale that is needed, in parallel to the proposed (non-legislative) SFSB, the Commission has proposed legislative measures in both the EPBD and the EED. The proposed changes to the EPBD include measures to link financial incentives provided by public funds with the energy savings achieved. However, the calculation of the savings will be based on the cost-optimum methodology which does not lead to ambitious energy renovation (Figure 3.1). On the other hand, the proposed changes to the EED include the continuation of EEOSs to further boost bundling small-scale projects. However, the Commission's proposal doesn't tackle the low ambition of efficiency measures implemented under Article 7 of the EED. Moreover, the Commission's legislative proposal does not include measures to ensure building owners will renovate their buildings at a certain level of performance. It is, therefore, doubtful that the SFSB initiative will create enough demand for energy renovation and trigger ambitious large scale renovation projects as shown in the following sections.

Figure 3.1 Net present value of energy renovation projects



Key point: The cost-optimality methodology does not lead to ambitious energy renovation.

Source: European Investment Bank (EIB) support to energy efficiency projects (presentation from EIB at a workshop on financing energy efficiency)

What to expect from the SFSB initiative?

The existing EU policy and financial framework has led to the emergence of an energy renovation market, especially in Member States where measures to stimulate economic recovery after the financial crisis have targeted the construction sector. The EU energy renovation market was estimated at €109 billion and 882.000 jobs in 2015 (OpenExp, 2016). The projected pivotal role of residential and tertiary buildings in cutting final energy consumption in the EUCO scenarios (see Chapter I) confirms the previous growth projections for the EU energy renovation market.

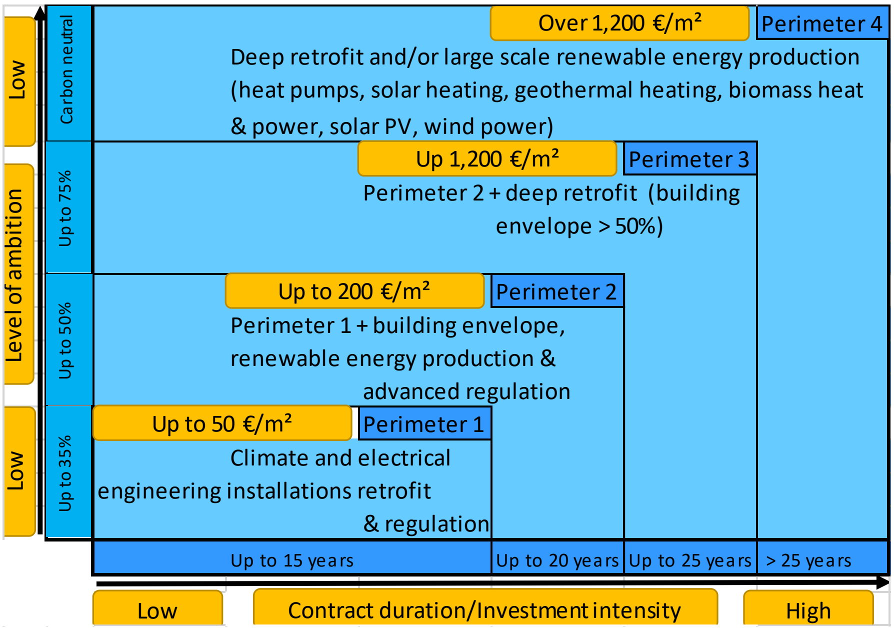
However, the identified EU energy renovation market is component-based and supported by public funds taking the form of grants. These grants come, very often, from the implementation of Article 7 of the EED, as shown by various analyses of existing energy renovation projects (JRC, 2015-c & Ricardo, 2016). This has led, at best, to shallow renovation and, at worst, to lock-in the savings potential until the next renovation round[21].

The choice of shallow renovation work is, usually, driven by its low-cost, its short pay-back (Figure 3.1) and its low burden on occupants due to the type of work undertaken. Energy renovation costs are the sum of the financial costs and the technological/technical costs. Reducing the financial costs

[21] Renovation cycles are estimated to take place in residential buildings every 30 years and in tertiary building every 15 years (IEA, 2008).

requires lowering the interest rates of renovation loans while reducing the technological/technical costs requires moving away from step by step renovation towards integrated, holistic renovation. This can be achieved through the industrialisation[22] of energy renovation and the automation of renovation tasks. Large-scale projects should make the industrialisation of energy renovation cost-effective and more attractive to the industry.

Figure 3.2 Energy renovation costs and pay-back time based on the quality of the renovation



Key point: Current energy renovation costs make net zero energy renovation too expensive and challenge the EU energy savings target[23]

Source: City-Invest. Increasing capacities in cities for innovating financing in energy efficiency

Making energy savings the first fuel of Europe in 2030, as projected by the EUCO scenarios, requires moving the energy renovation market towards a self-sustained market which delivers net zero energy consumption buildings with almost no burden for EU citizens. The SFSB initiative was designed for this purpose. The aim of this non-legislative initiative is to create an enabling framework to tackle market barriers to building renovation related to financing and to support the shift from current renovation practices based on shallow renovation financed by grants to large scale renovation projects financed by long-term loans paid back by energy savings.

The proposed SFSB initiative is based on three pillars. Each pillar addresses one set of risks:

- The first pillar of the SFSB initiative aims at financial de-risking by merging EU funds to provide an easy access to EU finance and a guarantee mechanism, which would lower interest rates of renovation projects. This would reduce financial costs of energy renovation and would be implemented through national/regional investment platforms. These

[22] Industrialisation of energy renovation means prefabrication of energy renovation kits for each building type, construction period and climate zone.

[23] The marginal cost of energy savings follows a growing exponential curve: the higher the energy savings rate rises, the more the marginal cost increases exponentially. A low energy savings rate (e.g. 25%) has a competitive marginal cost (between 20 and 50 € per m2 heated). For a major renovation, to the level NZEB (Nearly Zero Energy Building), the cost can exceed 1,200 €/ m2. Numerous studies show that, currently, energy savings cannot finance more than a 50% rate because of the high technological, technical and financial costs.

platforms would play the role of a risk sharing facility. Thus, allowing for mitigation of the risk of financial intermediaries. The platforms will ensure an effective combination of public funds, in particular EU funds from the European Structural and Investments Funds (ESIF) and financing from the European Funds for Strategic Investments (EFSI). They will also encompass technical assistance for the rolling out of lending programmes.

- The second pillar of the initiative aims at technological/technical de-risking by providing technical assistance to allow for aggregation of small projects. This would reduce technological/technical costs of energy renovation and would be implemented through local one-stop-shops, projected to play the role of energy renovation facilitators. The deployment of energy renovation facilitators is essential to reduce the transaction costs, address operational obstacles, and develop project pipelines of bankable projects allowing for economies of scale and consequently reduced technological/technical costs through the industrialisation of energy renovation.

- The third pillar of the initiative aims at behavioural de-risking by providing accurate and detailed information on energy consumption, energy savings and the cost of energy renovation to various market actors. The objective is to change the perceived risk of energy renovation and to trigger renovation work. It will be implemented through various EU/national/regional information platforms.

These de-risking activities should initiate and accelerate the transformation of the market of energy renovation where fundamentals such as the lower probability of default in the case of energy efficiency related loans or the increased value of assets due to higher energy performance of investments are progressively considered and reflected in the pricing of the financing products offered by banks. Effective implementation of the SFSB initiative would also lead to create a re-financing market for energy efficiency loans, to attract more liquidity from large investors and ultimately reduce the cost of capital for energy renovations.

The SFSB initiative is based on lessons learnt at EU and Member States level. The national/regional investments platforms proposed are close to the Private Finance for Energy Efficiency (PF4EE) scheme funded by the EU and managed by the EIB and they have some similarities with the scheme implemented in Germany via KfW. The proposed local one-stop-shops are very close to the existing local one-stop-shops in France and the energy renovation facilitator set for the implementation of the Energiesprong project in the Netherlands. Each of these good practices has contributed, in the Member State where they were implemented, to the emergence of an energy renovation market. However, none of them has led, so far, to the complete transformation of the energy renovation market from shallow renovation financed by grants to a self-sustained net zero energy renovation.

The German KfW experience, launched 16 years ago, was the first initiative to trigger energy renovation at a meaningful scale. The first phase of the initiative targeted integrated renovation aiming at low energy consumption buildings as, at the time, the concept of net zero energy building was not common. However, the initiative attracted very few projects despite the available finance at low cost (IEA, 2013), most probably because the technological costs was not addressed by the initiative. The second phase of the initiative introduced step by step renovation with increased attractiveness of finance based on the increased stringency of the energy renovation (IEA, 2013). The second edition of the KfW scheme has been much more successful than the first phase. The KfW scheme was the first scheme to link finance to the energy savings ambition and to facilitate access to all existing public funds to building owners via a one-stop-shop.

The Dutch Energiesprong experience, launched six years ago, is the first initiative aiming at net zero energy renovation in the meter. At the start of the initiative, the cost of the energy renovation was at € 130,000 per house. After four years, the cost was reduced to € 60,000. The aim of the initiative is to reduce the renovation cost further to € 40,000. Cost reduction was made possible by bundling small projects into larger ones which made the industrialisation of energy renovation cost-effective and attractive to industry. It has also reduced the time of on-site intervention to ten days which reduced the burden of buildings' occupants. The initiative has been, so far, implemented to the specific case of single family houses constructed after the second war and owned by social housing associations. The initiative has been recently extended to multi-family buildings from the same construction period. Extending the initiative to privately owned buildings is under considered. However, this would require obligating building owners to upgrade their buildings to the net zero-energy consumption level. While extending the initiative to other construction periods would require industry to innovate in the design of the zero energy renovation kits which match existing structures of buildings constructed before the second war and those constructed more recently.

The proposed instruments (risk sharing facility, energy renovation facilitator, information platforms) under the SFSB initiative will certainly contribute to increase the size of the energy renovation market, especially in Member States with an already existing technical capacity. However, the initiative would succeed to mobilise private financing at the scale needed only if the regulatory framework is strengthened by requiring building owners to renovate their buildings at a certain level of energy performance (Table 3.1). Furthermore, the initiative links providing finance with the ambition level of the energy renovation, which is a good practice. However, the estimate of the ambition level of energy renovation is based on the cost-optimum methodology which does not encourage zero energy renovation (Figure 3.1).

The initiative is also unclear about how EU funds would be bundled with ETS and EEOSs revenues as well as with the existing tax credits schemes at national level. Furthermore, uncertainties about the availability of EU funds for the period 2021-2030 may increase the perceived risk by investors and put the overall SFSB initiative at risk of failure. Moreover, provisions on reducing energy consumption of existing buildings are fragmented across several EU instruments which makes enforcement of the provisions rather difficult at local level (OpenExp, 2016).

Given the projected pivotal role of the building sector in the energy transition, the EU must succeed in the transformation of the energy renovation market towards a self-sustained market delivering net zero energy buildings. Setting an ambitious energy savings target for 2030 is the first step towards this goal. Strengthening the regulatory framework and providing investors with a long-term perspective are the two other necessary ingredients to ensure effective implementation of the SFSB initiative.

Table 3.1 Detailed SWOT analysis of the SFSB initiative

Strengths	Weaknesses	Opportunities	Threats
Reducing financial costs of energy renovation through the proposed guarantee which would increase access to capital at lower interest rates. More effective use of public funds, including EU funds by local actors through the expected combination of ESIF and EFSI resources by the proposed "financing platforms". Reducing the burden for project developers with the proposed energy renovation facilitators at local/regional level. This should lead to large scale projects which would also contribute to reduce technological costs through industrialisation of energy renovation. Changing how the banks and investors perceive energy efficiency investments. This should lead to the development of tailored and attractive financing products, and create a re-financing market to attract large investors.	Weak regulatory framework: • Building owners are not required to undertaken energy renovation work. • Cost-optimum calculation methodology is not appropriate to address the challenge of deep energy cuts. • The definition of major renovation does not require the implementation of minimum energy requirements in residential buildings. • Fragmentation of the provisions aiming to reduce energy consumption of existing buildings among at least 14 EU policy instruments. Lack of clarity about the use of ETS, EEOS revenues and other national funding mechanisms within the SFSB initiative. Lack of clarity about how to fill the financing gap identified in the EED impact assessment.	Triggering technological innovation through the industrialisation of energy renovation that would be needed if small projects are bundled into larger ones. Modernisation of the construction sector. Thus, making it attractive for young generations, females and elders. Acceleration of the implementation of integrated energy efficiency and renewable energy solutions.	Uncertainty about the continuation of the initiative after 2020 as the future of EFSI and ESIF is unknown. Lack of ambition regarding the energy savings target. The proposed 30% energy savings could be met with business as usual renovation work. It is unlikely that it triggers large scale renovation projects nor increases the ambition of energy renovation. Lack of technical capacity, especially in Member States with GDP per capita lower than the EU average.

Key point: Additional policy intervention is needed to ensure effective implementation of the SFSB initiative.

Source: OpenExp

Conclusions and next steps

The impact assessment undertaken by the Commission was a complex exercise that was conducted in a comprehensive manner. Compared to the previous impact assessments, significant progress was made in estimating various impacts of energy efficiency on EU priority areas. This confirmed the significant role of energy efficiency in reducing the size of the EU energy trilemma (see front cover).

However, as shown in this report, there are inconsistencies between the assumptions used for the EPBD and the EED impact assessments and the expected positive outcomes from the SFSB initiative do not seem to be considered in the Commission's modelling. Furthermore, an evidence-based selection of the 2030 target is not obvious due to the lack of data to conduct proper cost-benefit analysis and the inconsistencies between sectoral investment costs/energy related costs and their expected energy savings.

To ensure the adopted version of the Clean Energy for all Europeans package will deliver on the *Efficiency First* principle, the on-going debate on the efficiency files at the Parliament and the Council would benefit from:

Conducting sensitivity analyses of different discount rates levels

The financing gap identified by the analyses of the total energy system and investment expenditures is directly linked to the use of a 10% discount rate in the Commission's modelling. The investment challenge identified may well discourage some Member States to adopt an ambitious energy savings target despite the benefits such a target would bring to each country individually and to the EU as whole. Running the PRIMES model with different discount rates levels, including the expected one from an effective implementation of the SFSB initiative, would allow for evidence-based selection of the most appropriate energy savings target for Europe.

Increasing transparency about modelling assumptions and results

Not all the questions raised by the Commission's impact assessment are answered in this report because of the decision to publish the modelling assumptions and results in an aggregated manner. The on-going debate at the Parliament and the Council would benefit from the publication of disaggregated results, especially those related to costs and investments, per sector. This would be an opportunity to conduct proper cost-benefit analysis leading to a better assessment of the most appropriate energy savings target for Europe. Furthermore, it would be good to have the disaggregated assumptions and results shared with stakeholders prior to the selection of the preferred option. This would reflect the practice, already in place in some Member States, which consists of co-building policy options with stakeholders.

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Executive summary

Chapter I

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Chapter I

List of acronyms

BEAM^2	Built Environment Analysis Model
CF	Cohesion Fund
EED	Energy Efficiency Directive
EEOS	Energy Efficiency Obligations Scheme
EFSI	European Fund for Strategic Investment
EESS	European Energy Security Strategy
EEVs	Energy Efficiency Values
EIB	European Investment Bank
EPBD	Energy Performance of Buildings Directive
ERDF	European Regional Development Fund
ESD	Effort Sharing Decision
ESIF	European Structural Investment Fund
ETP	Energy Technology Perspectives
ETS	Emission Trading Scheme
EUCO	European Council
EU	Europe (28 Member States)
E3ME	Energy-Environment-Economy Model for Europe
GAINS	Greenhouse gas and Air Pollution Information and Simulation
GDP	Gross Domestic Product
GEM-E3	General Equilibrium Model for Energy, Economy and Environment interactions
GHG	Greenhouse Gas
IEEM	Industrial Energy Efficiency Model
Mtoe	Millions of tonnes of oil equivalent
NOX	Oxides of Nitrogen
NPV	Net Present Value
PDA	Project Development Assistance
PF4EE	Private Finance for Energy Efficiency
PM2.5	Particulate Matter2.5
POLES	Prospective Outlook on Long-term Energy Systems
PPP	Public Private Partnership
PRIMES	Price-Induced Market Equilibrium System
RED	Renewables Energy Directive
SFSB	Smart Finance for Smart Building
SO2	Sulphur dioxide

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