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IMPACT ASSESSMENT

Accompanying the document

Communication from the Commission to the European Parliament and the Council

on the Energy Efficiency Review

Contents

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Organization and timing

The preparation of the Impact Assessment (IA) for the Energy Efficiency Review started in 2012 following the adoption of the Energy Efficiency Directive (Directive 2012/27/EC, 'EED') which requires it. Its scope was broadened by the Communication "A policy framework for climate and energy in the period from 2020 to 2030" ('2030 Communication'), and the IA builds on the preparatory work and impact assessment done for that Communication[1].

Interservice meetings at Director level were held on 22 March and 9 April 2014. The energy efficiency interservice group (ISG) discussed the IA 4 times, on 13 March, 28 March, 30 April and 13 May 2014. The lead DG is Energy. The services invited to the ISG were Agriculture and Rural Development; Budget; Communications Networks, Content and Technology; Climate Action; Competition; Economic and Financial Affairs; Employment, Social Affairs and Inclusion; Enterprise and Industry; Environment; Eurostat; Health and Consumers; Infrastructure and Logistics in Brussels; Internal Market and Services; Joint Research Centre; Mobility and Transport; Regional and Urban Policy; Research and Innovation; Secretariat-General; Taxation and Customs Union; Legal Service; and the Executive Agency for Small and Medium-sized Enterprises.

1.2. Consultation and expertise

1.2.1. Consultation

Public consultation was conducted between 3 February and 28 April 2014. Stakeholder views were sought on (i) the right approach for addressing the shortfall in progress towards the 2020 target; (ii) the design of a possible future energy efficiency target; (iii) possible additional measures to address the economic saving potentials in different sectors. 721 responses were submitted representing a broad spectrum of stakeholders.[2] The Commission's minimum consultation standards were met. The report of the public consultation is in Annex I.

The review was discussed with Member States in the Energy Efficiency Directive Committee on 14 March 2014. A high-level stakeholder conference was held on 22 May 2014. [It provided useful first-hand accounts on the major issues addressed by the consultation and complemented the formal public consultation – *to confirm after the meeting.*]

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[1] http://ec.europa.eu/energy/2030_en.htm

[2] 36% of respondents were individuals, 34% organisations, 25% companies, 3% public authorities – including 8 Member States - and 2% others.

Box 1: Main findings of the public consultation

Many respondents argued that energy efficiency is a sound response to the prevailing energy security issue in Europe and also an effective tool for climate mitigation. It triggers innovation and creates new jobs. A number of replies indicated in particular that there is still untapped potential in manufacturing industry and that more needs to be done in buildings.

Most respondents considered that the shortfall in achieving the EU energy efficiency objective for 2020 should be addressed through targets or new policy measures. 108 respondents suggested other means of tightening the gap.

Among 313 respondents favouring targets for 2020 and/or 2030, 43% considered that these should be expressed in terms of absolute energy savings; 20% in terms of energy intensity; and 29% as a combination of the two. Respondents favouring targets argued for them at EU (77), national (78) or sectoral (43) level. 85 respondents (69%) favoured legally binding targets while 34 (28%) would prefer indicative targets.

535 respondents saw the need for additional financing instruments and mechanisms at EU level. For many, this should go hand in hand with reducing the market and non-economic barriers and raising awareness of the underlying benefits of energy efficiency.

One group of stakeholders stressed the need for the development and uptake of new technologies, while a second emphasised that the necessary solutions are already available and should be promoted through demand side policies and exchange of best practice, awareness raising and information campaigns.

1.2.2. External expertise

The IA is supported by:

- Analysis of **security of supply** through energy system modelling using the PRIMES partial equilibrium model, developed and used by the National Technical University of Athens (NTUA). The model provided projections of energy consumption and import dependency. A number of energy efficiency scenarios were modelled to analyse their impacts on import dependency;
- Analysis of **European competitiveness** on the basis of the Communication and assessment of energy prices and costs in Europe[3] and accompanying ECFIN reports; macroeconomic modelling using GEM-E3, a general equilibrium model, maintained and used by NTUA; and macroeconomic modelling using E3MG, a macro-econometric model run by Cambridge Econometrics. GEM-E3 and E3MG were used to assess GDP, employment and related impacts of the energy efficiency scenarios;
- Analysis of **sustainability** aspects through the PRIMES model;

[3] COM(2014) 21 /2 and SWD(2014) 20 final/2

- Analysis of **potentials and progress** through:
    - o Bottom-up analysis of the impact of current EU and Member State energy efficiency measures; decomposition analysis of factors contributing to changes in energy consumption in the EU; and bottom-up analysis of sectoral energy-saving potentials by Fraunhofer ISI;
    - o Analysis of Member States' energy efficiency obligation schemes and alternatives under the Energy Efficiency Directive (EED)[4] by CE Delft.

1.3. Opinion of the Impact Assessment Board

[to be added after the IAB meeting]

2. PROBLEM DEFINITION

2.1. Policy context

In 2007 the European Council set the target of saving 20% primary energy by 2020 (compared to 2007 projections). The Energy Efficiency Directive (EED) establishes a common framework of measures for the promotion of energy efficiency to ensure the achievement of the target. It requires the Commission to assess by June 2014 whether the EU is likely to reach the target and to propose further measures if necessary[5].

Amid concerns over current events in the Ukraine on the one hand, and growing energy costs for EU consumers and businesses on the other, the European Council of 21 March 2014 invited the Commission to consider the role energy efficiency should play in:

- increasing the security of energy supply to the EU market; and
- hedging against energy price increases.

The Council highlighted the timely review of the EED and the development of an energy efficiency framework as elements to reach an early agreement on a new policy framework for energy and climate in the period 2020 to 2030.

The 2030 Communication indicates that the exact ambition of future energy savings policy is to be established in the review of the EED building on the analysis underpinning the 2030 framework and the targets and objectives for greenhouse gas reductions and renewable energy, in addition to considering whether *"energy intensity improvements of the economy and economic sectors, or absolute energy savings or a hybrid of the two represents a better benchmark upon which to frame a 2030 objective"*.

[4] Art. 7 of the EED requires Member States to establish an energy efficiency obligation scheme or alternative to achieve new savings every year from 2014–2020 of up to 1.5% of the annual final energy consumption averaged over the years 2010-2012.
[5] EED Arts. 3(2), 3(3), 24(7).

2.2. Progress achieved and lessons learned

2.2.1. Trends in energy consumption and energy efficiency; lessons learned

The European Union's energy efficiency target for 2020, adopted in 2007, equates to primary energy consumption of no more than 1483 Mtoe.

Having increased from 1618 Mtoe in 2000 to 1721 Mtoe in 2006, primary energy consumption has since decreased to 1584 Mtoe in 2012. While the economic crisis that began in 2008 had a significant impact on energy demand, the effect of efficiency gains (driven by prices and policies) was greater. The rate of improvement of efficiency has accelerated since 2008. The EU policy framework (including an indicative EU target and concrete measures in the fields of buildings, appliances, power generation, transport and industry) seems to have served as a reasonable effective framework to support this acceleration, while needing to be accompanied by appropriate action in the fields of financing and of policy implementation.

The energy efficiency policy framework has been developed significantly in the last years. The EU target has been clearly defined, providing political momentum, guidance for investors and a benchmark to measure progress. The Energy Efficiency Directive of 2012 has the potential to drive energy efficiency in the EU provided it is properly implemented by Member States. Its long-term potential is however limited as some of the key provisions stop applying in 2020. In the areas of buildings and products, including cars, progressive rules have been established although their implementation and enforcement remains an issue in some cases. Despite the economic crisis investment in energy efficiency is growing although it remains below the thresholds necessary to realise the cost-effective efficiency potential of the EU economy. Experience from funding energy efficiency indicates that what is needed is a robust framework enabling better understanding, knowledge, transparency, performance measurement and de-risking at the EU level, accompanied by tailored Financial Instruments at the appropriate level, closer to final beneficiaries.

The latest projections using PRIMES are for primary energy consumption of 1539 Mtoe in 2020 - savings of about 17%. However, this consumption estimate is likely to be too high for two reasons:

1. Member States' latest reports on their national targets and planned measures under the EED suggest that these will deliver significantly more savings in 2020 than assumed in PRIMES[6]. For example, the UK has increased its savings expectation for 2020 from 18% to 20%, while Germany's objectives for 2020 under the *Energiewende* are also more ambitious than those in its national indicative target.

2. The EU economy has recently on aggregate performed less well than assumed in PRIMES reference scenario – so that at the end of 2013, GDP was 3% lower

[6] National Energy Efficiency Action Plans submitted in accordance with Article 24(2) of the EED (deadline 30 April 2014): http://ec.europa.eu/energy/efficiency/eed/neep_en.htm.

than assumed. Unless growth accelerates rapidly to make up this shortfall, this will translate into additional energy savings in 2020.

It is therefore expected that on current trends, the EU will achieve primary energy savings in 2020 in the range of **18-19%.**

More details are given in Annex II.

2.2.2. Trends in Member States

Between 2008 and 2012, primary energy consumption fell in all Member States except Austria, Estonia, Latvia, Lithuania, Luxembourg and Poland. Changes in the level of economic activity played a big part in this, as did changes in the electricity generation mix; changes in industrial structure; and – especially in Bulgaria, Croatia, Latvia, Lithuania and Romania - changes in the level of energy services consumed (e.g. bigger dwellings). When the effects of these factors and of climatic variation are stripped out, the Member States that made the greatest improvements in final energy consumption per unit of energy service were Bulgaria, Denmark, Greece, Hungary and Slovakia. Details are in Annex III.

2.2.3. Current energy efficiency trends compared to the identified cost-effective energy-saving potentials and the EU decarbonisation goals

Looking at long-term trends, different analyses have shown that current improvements in energy efficiency in the EU are below the cost-effective energy-saving potential and are not sufficient to contribute to the EU decarbonisation goals. A study by Fraunhofer ISI[7] concluded that significant cost-effective potentials remain in all sectors at the EU level, notably in buildings. The findings of this study are broadly in line with the analysis of the IEA[8]. According to the IEA, efficiency gains compared to current trends could increase the EU GDP by 1.1% in 2035, whereas additional investments required in end-use efficiency are $2.2 trillion over 2012-2035 compared with reduced energy expenditures of $4.9 trillion during that period. The Impact Assessment accompanying the 2030 Communication established that under current trends (the Reference 2013 Scenario) only 21% savings compared to projections would be achieved; whereas 25% savings would be needed to meet the 2030 GHG reduction objectives, with higher improvements having positive impacts on employment and the security of supply. The Impact Assessment also makes it clear that these savings could not be driven by the EU Emission Trading Scheme alone.

2.3. What is the problem?

2.3.1. General problem

[7] Draft study commissioned by DG ENER for supporting the Energy Efficiency Review.
[8] World Energy Outlook 2012

The general problem is that despite policies which foster energy efficiency being already in place, certain persistent barriers to energy savings still remain and the cost-effective energy-saving potential (both short- and long-term) is not fully realised; therefore, energy efficiency does not sufficiently contribute to the EU's energy policy objectives. This has the following consequences:

- In terms of **security of supply**, high energy demand increases the dependence of the EU on energy imports, notably of gas. (In 2011, energy dependency was already 54% and gas imports were at 352 Mtoe.) While international trade, including in commodities, is one of the foundations of the global economy and relatively small indigenous fossil fuel resources in the EU are a geological fact, the overexposure of several Member States to fossil fuel imports from single providers and dependency on single import routes create several risks, including price volatility and sudden disruptions of supply. Reliance on single providers has also negatively affected the EU internal energy market by fragmenting it. The potential savings to be made on fuel import bills could instead be invested in other areas of the EU economy – leading to economic growth and job creation.

- In terms of **affordability (for households)** and **competitiveness (for the EU economy),** the unused energy efficiency potential hampers the economy in several ways: it limits productivity and economic output; it negatively affects the trade balance of the EU; it limits employment especially in the current economic environment with significant spare capacity; it creates uncertainty on markets given their exposure to the volatility of energy prices; and it leads to a loss of budget revenue.

- High energy demand makes the transition to a **low-carbon economy** more costly because many energy efficiency measures are among the cheapest options for GHG abatement. While considerable progress has been made in terms of lowering the energy system's carbon intensity, the reduction of energy consumption is a "no-regrets" option for emissions reduction both in the short and the long term. Lower performance in energy efficiency means that the EU will not be on track to reach its long-term climate objectives (and will be confronted with higher costs linked to health problems).

2.3.2. Specific problems

This general problem is underpinned by the following specific problems:

1) Despite existing policies the EU energy savings target for 2020 will not be fully met

   Significant progress has been made since the analysis carried out in 2010 that showed that the EU was far from reaching its target and needed to double its efforts on energy efficiency. Now the gap is projected to be much smaller also

thanks to new policies such as the Energy Efficiency Directive, but still remains at 1-2%. In addition this progress was in part driven by lower economic growth than expected. Consequently, some of the short-term energy efficiency potential of the EU economy remains untapped and will remain so under current trends.

2) The 2020 time horizon is not sufficient to create investment security

   In the absence of a clear objective post-2020 there is no signal orienting the market to the outcomes that public policy aims to achieve. This is a particular problem given the long timeframe of investments in some sectors, especially energy generation and buildings. The viability of such investments needs to be weighed against long-term projected energy demand which can be heavily affected by energy efficiency policies. The period up to 2020 is also insufficient for the establishment of business solutions and of markets for energy efficiency and services. A long-term and coherent policy framework is needed to reduce the perceived risk amongst investors and consumers alike.

   From a policy perspective in the absence of these long-term determinants, the choice of present policy instruments risks to be driven by short term analysis.

3) Ensuring coherence of different targets and policies

   Given the key role of energy efficiency for energy security, competitiveness and GHG reductions, as well as the interactions between GHG, renewables and energy efficiency targets and policies, the future energy efficiency framework needs to be defined in a coherent way with the general 2030 framework. Otherwise there is a risk that different policy instruments within the energy and climate framework will be set up and applied in an incoherent way driving down their effectiveness, undermining the internal market and increasing the overall cost.

2.4. What are the drivers for the problem?

There is a broad body of evidence and theoretical analysis of barriers preventing consumers and investors from adopting cost-effective energy efficiency measures. These have been categorised into economic, behavioural and organisational barriers[9] or into market and non-market failures[10].

The current policy framework addresses existing market, regulatory and behavioural failures in several ways. There is however evidence that this framework does not address existing barriers sufficiently. The following elements can be singled out:

[9] Energy efficiency policy and carbon pricing, International Energy Agency, August 2011 after O'Malley et al., 2003
[10] Ibid after Jaffe and Stavins, 1994

- The principal reason why the 2020 target is expected to be missed is insufficient committement at Member State level to the implementation of the existing legislative framework. Regarding the EPBD the following main issues arise: (i) there is not enough national supervision and technical capacity for checking at local and/or regional level the compliance of energy performance requirements in building energy codes; (ii) the reliability of Energy Performance Certificates is undermined by a lack of transparency of how they are established for establishing them use underlying calculations which are often not sufficiently transparent for the outcomes to be directly comparable. Regarding Ecodesign the main problem driver is insufficient market surveillance. Only 5 Member States are estimated to have an active policy in that regard and the total amount spent on it is estimated to represent some 0.05% of the value of lost energy savings[11].

- Some of the key policy tools were designed within a 2020 timeframe and therefore do not provide long-term incentives for investing in energy efficiency. Examples include the fact that Article 7 of the EED ceases to apply after 2020 and there is no post-2020 overall target

- Certain existing policy tools need to be revised to address existing barriers more effectively. As an example under the Energy label the A+, A++ and A+++ labelling scales that were introduced during the previous revision of the Directive have been shown to negatively affect consumers' motivation to buy more energy efficient products. This change has weakened the market transformation impact of the label.

- Regarding financing, important barriers that hamper further uptake of energy efficiency investments in buildings continue to be in place, including a lack of awareness and expertise regarding energy efficiency financing on the part of all actors; high initial costs, relatively long pay-back periods and (perceived) credit risk associated with energy efficiency investments; and competing priorities for final beneficiaries[12].

2.5. The Union's right to act, subsidiarity and proportionality

The EU's competence in the area of energy in general and energy efficiency in particular is enshrined in the Treaty on the Functioning of the European Union, Article 194(1). In acting, the EU needs to respect the principles of subsidiarity and proportionality. Member States are at the centre of the realization of energy efficiency policy and EU intervention should be well targeted and supportive to their actions. The EU's role is in:

[11] Evaluation of the Energy Labelling Directive and specific aspects of the Ecodesign Directive, Ecofys, 2014

[12] 2013 financial support for energy efficiency in buildings report (http://ec.europa.eu/energy/efficiency/buildings/doc/report_financing_ee_buildings_com_2013_225_en.pdf)

- Establishing a common framework which creates the basis for coherent and mutually reinforcing mechanisms while leaving in being the responsibility of Member States to set, in a transparent and comparable way, the concrete means and modalities to achieve the agreed objectives;
- Creating a platform for exchanging best practice and stimulating capacity building;
- Setting minimum requirements in areas where there is a risk of internal market distortions if Member States take individual measures;
- Using EU instruments to promote energy efficiency, e.g. through financing, and to mainstream it in other policy areas.

3. SCOPE AND OBJECTIVES

3.1. Context and objectives

The target of 20% energy saving by 2020 is an integral element of EU energy policy, with its triple objectives of security of supply, competitiveness and sustainability. In March 2014 EU leaders reiterated that the 20% energy efficiency target must be met. As established in section 2.2, while the picture has improved, this will nevertheless not happen under current trends. Here, the objective is for appropriate responses to be identified and analysed.

The 2030 Communication sets the framework for energy and climate policy for 2020-2030. It indicates that the level of energy savings to be aimed at in 2030 now needs to be established, in a way that ensures full coherence with the binding targets the Communication has already proposed: a 40% reduction in GHG emissions (relative to 1990 levels) and at least a 27% share of renewable energy target in final energy consumption. Here, the objectives are:

(i) to analyse the appropriate level of ambition for energy efficiency from the perspective of EU energy policy and its objectives for security of supply, competitiveness and sustainability;

(ii) to reflect on how an energy efficiency target should be expressed; and

(iii) to identify where the richest potential for energy efficiency development lies, without entering into the details of policy measures, which would – if needed - be underpinned by dedicated impact assessments in the future.

3.2. Consistency with other policies

The above objectives are in line with other EU policies. They:

- Promote economic recovery and enhance the competitiveness of EU industries in line with the Europe 2020 Strategy, contributing to the Resource Efficiency flagship initiative and the sustainability layer of Europe 2020;

- Increase security of energy supply as called for in the Energy 2020 Strategy: less energy used in Europe means less reliance on imports and a lower energy import bill. [add link to June 2014 security of supply paper when available]
- Create jobs and reduce energy poverty in support of the EU's social agenda.
- Enable the reduction of GHG emissions up to 2020 and thus contribute in a cost-effective way to reaching the EU's climate objectives.
- Facilitate further commitments on GHG emission reduction after 2020.

4. POLICY OPTIONS

4.1. Options for closing the gap towards the 2020 target

The following options are considered:

1. No action.
2. New primary legislation laying down binding national targets or additional binding measures.
3. Strengthened implementation of current policies.

Option 1 is discarded from further detailed analysis as the 2020 target would not be fully achieved and the benefits associated with meeting it would not be realised.

4.2. Analysis of the optimal level of savings for 2030

Building on the 2030 Communication and its accompanying IA, five scenarios with a stepwise increase in the intensity of energy efficiency efforts in all sectors targeted by current policy measures were modelled to assess the impacts these efforts would have on security of supply, competitiveness and sustainability up to 2030.

The analysis underpinning the 2030 Communication indicates that for the goal of a 40% GHG reduction alone, the cost-efficient level of energy savings amounts to 25%[13] (in comparison to 2007 projections for 2030). The accompanying IA investigated scenarios with energy efficiency measures reaching higher levels of energy savings (up to 30% in scenarios with 40% GHG reduction). The IA indicated that this higher ambition in energy efficiency would have additional benefits in terms of energy security, growth and jobs and lowered imports bill as well as on health – while incurring higher costs within the energy system.

In the present IA the analysis underpinning the 2030 Communication is continued in a coherent way, taking into account the progress that Member States are making towards their national targets under the EED and taking into account studies on energy-saving potentials and responses to the public consultation. Starting from the 25% level of energy savings, five energy efficiency scenarios were modelled with primary energy

[13] Here and subsequently, energy savings in 2030 are calculated relative to the energy consumption projected, in PRIMES in 2007, for that year (1874 Mtoe).

reductions in 2030 relative to PRIMES 2007 projection of 25%, 28%, 30%, 35% and 40%. Annex V shows the assumptions on energy efficiency measures in the scenarios that have been modelled. The scenarios are based on common assumptions regarding GDP and population growth, imported fossil fuel prices and technology costs. The assumptions used are the same as in the PRIMES Reference Scenario 2013 and the IA underpinning the 2030 Communication[14].

The assumed structure of energy efficiency policies is similar to the current set of legislation including the EED, EPBD and regulations adopted under ecodesign/energy labelling, It is assumed that in the context of the energy efficiency scenarios the legislation continues after 2020 and further intensifies in terms of saving obligations. The policies are assumed to intensify until 2030 and then intensify only moderate beyond 2030.

The intensity of saving obligations is defined in each energy efficiency scenario. The aim is to explore the range up to 40% for year 2030. The energy efficiency assumptions imply reduced demand for energy by end-users of energy and also reduced demand for electricity. For each scenario the model simulates a new equilibrium in energy markets and also in ETS market taking into account the reduced demand.

The table below shows the assumptions on energy efficiency measures in the scenarios that have been modelled.

Table X: Assumptions **of the policy scenarios assessed**[15]

EE 25	Primary energy savings: 25.9% GHG reduction in 2030 (wrt. to 1990): 40.3% RES share in 2030: 28% Energy efficiency policies: - Increasing energy efficiency of houses and buildings leading to renovation rates of 1.39% in 2015-2020, 1.59% in 2021-2030 and 1.10% in 2031-3050 which will bring average energy savings after renovation of 21.68% in 2015-2020, 39.44% in 2021-2030 and 41.36% in 2031-3050 - Reduction of discount rates by elimination of market failures and imperfections from 17.5% to 12% in the residential sector and from 12% to 10% in the tertiary sector - Increased uptake of advanced technologies (Ecodesign) - Increased uptake of BAT in industry - Higher penetration of district heating; assuming that 11% of households will be connected to district heating networks in 2030 - Measures limiting grid losses to 7 - Measures reducing energy consumption in transport (no tightened CO2 standards compared to Ref Plus)

[14] http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2050_update_2013.pdf
[15] See Annex XX for further details.

	The scenario is set in enabling conditions
EE 28	Primary energy savings: 28.1% GHG reduction in 2030 (wrt. to 1990): 40.6% RES share in 2030: 27.7% Energy efficiency policies: - Increasing energy efficiency of houses and buildings leading to renovation rates of 1.48% in 2015-2020, 1.84% in 2021-2030 and 1.15% in 2031-3050 which will bring average energy savings after renovation of 21.94% in 2015-2020, 43.54% in 2021-2030 and 54.77% in 2031-3050 - Reduction of discount rates by elimination of market failures and imperfections from 17.5% to 10.2% in the residential sector and from 12% to 9% in the tertiary sector - Increased uptake of advanced technologies (Ecodesign) - Increased uptake of BAT in industry - Higher penetration of district heating; assuming that 11% of households will be connected to district heating networks in 2030 - Measures limiting grid losses - Measures reducing energy consumption in transport (e.g. CO2 standard of 78 gCO2/km in 2030 (27 gCO2/km in 2050) for passenger cars and 110 gCO2/km in 2030 (60 gCO2/km in 2050) for LCVs) The scenario is set in enabling conditions
EE 30	Primary energy savings: 30.6% GHG reduction in 2030 (wrt. to 1990): 41% RES share in 2030: 27.7% Energy efficiency policies: - Increasing energy efficiency of houses and buildings leading to renovation rates of 1.62% in 2015-2020, 2.20% in 2021-2030 and 1.23% in 2031-3050 which will bring average energy savings after renovation of 22.08% in 2015-2020, 45.83% in 2021-2030 and 48.49% in 2031-3050 - Reduction of discount rates by elimination of market failures and imperfections from 17.5% to 9% in the residential sector and from 12% to 8.5% in the tertiary sector - Increased uptake of advanced technologies (Ecodesign) - Increased uptake of BAT in industry - Higher penetration of district heating; assuming that 12% of households will be connected to district heating networks in 2030 - Measures limiting grid losses - Measures reducing energy consumption in transport (e.g. CO2 standard of 75 gCO2/km in 2030 (26 gCO2/km in 2050) for passenger cars and 110 gCO2/km in 2030 (60 gCO2/km in 2050) for LCVs) - The scenario is set in enabling conditions
EE	Primary energy savings: 35.0%

35	GHG reduction in 2030 (wrt. to 1990): 42.1% RES share in 2030: 27.4% Energy efficiency policies: - Increasing energy efficiency of houses and buildings leading to renovation rates of 1.64% in 2015-2020, 2.40% in 2021-2030 and 1.32% in 2031-3050 which will bring average energy savings after renovation of 22.12% in 2015-2020, 46.34% in 2021-2030 and 49.01% in 2031-3050 - Reduction of discount rates by elimination of market failures and imperfections from 17.5% to 9% in the residential sector and from 12% to 8.5% in the tertiary sector - Increased uptake of advanced technologies (Ecodesign) - Increased uptake of BAT in industry - Higher penetration of district heating; assuming that 14% of households will be connected to district heating networks in 2030 - Measures limiting grid losses - Measures reducing energy consumption in transport (e.g. CO2 standard of 72 gCO2/km in 2030 (25 gCO2/km in 2050) for passenger cars and 110 gCO2/km in 2030 (60 gCO2/km in 2050) for LCVs) The scenario is set in enabling conditions
EE 40	Primary energy savings: 40% GHG reduction in 2030 (wrt. to 1990): 44.9 % RES share in 2030: 27.4 % Energy efficiency policies: - Increasing energy efficiency of houses and buildings leading to renovation rates of 1.65% in 2015-2020, 2.43% in 2021-2030 and 1.33% in 2031-3050 which will bring average energy savings after renovation of 22.11% in 2015-2020, 46.36% in 2021-2030 and 49.07% in 2031-3050 - Reduction of discount rates by elimination of market failures and imperfections from 17.5% to 9% in the residential sector and from 12% to 8.5% in the tertiary sector - Increased uptake of advanced technologies (Ecodesign) - Increased uptake of BAT in industry - Higher penetration of district heating; assuming that 14% of households will be connected to district heating networks in 2030 - Measures limiting grid losses - Measures reducing energy consumption in transport (e.g. CO2 standard of 60 gCO2/km in 2030 (17 gCO2/km in 2050) for passenger cars and 110 gCO2/km in 2030 (60 gCO2/km in 2050) for LCVs) The scenario is set in enabling conditions

This IA does not aim at assessing in detail specific policy measures within a 2030 perspective. Neither does it compare the impact of typical policy alternatives (regulation, voluntary agreements, financing, training and awareness) as it is likely that

they would all play a role within the long timeframe considered. Rather, the IA aims at identifying the optimum strategic direction, to be complemented by specific IAs in the future.

4.3. Options for the architecture of the energy efficiency framework post-2020

The current, **2020** framework is based on:

- an indicative EU target underpinned by indicative national targets;
- EU legislation for products traded in the internal market;
- EU legislation coupled with administrative support in other areas, such as buildings and combined heat and power, providing general overall provisions while leaving flexibility for the national and local level to implement them in an appropriate way;
- national and local provisions not linked to common EU rules
- financing through European, national and local sources.

This design provides a mutually-reinforcing set of instruments. At the same time it is the result of an 'organic' evolution of policies and has not so far been thoroughly compared with alternatives. This analysis with its long-term perspective allows such a comparison.

The following options for the architecture of the framework for **2030** are identified:

I. No action. This implies that post 2020, any EU target would be abandoned and efforts at European level would be based solely on specific instruments.

II. Indicative EU target, coupled with specific EU measures. This would be a continuation of the current framework.

III. Binding EU target, coupled with specific EU measures. This would replicate the approach proposed by the Commission in the 2030 Communication for RES.

IV. Binding MS targets, coupled with EU polices solely in areas linked to the internal market.

In addition, irrespective of the character and level of a possible target, it needs to be considered how it could be formulated. The following options for target formulation are identified:

- Consumption target
- Intensity target
- Hybrid approach

5. ANALYSIS OF IMPACTS

5.1. Methodology

This IA follows and is fully consistent with the 2030 communication.

The 2030 communication proposes two binding targets for 2030: 40% GHG reduction and at least 27% renewable energy. These targets were taken as constraints[16].

The 2030 communication took into account climate and energy policies adopted up to June 2012. Given the requirement for the EED review to assess whether or not the EU is on track for its 2020 energy saving objective, it was necessary to update this. The present IA takes into account policies adopted up to February 2014. Scenarios are compared both with the reference scenario used for the 2030 communication ("Ref 2013") and with this updated reference scenario ("Ref plus").

Table 2 compares the methodology used with that of the 2030 communication.

[16] In practice, it proved impossible to avoid depicting in the modelling a limited tendency for greenhouse gas emissions to fall as energy efficiency policy became more ambitious. The only serious divergence was in the "very ambitious" scenario, which ended up depicting greenhouse gas savings of 44.9%.

Table 2: Methodological approach for modelling– consistency with 2030 communication

	2030 Communication	2014 EED review	Notes
Reference scenario	Climate and energy policies adopted up to June 2012	As "2030", plus policies adopted up to February 2014[17]	Modelling results suggest that the 13 ecodesign/ energy labelling regulations adopted since June 2012 have no impact.
GDP growth	2010-20: 1.5% p.a. 2020-30: 1.6% p.a.	As "2030"	
Fossil fuel prices (€'10/boe, 2020/30)	Oil 89/93; gas 62/65; coal 23/24	As "2030"	
Energy technology progress	Decreasing costs and increasing performances for specific technologies	As "2030"	
Structure of EU28 economy	Increasing share of services in the gross value added of the economy	As "2030"	
Population growth	2010-20: 0.3% p.a; 2020-30: 0.2% p.a.	As "2030"	
Degree days	Kept constant at 2005 level	As "2030"	
Policy scenarios: GHG emissions	-40%	As "2030"	Most ambitious scenario (proposed by EP): overshooting allowed
Policy scenarios: share of renewable energy	at least 27%	As "2030"	
Representation of active public policy in energy efficiency and other sectors	"Carbon values"[18], "renewables values" and, post-2030, "enabling settings"[19]. (The impact assessment also included some scenarios with modelling of energy efficiency measures[20] and with "reference settings").	As "2030"	Carbon values, and enabling settings in the case of energy efficiency, replaced by energy efficiency measures as in footnote 20.

[17] F-Gas regulation; new transport measures (alternative fuels infrastructure, better quality and more choice in railway services, improvements in fuel efficiency of lorries, speeding up the reform of Europe's air traffic control system); new ecodesign and energy labelling regulations; updated depiction of 2012 Energy Efficiency Directive, reflecting reporting by Member States.

[18] Mirroring ETS prices in the non-ETS sector – representing still undefined policies that will drive GHG reduction.

[19] Assumption of perfect market coordination and consumer confidence driven by firm commitment to decarbonisation, leading to lower system costs and faster uptake of EE, RES and emission reduction technologies.

[20] Savings obligations for utilities; energy management systems; ESCOs; energy labelling; CHP and district heating/cooling; efficiency in grids; ecodesign; take-up in industry of best available techniques; internalisation of local externalities in transport; CO_2-related element in vehicle registration and circulation taxes;

Discount rates used to depict decision-making by economic actors	8-17.5%; some energy efficiency measures can lower discount rates	As "2030"[21]	
System costs	Calculated using standard (un-lowered) private discount rates[22]	As "2030"	
Market failures and imperfections	2030 Impact assessment: "*So far, reduced discount rates in the context of economic decision making of agents, following from energy efficiency policies, have not been applied in the same way to calculate the capital cost and direct energy efficiency investment component of energy system costs. With energy efficiency policies increasingly changing energy markets by addressing market failures and imperfections,* ***it appears appropriate to revisit this issue in future analyses***."	Figures presented.	

revised Energy Taxation Directive; ITS for road and waterborne transport; ecodriving; tighter CO_2 standards for cars and vans; efficiency improvements for heavy duty vehicles.

[21] In the 2030 impact assessment, the scenarios with ambitious energy efficiency policies made the assumption of a wide deployment of energy performance contracting and strong penetration of ESCOs, which is mirrored by a further reduction of discount rates for households from 12% in 2020 under Reference scenario conditions to 11% in 2025, 10% in 2030 and 9% from 2040 onwards, where the rate remains up to 2050. For tertiary, offering particular high potential for energy performance contracting, the discount rate goes down from 10% in 2020 to 9.5% in 2025 and 8.5% in 2030 to 2050.

[22] Households, private cars 17.5%; industry, tertiary, trucks, inland navigation 12%; power generation 9%; public transport 8%.

5.2. Policy options for 2020

On present trends, EU primary energy savings are likely to achieve 18-19% in 2020, a shortfall compared to the target of approximately **20-40 Mtoe** (Chapter 2). Chapter 4 identified two options to address the gap:

- New primary legislation laying down binding nation targets or additional binding measures
- Strengthened implementation of existing legislation

Based on the precedents of the EED and the Energy Performance of Buildings Directive (EPBD), **new primary legislation** – whether binding measures or binding targets – would be unlikely, even on an optimistic timetable, to enter into force before 2018.[23] The EU would then need to reduce energy consumption, compared to what it would otherwise have been, by an additional 12 Mtoe in each of the next three years, doubling the rate projected in the modelling. It is unlikely that this could be achieved at such short notice without a noticeable level of disruption to the functioning of the EU economy and society.

By contrast, this modelling assumes a level of **implementation** of the requirements of the EED, EPBD and regulations adopted under ecodesign/energy labelling that falls well short of full compliance. It is estimated that for the EED, poor implementation risks reducing the obtained energy savings by more than 20 Mtoe[24]; for the EPBD, the figure is 15 Mtoe[25]; and poor compliance with the requirements of product regulations is estimated to be reducing the obtained energy savings by 4 Mtoe[26] - for a combined total of more than **39 Mtoe.**

This analysis suggests that the approach with the best potential to close the remaining gap to 2020 is strengthened implementation of existing legislation. This could be achieved through:

- Full implementation of EU legislation at national level, with effective monitoring;
- Reinforced resourcing of market surveillance and better cooperation among national market surveillance authorities;
- Strengthening energy performance certificates under the EPBD through benchmarking of the effectiveness of certification frameworks in all Member States, assisting Member States in compliance checks and linking national schemes to reliable EN standards;
- Making wider use of innovative financing in the form of standardised investment products to support energy efficiency financing products;

[23] Proposal by Commission: January 2015. Adoption by co-legislators: July 2016. Transposition: January 2018.

[24] The PRIMES modelling reported here assumes that the Energy Efficiency Directive as a whole will lead to a reduction in annual final energy consumption of 39 Mtoe in 2020. By contrast, the targets notified by Member States for the implementation only of Article 7 of the Directive sum, if fully achieved, to savings of 59 Mtoe in 2020. Equivalent figures in primary energy would be higher.

[25] Fraunhofer, section 3.5.1.

[26] Studies conducted in 2011 estimated that about 20% of products do not meet the declared energy efficiency levels (ATLETE project funded under the IEE Programme) and this leads to a loss of more than 10 percent of the energy savings envisaged (Monitoring, Verification and Enforcement Capabilities and Practices for the Implementation of the Ecodesign and Labelling Directives in EU Member States, CLASP, 2011). This would represent about 4 Mtoe additional savings in final energy that could be realised if market surveillance was significantly strengthened.

- Databases on product and building energy performance and indicators for measuring progress.

Accelerating secondary legislation in the products sector could play a supporting role. Preparatory work is under way for seven new product groups, including windows, servers and data centres, steam boilers and water-related products. Accelerated implementation (in collaboration with stakeholders, Member States and the European Parliament) could bring this legislation into force a year earlier – with adoption dates in 2015/16 rather than 2016/17. It is estimated that this acceleration would increase primary energy savings by a further 5 Mtoe.

5.3. Ambition level 2030

5.3.1. Energy system impacts

The main results of PRIMES modelling concern the impacts of EE on the energy system. These impacts vary for different levels of ambition of energy efficiency as portrayed by the scenarios analysed in this IA. The energy savings (calculated against the 2007 PRIMES baseline projections for 2030) achieved by the scenarios is the key metric, which, because of its importance, is used for labelling of scenarios. The scenarios achieve respectively energy savings in 2030 of 25%, 28%, 30%, 35% and 40%. Consequently later they are referred to as EE25, EE28, EE30, EE35 and EE40 scenarios.

Measured as an absolute value, **primary energy consumption**[27] is clearly reduced in all scenarios analysed (6 to 17% in 2030 and 7 to 27% in 2050[28] in comparison to the Reference+ scenario) despite the steady growth of the EU GDP that is assumed[29]. The reductions are higher for all new scenarios than for the GHG40 scenario as the concrete EE policies acting both on the supply and the demand side have more impact than the carbon values previously assumed. It should be also noted that some reduction in primary energy consumption is due to the RES target of 27% (except for EE25 which has 28% RES) present in all new scenarios - thanks to high efficiency of RES in electricity production.

As a result of reduced primary energy consumption, the **energy intensity of the EU economy** is reduced under all scenarios. The more ambitious the scenario is, the lower the energy intensity of the EU economy gets. Among the sectors, lowering of the energy intensity is most visible in the residential and tertiary sectors reflecting the fact that the policies proposed most affect these two sectors.

The policy scenarios demonstrate also significant differences in terms of **the consumption of various primary energy sources**. Table 1 below shows both the changes in the relative shares of fuels, as well as the changes compared to reference, as all the scenarios achieve decreases in total energy consumption impacting the fuel shares.

- As regards **solid fuels** (notably coal), already in 2030 their consumption in absolute terms declines substantially under EE25, EE28, EE30 and EE40 scenarios (between 16 and 8% in comparison to the Reference+) whereas only a small reduction is visible

[27] Gross Inland Consumption according to Eurostat convention.
[28] To be updated.
[29] Avg. 1.6% pa over the period 2015-2030 and avg. 1.4% pa over the period 2030-2050).

under the EE35 scenario. The EE35 has a high ambition of EE measures and consequently a rather low ETS prices is necessary to achieve the 40% GHG reduction allowing to maintain the same share of solids as the Reference+ scenario. In longer term, all ambitious scenarios (EE30, EE35 and EE40) achieve a reduction of solids consumption (in comparison to Reference+).

The share of solids in the fuel mix in 2030 remains largely stable (in comparison to Reference+) for EE25 and EE28 while it grows slightly for all ambitious scenarios.

- For **oil**, the reduction of consumption is higher the more ambitious the scenario gets and becomes more substantial with time (in 2030 between 6 to 12% and in 2050 between 59-63% in comparison to the Reference+) – closely linked with CO_2 standards for light vehicles becoming more stringent.

  The share of oil in 2030 remain very stable (in comparison to Reference+) in EE25, EE28 and EE30 scenarios at 32-33%, while it grows slightly in EE35 and EE40 scenarios.

- For **natural gas,** the reduction of consumption is higher the more ambitious the scenario gets and becomes more substantial with time (in 2030 between 12 to 35% and in 2050 between 23-45% in comparison to the Reference+) – closely linked to policies improving the thermal integrity of buildings.

  The shares of natural gas decline as the scenarios get more ambitions. In 2030, they go from 25% for Reference+ to 23% for EE25 and to 19% for EE40.

- The consumption of **nuclear** reduces in 2030 in all scenarios in comparison to the Reference+ but in 2050 perspective it grows very strongly for EE25 and EE28 scenarios, slightly for EE30 scenario and declines in the two most ambitious scenarios as the strong EE makes the nuclear less necessary for the achievement of decarbonisation.

  The shares of nuclear in 2030 remain very stable (in comparison to Reference+) in all scenarios between 12-13%.

- Finally, the absolute consumption of **renewables** grows in 2030 for EE25 and EE28 scenarios (in comparison to Reference+) but declines in all more ambitious scenarios, where by the sheer reduction of energy consumption there is less need for the development of RES is absolute values. The main driver of renewables is the RES target which is between 27 and 28% for all scenarios. In longer perspective, the consumption of RES grows for all scenarios driven by the decarbonisation and facilitated by enabling conditions. It should be noted that increased share of RES strengthens the effects of EE through increased efficiency in power generation.

  The shares of renewables in 2030 are slightly higher (than in Reference+) in all scenarios: between 22-23%

The changes described above will have some effects on the power generation capacity installed for different fuels as well as the related investments.

The **share of renewables in final energy consumption** as specified by the target can be translated into specific shares in electricity, heating & cooling and transport. The scenarios analysed in this IA show very little variation with respect to the overall RES target and also for the shares in these specific sectors.

Table 1: Impacts on primary energy consumption in 2030 and 2050.

Indicator *(figures are presented in a 2030/2050 format)*	**Ref**	**Ref plus**	**Decarbonisation Scenarios**					
			GHG40	EE25	EE28	EE30	EE35	EE40
Primary Energy Consumption (Mtoe)	1611 / 1630	1611 / 1632	1534 / 1393	1518 / 1517	1474 / 1380	1424 / 1286	1337 / 1196	1243 / 1129
Energy Savings (*evaluated against the 2007 Baseline projections for 2030)*	21 / n.a.	21 / n.a.	25.1 / n.a.	25.9 / n.a.	28.1 / n.a.	30.6 / n.a.	35 / n.a.	39.8 / n.a.
Energy Intensity (2010 = 100) (*primary energy to GDP)*	67 / 52	67 / 52	64 / 44	63 / 48	62 / 44	59 / 41	56 / 38	52 / 36
- Industry[30]	81 / 68	81 / 68	78 / 55	76 / 56	74 / 48	72 / 48	68 / 48	68 / 48
- Residential[31]	72 / 54	71 / 54	67 / 40	67 / 47	63 / 41	59 / 35	52 / 29	43 / 24
- Tertiary[32]	65 / 49	65 / 49	59 / 34	61 / 44	55 / 40	50 / 34	43 / 29	33 / 24
- Transport[33]	71 / 56	71 / 56	70 / 44	68 / 44	68 / 44	68 / 44	68 / 43	68 / 43
Primary Energy Consumption in Reference and % change compared to Reference	1611 / 1630	1611 / 1632	-4.8 / -14.5	-5.8 / -7	-8.5 / -15.3	-11.6 / -21.1	-17 / -26.6	-22.8 / -30.8
- Solid fuels	174 / 124	174 / 124	-10.8 / 7.2	-15.9 / 20.4	-8.3 / 4.8	-7.5 / -3.8	-0.8 / -13.1	-11.6 / -16.5
- Oil	520 / 498	514 / 487	-3.3 / -62.1	-6.2 / -58.6	-8 / -59.9	-9.7 / -60.5	-12 / -62.5	-13.6 / -62.8
- Natural gas	397 / 397	404 / 408	-13.2 / -36.9	-12.4 / -22.5	-19.2 / -33.8	-24.7 / -40.6	-35.3 / -44.9	-42.2 / -49.9
- Nuclear	201 / 216	201 / 216	-0.2 / 17.1	-5.4 / 20.2	-6.9 / 11.3	-11.1 / 2	-21.7 / -8.5	-31.5 / -17.2
- Renewables	320 /	320 /	3.5 / 43.6	8.3 / 49.9	2.7 / 38.2	-1 / 29.7	-8.3 / 22.7	-14.4 / 16.8

[30] Energy on Value added

[31] Energy on Private Income

[32] Energy on Value added

[33] Energy on GDP

	398	399						
Primary Energy Consumption Share of :								
- Solid fuels	10.8 / 7.6	10.8 / 7.6	10.1 / 9.5	9.6 / 9.8	10.8 / 9.4	11.3 / 9.3	12.9 / 9	12.4 / 9.2
- Oil	32.3 / 30.5	31.9 / 29.8	32.8 / 13.5	32.1 / 13.6	32.5 / 14.5	33 / 15.3	34.2 / 15.6	36.2 / 16.4
- Natural gas	24.6 / 24.3	25 / 25	22.5 / 17.9	22.9 / 20.3	21.8 / 19	21 / 18.3	19.2 / 18.3	18.5 / 17.6
- Nuclear	12.5 / 13.2	12.5 / 13.2	13.1 / 18.1	12.5 / 17.1	12.7 / 17.4	12.6 / 17.1	11.8 / 16.5	11.1 / 15.8
- Renewables	19.9 / 24.4	19.9 / 24.5	21.6 / 41	22.9 / 39.3	22.3 / 39.8	22.3 / 40.1	22 / 40.8	22.1 / 41.2
Renewables Share - Overall	24.4 / 28.7	24.4 / 28.7	26.5 / 51.4	28 / 49.2	27.7 / 50.1	27.7 / 50.7	27.4 / 51.7	27.4 / 52.4
- Share in electricity, heating & cooling	31 / 36.8	31 / 36.9	34.2 / 51.4	36.2 / 49.1	36.1 / 50.8	36.5 / 51.7	36.9 / 53	37.8 / 54
- Share in heating & cooling	23.8 / 26.6	23.8 / 26.7	25.9 / 49	27.3 / 44.9	27.3 / 46.7	27.5 / 46.4	27.4 / 45.9	27 / 46.4
- Share in electricity	42.7 / 50.1	42.7 / 50.3	47.3 / 53.2	50.4 / 52.7	49.1 / 54	49.5 / 55.8	50.3 / 58.1	52.7 / 59.3
- Share in transport	12 / 13.9	12 / 14.1	12.8 / 67.9	13.6 / 64.6	13.7 / 65.2	14 / 66	14.2 / 68.6	14.4 / 68.9

Source: PRIMES 2014

The impacts of EE on overall energy consumption and on the fuel mix have important effects on **energy imports**. Clearly, the energy efficiency policy can contribute to increasing the security of supply, which is currently a high political priority in the context of events in Ukraine.

In the table below it is visible that **net energy imports** decrease significantly for all EE scenarios already in 2030. While the reduction of net energy imports in 2030 is 4% for the Reference+ (in comparison the year 2010), the scenarios achieve up to 226 reduction (for EE40 - the reductions getting higher, the more ambitious the scenario is. All scenarios achieve higher reduction than the GHG40 scenario presented in the 2030 IA. The trend is even more pronounced in 2050 (where for all scenarios the imports practically halve in comparison to the year 2010). In this longer term perspective, the drivers are both EE policies and higher share of (domestically produced) renewables.

Looking at specific imported fuels in 2030:

- **imports of solids** decrease for all scenarios and up to 41% for EE40 scenario (in comparison to 2010) whereas the Reference+ achieves only 23% reduction;

- **imports of oil** decrease for all scenarios and up to 19% for EE40 (in comparison to 2010) whereas the Reference+ achieves only 8% reduction;
- the **imports of gas** decrease for all scenarios and up to 40% for EE 40 scenario (in comparison to 2010) whereas in Reference+ imports grow by 7%.

Import dependency is in the short term much less affected by policy choices and there are little differences between scenarios in 2030 with respect to the Reference+ and even present levels. In 2050, however, the Reference scenario still has 57% import dependency whereas all other scenarios decrease it to below 40%, due to reduced demand for imported fossil fuels – brought about by the EE policies. It has to be also borne in mind that EE reduces global energy consumption which has the impact on shares of imports. Decreasing import dependency under all EE scenarios demonstrates that EE policy reduced energy consumption of imported fuels to a greater extent than consumption of those produced domestically.

Another manner of illustrating the impact of EE on imports is calculation of **fossil fuel net imports in monetary value** which decreases for all scenarios and most markedly for the most ambitious scenarios. In the long term, the value of imports under the Reference+ would increase taking into account growing fossil fuel prices but it decreases even further in all scenarios analysed reflecting their impact on curbing the demand.

Net energy import decreases translate into **savings in the energy fossil fuel imports bill** (calculated here as a cumulative value over a 20 year period). For the period 2011-2030 cumulative savings range from €240 billion to €552 billion and for the period 2031-2050 from €3078 billion to €4361 billion. These savings indicate that rather than paying for exports, the EU economy can have these resources invested either in technology development and/or new assets and/or education, all of which contribute to job creation and economic growth.

Table 2: Impacts on energy security in 2030 and 2050.

Indicator *(figures are presented in a 2030/2050 format)*	**Ref**	**Ref plus**	**Decarbonisation Scenarios**					
			GHG40	EE25	EE28	EE30	EE35	EE40
Net Energy Imports Volume (2010=100)	96 / 101	96 / 101	89 / 56	87 / 64	84 / 57	82 / 54	78 / 51	74 / 49
- Solid	77 / 49	77 / 49	68 / 42	60 / 49	62 / 38	62 / 34	70 / 30	59 / 29
- Oil	93 / 96	92 / 94	90 / 41	87 / 44	86 / 43	84 / 43	82 / 41	81 / 41
- Gas	105 / 122	107 / 125	91 / 74	91 / 92	84 / 78	78 / 69	67 / 65	60 / 59
- Renewable Energy Forms	492 / 601	490 / 598	505 / 1043	527 / 1049	499 / 972	482 / 924	458 / 875	433 / 852
Import Dependency (net imports to total primary energy consumption)	55.1 / 56.6	55.1 / 56.5	53.6 / 36.8	53 / 38.6	52.7 / 38	52.7 / 38.3	53.5 / 38.6	54.4 / 39.1
Fossil Fuel Net Imports in bn €'10 *(average annual 2011-30)*	461 / 548	461 / 545	452 / 377	449 / 394	445 / 373	441 / 358	436 / 340	433 / 330
- Solids								

- Oil - Gas								
Fossil Fuels Import Bill Savings in 2011-2030 and 2031-2050 compared to reference (bn € '10) *(cumulative 20 year savings from imports)*	n.a	n.a	-190 / -3404	-240 / -3078	-315 / -3491	-397 / -3798	-505 / -4145	-552 / -4361

Source: PRIMES 2014

Final energy demand declines in a similar manner to primary energy consumption with increasing magnitude of the decreases brought by the EE policies. Differences are already visible in 2030 and they gain in magnitude in the longer term. Looking at the specific sectors, the residential and tertiary sectors experience the strongest reduction (in comparison to the Reference+) as they are affected by a majority of energy efficiency policies with the biggest changes brought about by improving thermal integrity of buildings – consequently their share in total final energy demand decreases. The share of industry in final energy demand almost does not change from the Reference case demonstrating the countervailing effects of EE policies and ETS prices. On the other hand, the share of transport grows slightly in EE25 and EE28 and more significantly in EE30 and EE35 scenarios reflecting relatively smaller potential for GHG abatement in transport.

Gross electricity generation decreases by 2030 for all scenarios in comparison to Reference+. In a 2050 perspective, however, it grows (in comparison to Reference+) except for EE35 and EE40 scenarios reflecting increasing demand for electricity from heating, appliances and transport. In electricity generation, the share of gas declines for all scenarios. The demand side load factor for electricity improves in all scenarios in 2030 and even more in 2050 reflecting the smoothing of the demand curve. Electricity grid losses remain the same for all scenarios and Reference+ except for EE35 and EE40 scenarios, in which losses visibly decline.

Among impacts on **technologies**, a key impact to be observed is the increase observed for shares of electricity produced from **combined heat and power (CHP)** up to 17% already in 2030 in EE25, EE28 and EE30 scenarios (from 16% in the Reference+). The increase in 2030 is due to synergies between the RES target and co-generation which mainly uses biomass as a feedstock. In 2050 perspective, however, CHP shares decline (in comparison to the Reference) for all scenarios as there is increasing competition for biofuels/biomass feedstocks in transport.

Concerning **CCS** development, the % of electricity it represents is higher than in Reference+ in EE25 and EE28 scenarios but its role is lesser than in the Reference+ in more ambitious scenarios reflecting low ETS prices.

Energy related CO_2 emissions decrease in all scenarios reflecting the declining demand for energy as well as declining carbon intensity of power generation, the latter mostly influenced by ETS and renewables policy.

Table 3 Other energy system impacts

Indicator *(figures are presented in a 2030/2050 format)*	**Ref**	**Ref plus**	**Decarbonisation Scenarios**					
			GHG40	EE25	EE28	EE30	EE35	EE40
Final Energy Demand (Mtoe)	1126 / 1151	1126 / 1152	1073 / 885	1064 / 964	1020 / 876	983 / 818	920 / 759	859 / 712
- Industry share	27.3 / 26.8	27.3 / 26.8	27.5 / 28.3	27 / 26.5	27.3 / 24.9	27.7 / 26.4	28.1 / 28.4	29.8 / 30.2
-Residential share	26.4 / 26.4	26.4 / 26.3	25.9 / 25.5	26.4 / 27.6	25.7 / 26.4	24.8 / 23.8	23.4 / 21.4	21 / 18.8
-Tertiary share	14.9 / 15	14.9 / 15	14.2 / 13.4	14.8 / 15.9	13.9 / 15.8	13.2 / 14.6	12 / 13.5	10.1 / 11.9
-Transport share	31.4 / 31.8	31.5 / 31.9	32.4 / 32.9	31.8 / 30	33.1 / 33	34.2 / 35.2	36.5 / 36.7	39.1 / 39.1
Gross Electricity Generation (*TWh*)	3664 / 4339	3667 / 4347	3532 / 5040	3521 / 5378	3467 / 4935	3345 / 4560	3082 / 4267	2804 / 3969
- Solids Share	13 / 8.4	13 / 8.4	11.6 / 10.1	10.2 / 10.8	12.5 / 10.7	13.3 / 10.1	16.6 / 9	15.5 / 9
- Oil Share	0.6 / 0.5	0.6 / 0.5	0.5 / 0.1	0.5 / 0.1	0.5 / 0.1	0.5 / 0.1	0.5 / 0.1	0.5 / 0.1
- Natural Gas Share	19.5 / 17.3	19.5 / 17.2	15.3 / 12.5	14.8 / 13.1	14 / 12.3	13.1 / 11.2	10.2 / 11	9.8 / 10.3
- Nuclear share	21.8 / 21.3	21.8 / 21.3	22.6 / 21.6	21.4 / 20.7	21.3 / 20.9	21 / 20.7	20 / 19.7	19.1 / 19.1
- Renewables share	44.5 / 51.6	44.6 / 51.7	49.3 / 54.2	52.4 / 53.7	51 / 54.6	51.4 / 56.4	52.1 / 58.6	54.6 / 59.8
- of which hydro share	10.8 / 9.8	10.8 / 9.8	11.2 / 8.6	11.3 / 8.1	11.5 / 8.8	11.8 / 9.5	12.8 / 10.1	13.9 / 10.8
- of which wind share	21 / 24.8	21 / 25	23.9 / 26.5	25.2 / 26.5	24.4 / 27	24.3 / 27.3	24.2 / 27.8	25.2 / 27.6
- of which Solar, tidal, etc share	5.8 / 8.4	5.8 / 8.4	6.4 / 9.5	6.9 / 9.8	6.5 / 9.5	6.5 / 9.5	6.7 / 9.8	6.9 / 9.8
- of which Biomass & waste share	6.6 / 7.9	6.7 / 7.9	7.5 / 8.6	8.6 / 8.4	8.3 / 8.4	8.4 / 9.2	8.2 / 9.9	8.3 / 10.7
CCS indicator (% of electricity from CCS) (difference in p.p.)	0.45 / 6.9	0.45 / 6.88	0.77 / 14.72	0.72 / 15.6	0.51 / 13.65	0.27 / 11.83	0.29 / 10.64	0.3 / 10.2
CHP indicator (% of electricity from CHP) (difference in p.p.)	16.1 / 16.2	16.1 / 16.1	16.4 / 14	17.4 / 14.9	16.9 / 14.6	17 / 15.1	16.3 / 15.2	16.2 / 15.3

Demand side load factor[34] for electricity (%)	67.6 / 67.9	67.6 / 68.1	68.1 / 78.2	68.4 / 77.6	68.5 / 78.2	68.7 / 78.8	69.2 / 80	69.9 / 81.5
Demand side load factor for steam (%)	77.8 / 77.6	77.8 / 77.6	77.9 / 76.4	77.7 / 76.3	77.9 / 76.6	78.2 / 76.7	78.7 / 76.6	78.9 / 76.7
Energy related CO2 emissions reduction vs 2005	-30.5 / -42.9	-30.6 / -43	-36.8 / -80.9	-38.7 / -76.8	-39.1 / -79.1	-40.4 / -80	-42.2 / -81.4	-46.1 / -82.4
Carbon intensity of power generation *(per MWhe+MWhth)*	17.8 / 7.9	17.8 / 7.8	15.1 / 0.7	13.9 / 1.1	15.5 / 1.2	16.1 / 1.2	17.7 / 1.3	16.9 / 1.1
Electricity Grid Losses[35]	6.4 / 6.7	6.4 / 6.7	6.3 / 6.4	6.5 / 6.6	6.4 / 6.6	6.1 / 5.8	5.6 / 4.9	5.5 / 4.9
Annual Electricity Grid Cost in Reference (€'10 per MWhe) and % change compared to Reference	41.6 / 44.4	44.4 / 0	-1.4 / 0.5	0 / 0	-1.2 / 1.6	-1.3 / 0.8	-1.8 / 0	-1.9 / -1.3

Source: PRIMES 2014

5.3.2. Economic impacts in the energy system

The EU Reference scenario 2013 - projecting the consequences of already adopted policies as well as developments largely unrelated to policy - shows, until 2030, that there will in any case be an increasing **ratio of total energy system cost to GDP**, from 12.8 % in 2010 to 14.0% in 2030, before decreasing to 12.3 % in 2050. The policy scenarios evaluated in the 2030 IA all showed higher energy system costs up to 2030 and beyond with costs being the lowest for the GHG40 scenario and highest for the scenarios with the ambitious EE policies.

This chapter revisits the costs estimation and shows the level of cost increase brought by different levels of ambition of EE policies. Looking at a metric of **differences in average annual costs for the period 2011-2030**, across all scenarios they are between 0.01 and 0.8 percentage points of GDP higher compared to the Reference 2013. Looking specifically at the year 2030, energy system costs in policy scenarios are between 0.14 and 1.8 percentage points of GDP higher than the Reference 2013. The additional increases are higher in 2050, reflecting the costs necessary to achieve decarbonisation rather than the costs of energy efficiency policy. Regardless of the method of comparison, these additional increases are smaller than those resulting under the Reference scenario itself.

Energy system costs from an end user perspective as calculated in the modelling comprise mainly three elements: annuities for capital expenditure on energy using equipment, fuel and electricity costs, including capital expenditure for the production and distribution of electricity as well as so-called direct energy efficiency costs incurred (not related to energy equipment itself), such as expenditure for insulation.

These components of energy system costs differ substantially across policy scenarios:

[34] Demand side load factor = demand/(peak load x 8760hours)

[35] Ratio of electricity transmission and distribution losses to electricity supply excluding self consumption (in %)

- **Energy purchases** are significantly reduced in all scenarios, most significantly in ambitious scenarios (EE30, EE35 and EE40). For the period 2011-2030, average annual energy purchasing costs are between €16 bn to €87 bn lower than for the Reference+. Across all scenarios, the reductions are mainly achieved in residential and tertiary sectors.
- On the other hand, **capital costs** increase – again most significantly in EE35 and EE40 scenarios and again mostly in residential and tertiary sectors. For the period 2011-2030, average annual capital costs (calculated by applying annuities to investments) are between €13 bn to €22 bn higher than for Reference+.
- Also **direct efficiency investments**, representing investment in building insulation, more efficient appliances etc. increase most significantly in EE35 and EE40 scenarios and in residential and tertiary sectors. For the period 2011-2030, average direct efficiency investments (calculated by applying annuities) are between €12 bn to €180 bn higher than for Reference+.

Table 4: Energy system costs and its components[36,37]

Indicator *(figures are presented in a 2030/2050 format)*	**Ref**	**Ref plus**	**Decarbonisation Scenarios**					
			GHG40	EE25	EE28	EE30	EE35	EE40
Total System Costs in bn €'10 *(average annual 2011-30 and 2031-2050)*	2067 / 2520	2066 / 2519	2069 / 2727	2069 / 2657	2076 / 2701	2091 / 2820	2126 / 3016	2183 /3369
Total System Costs as % of GDP *(average annual 2011-30 and 2031-2050)*	14.3 / 13.03	14.29 / 13.02	14.31 / 14.1	14.31 / 13.74	14.36 / 13.97	14.46 / 14.58	14.71 / 15.59	15,1 /17,42
Total System Costs as % of GDP increase *(average annual 2011-30 and 2031-2050)* compared to Reference in % points	n.a.	n.a.	0.01 / 1.07	0.01 / 0.71	0.06 / 0.94	0.16 / 1.55	0.41 / 2.56	0,8 / 4,39
Total System Costs as % of GDP in 2030 *(2010 value: 12.76 %)*	14.03 / 12.3	14.02 / 12.31	14.18 / 13.96	14.17 / 13.43	14.37 / 13.7	14.75 / 14.47	15.83 / 15.61	18,03 /17,49
Total system Costs in 2030as % of GDP increase compared to	n.a.	n.a.	0.15 / 1.65	0.14 / 1.13	0.34 / 1.4	0.72 / 2.17	1.8 / 3.31	4,01 / 5,19

[36] Total system costs for the entire energy system include capital costs (for energy installations such as power plants and energy infrastructure, energy using equipment, appliances and vehicles), energy purchase costs (fuels + electricity + steam) and direct efficiency investment costs, the latter being also expenditures of capital nature. Capital costs are expressed in annuity payments. Total system costs do not include any disutility costs associated with changed behaviour, nor the cost related to auctioning – but do include an attribution of monetary costs to non-financial barriers such as the effort needed to find out energy performance of appliances, and the deterrent to tenants' adoption of energy-saving behaviours when their landlord is responsible for paying energy bills.

[37] The small difference between the total system costs and the summation of capital costs, energy purchase costs and direct efficiency investment costs is due to the inclusion of the supply side auction payments under energy purchases, embedded in the energy prices (but not included under the reported total system costs which exclude auction payments).

Reference in % points								
Capital Costs in bn €'10 *(average annual 2011-30 and 2031-2050)*	590 /939	589 /940	598 /1071	602 /1079	609 /1087	611 /1087	609 /1085	607 /1059
Industry	57 /84	57 /84	60 /91	58 /87	59 /84	60 /84	59 /83	59 /82
Residential	304 /450	303 /447	305 /438	306 /455	312 /464	314 /461	313 /452	313 /437
Tertiary	52 /83	52 /83	51 /67	52 /80	51 /76	50 /68	48 /59	47 /48
Transport	177 /322	178 /326	182 /474	187 /457	187 /463	188 /475	189 /491	189 /491
Direct Efficiency Investments[38] in bn €'10 *(average annual 2011-30 and 2031-2050)*	35 /35	36 /35	47 /274	48 /124	62 /257	88 /451	147 /731	216 /1182
Industry	1 /5	1 /5	2 /74	3 /34	5 /80	6 /91	13 /102	15 /104
Residential	24 /22	25 /22	29 /128	31 /64	39 /124	55 /246	87 /420	125 /699
Tertiary	10 /8	10 /8	16 /71	14 /26	18 /53	27 /114	47 /210	77 /380
Transport	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Energy Purchases in bn €'10 *(average annual 2011-30 and 2031-2050)*	1454 /1586	1452 /1582	1436 /1394	1431 /1468	1416 /1370	1401 /1290	1378 /1206	1365 /1129
Industry	279 /291	278 /291	273 /258	274 /266	271 /240	269 /233	264 /225	263 /223
Residential	426 /498	426 /498	421 /455	421 /474	413 /427	405 /384	395 /342	388 /299
Tertiary	238 /262	238 /262	234 /218	235 /249	230 /226	225 /198	217 /171	212 /139
Transport	510 /534	509 /531	508 /463	502 /480	502 /477	501 /475	501 /468	502 /469

Source: PRIMES 2014

Investments expenditure increases sharply in all scenarios - again most significantly in EE35 and EE40 scenarios and again mostly in residential and tertiary sectors. The average annual investment expenditure rises in the period 2011-2030 between €27 bn and €330 bn.

In the residential sector, increases are the most pronounced: the average annual investment expenditure rises in the period 2011-2030 between €5 bn and €154 bn. It has to be, however, noted that energy investments in the residential sector increase property values because of their improved energy performance (for which the benefit is captured in the model through

[38] Direct efficiency investment costs include costs for house insulation, double/triple glazing, control systems, energy management and for efficiency enhancing changes in production processes not accounted for under energy capital and fuel/electricity purchase costs.

lower fuel costs) and amenity value by an amount that one study estimated to correspond to some 40% of the cost of investments in energy efficiency in the residential sector[39].

The magnitude of investments in the entire economy should be also interpreted as a huge potential for driving jobs and growth in the EU, in particular due to the local nature of much energy efficiency investment and the industrial and technological leadership the EU companies still have in terms of energy efficient and low-carbon technology.

Table 5: Investment Expenditures

Indicator *(figures are presented in a 2030/2050 format)*	**Ref**	**Ref plus**	**Decarbonisation Scenarios**					
			GHG40	EE25	EE28	EE30	EE35	EE40
Investment Expenditures in bn €'10 in Reference *(average annual 2011-30 and 2031-2050)*	816 /949	817 /951	854 /1189	844 /1084	867 /1127	902 /1172	992 /1203	1147 /1211
Industry	19 /30	19 /30	24 /88	25 /46	30 /83	34 /82	45 /69	49 /65
Residential	36 /28	36 /28	49 /77	41 /43	54 /57	72 /96	115 /130	190 /160
Tertiary	14 /10	15 /10	25 /41	18 /13	28 /16	44 /30	87 /33	170 /23
Transport	660 /782	660 /783	662 /843	663 /832	664 /835	665 /839	665 /852	665 /852
Grid	37 /41	37 /41	40 /55	41 /59	40 /54	38 /49	34 /48	29 /44
Generation and boilers	50 /59	50 /59	53 /85	55 /90	52 /82	50 /75	46 /72	44 /66

Source: PRIMES 2014

As described in the 2030 IA, in assessing energy system costs, a series of important considerations need to be made: the energy modelling simulates economic decision making of various agents in power generation, industrial sectors, services, households, agriculture and transport. Such decisions involve investment choices, not only in power generation but also, for instance, in industrial equipment, heating boilers and appliances. The inter-temporal dimension of such investment decisions is modelled based on weighted average costs of capital (WACC) for power generation and on different implied discount rates for energy users according to the sector.

Some energy policies that address barriers to energy efficiency, such as lack of finance, of information or split incentives, can lead to lower implied discount rates, for example if Energy Service Companies (ESCOs) come into play and take care of services and households' energy operations and investment.

39 BIO Intelligence Service. 2013. Energy performance certificates in buildings in their impact on transaction prices and rents in selected EU countries. Cited at: http://ec.europa.eu/energy/efficiency/buildings/doc/20130619energy_performance_certificates_in_buildings.pdf

In the 2030 IA, reduced discount rates in the context of economic decision making of agents, following from energy efficiency policies, were not applied in the same way to calculate the capital cost and direct energy efficiency investment component of energy system costs.

In this IA, an **alternative approach for the cost calculations is also reported** using the same discount rate for the investment decision and the cost calculation. Such a reporting approach enables representation of the monetary value of market failures and imperfections which are dismantled by relevant policies.

Table 6: System and Capital costs under alternative cost reporting

Indicator *(figures are presented in a 2030/2050 format)*	Ref	Ref plus	Decarbonisation Scenarios					
			GHG40	EE25	EE28	EE30	EE35	EE40
Total System Costs in bn €'10 *(average annual 2011-30 and 2031-2050)*	2011 /2424	2009 /2423	2008 /2589	2008 /2535	2007 /2524	2012 /2578	2033 /2708	2075 /2958
Total System Costs as % of GDP *(average annual 2011-30 and 2031-2050)*	13,91 /12,53	13,9 /12,53	13,89 /13,39	13,89 /13,1	13,88 /13,05	13,92 /13,33	14,06 /14	14,35 /15,29
Total System Costs as % of GDP increase *(average annual 2011-30 and 2031-2050)* compared to Reference in % points		-0,01 / 0	-0,02 / 0,86	-0,02 / 0,57	-0,03 / 0,52	0,01 / 0,8	0,15 / 1,47	0,06 / 2,27
Total System Costs as % of GDP in 2030 *(2010 value: 12.76 %)*	13,52 /11,83	13,51 /11,83	13,58 /13,18	13,57 /12,81	13,53 /12,78	13,73 /13,13	14,51 /13,88	16,17 /15,19
Total system Costs as % of GDP increase compared to Reference in % points, in 2030		0 / 0,01	0,06 / 1,35	0,06 / 0,98	0,02 / 0,95	0,21 / 1,31	0,99 / 2,05	2,14 / 2,89
Capital Costs in bn €'10 in Reference and change compared to Reference (average annual 2011-30 and 2031-2050)	539 /848	539 /850	545 /972	549 /972	550 /948	549 /935	544 /934	542 /914
Industry	57 /84	57 /84	58 /81	58 /87	59 /84	60 /84	59 /83	59 /82
Residential	257 /366	256 /363	257 /356	258 /369	259 /350	257 /333	254 /325	254 /315
Tertiary	49 /76	49 /76	47 /62	48 /74	47 /66	46 /58	44 /51	43 /42
Transport	177 /322	178 /326	182 /474	184 /442	185 /448	186 /460	187 /476	187 /476
Direct Efficiency Investments in bn €'10 in Reference and change compared to Reference (average annual 2011-30 and 2031-2050)	30 /30	30 /30	40 /234	41 /109	52 /218	72 /361	118 /574	174 /916
Industry	1 /5	1 /5	2 /66	3 /34	5 /80	6 /91	13 /102	15 /104
Residential	20 /17	20 /18	24 /104	25 /52	31 /93	43 /177	66 /300	94 /500

Tertiary	9 /7	9 /7	14 /64	12 /23	16 /45	23 /93	40 /172	65 /312
Transport	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Source: PRIMES 2014

Other important economic impacts directly affecting all energy consumers are impacts on **electricity prices**[40] and the **ETS prices**. In the modelling underpinning this IA, the choice was made not to use carbon values but to model concrete EE policies. RES values and EE values representing the shadow values promoting respectively renewables and energy efficiency are also summarised in the table (see explanations of these metrics in Annex V).

The Reference scenario demonstrates that significant increases in electricity prices (31% increase in real terms until 2030, compared to 2010) should in any case be expected. Electricity price changes compared to Reference+ are very small in 2030 ranging from 1% to +3% in the year 2030. In a 2050 perspective, electricity prices grow in all scenarios – independently of the level of ambition.

Contrary to electricity prices, differences between policy scenarios are very pronounced with regard to the ETS price although projections in this regard are associated with significant degrees of uncertainty. Under Reference+, the ETS price is expected to reach 35 €/tCO2 in 2030 and 100 €/tCO2 in 2050. In the policy scenarios, it is expected to reach between 42 and 6 €/tCO2 in 2030. In a 2050 perspective, different policy scenarios would result in 250 to 165 €/tCO2, depending on the scenario. The more ambitious the scenario, the lower becomes the ETS price as EE policies reduce the demand for electricity in the ETS sector. Also EE improvements in industry reduce the demand for ETS allowances. In addition, in the EE40 scenario which significantly overshoots the GHG target, ambitious efficiency policies shift emission reduction efforts from ETS to non-ETS sectors to attain the same overall GHG reduction.

Table 7: Electricity and carbon prices, energy related costs for energy intensive industries

Indicator *(figures are presented in a 2030/2050 format)*	**Ref**	**Ref plus**	**Decarbonisation Scenarios**					
			GHG40	EE25	EE28	EE30	EE35	EE40
Average Price of Electricity[41] (€/MWh)	176 / 175	176 / 175	179 / 183	181 / 185	178 / 185	178 / 182	177 / 182	181 / 182
ETS carbon price (€/t of CO2-eq)	35 / 100	35 / 100	40 / 264	42 / 250	33 / 220	25 / 180	13 / 160	6 / 165
Implicit carbon price non-ETS	0 / 0	0 / 0	40 / 264	n.a.	n.a.	n.a.	n.a.	0 / 0

[40] Fossil fuel prices are exogenous in the modelling.

41 Average Price of Electricity in Final demand sectors (€/MWh) constant 2010 Euros. For reference scenario, corresponding value was 134 €/MWh in 2010.

(€/tCO2)								
Average Renewables value (€/ MWh)	34 / 16	34 / 16	34 / 15	41 / 16	40 / 15	42 / 15	43 / 15	43 / 14
Average energy efficiency value (€/ toe)	181 / 95	183 / 96	184 / 604	332 / 417	619 / 847	991 / 1642	1768 / 2595	2937 / 3798

Source: PRIMES 2014

5.3.3. Macro-economic impacts

The results on macro-economic impacts are preliminary and based on the PRIMES results for a set of scenarios achieving respectively 25, 28, 32, 36 and 40% energy savings (model runs without enabling settings, not reaching decarbonisation in 2050). In order to ensure better consistency, new macro-economic runs will be necessary. It is expected that the changes in comparison to results presented below may be minor.

The **models E3ME and GEM-E3** are applied to assess the impacts on GDP and employment of policy scenarios, in which there is greater investment in energy efficiency. The complex interactions between different sectors of economy can thus be assessed at the macro-economic level and results can be compared to the Reference Plus baseline.

The **path and magnitude of investment in energy efficiency** in each scenario is taken from projections made in PRIMES: the E3ME and GEM-E3 **models are then calibrated to represent these changes in the energy system so that their economy-wide impacts can be modelled**. The two macroeconomic models have many similarities. However, there are also important differences that arise from their underlying assumptions and respective structures. E3ME is a macro-econometric model, based on a post-Keynesian framework; GEM-E3 is a general equilibrium model that draws strongly on neoclassical economic theory and optimising behaviour of economic agents –see Annex VI for the description of methodology of each model.

1. Impacts on GDP

Application of both models shows that energy efficiency expenditures lead to increased demand for sectors providing goods and services to energy efficiency projects (construction, market services, metals, cement, chemicals, equipment goods, etc.). Depending on their linkages with other sectors of the economy the demand for inputs from these sectors is associated with chain changes in demand for inputs from other sectors of the economy (multiplier effect) as well as for imports. Additional effects are associated with a reduction in energy demand and subsequent imports for energy inputs resulting from energy consumption saving. Energy efficiency expenditures lead to substitution of imported fuels with domestically produced goods and services. On the other hand, increased expenditures in energy efficiency limit the funds available for other purposes and drive interest rates up in the GEM-E3 model (crowding-out effects). This results to higher cost of capital which hampers the competitiveness of the economy further affecting trade and overall economic activity.

The net outcome in the economy depends on the equilibrium resulting between the latter forces and assumptions about capital supply.

In GEM-E3 modelling, for the scenarios simulating the effects of achieving higher energy efficiency targets, the assessment of impacts on GDP generally found small but negative impacts especially in 2030 when energy efficiency expenditures peak (see table 8). In fact, the effects of crowding out effects also leading to higher cost of capital and competitiveness losses surpass the effects of improved energy efficiency and the multiplier effect of increased economic activity in sectors providing inputs to energy efficiency projects[42]. The magnitude of the effects increases with the amount of expenditures undertaken for energy efficiency improvements.

In the long term, the negative effects tend to diminish as the sectors benefit from reduction of costs due to the achieved level of energy efficiency – but less so for scenarios with a high level of ambition.

Table 8: GDP impacts in EU28

(% change from Reference)	2030	2040	2050	Cumulative (2015-2050)
EE25	-0.04	-0.05	0.00	-0.04
EE28	-0.11	-0.04	-0.07	-0.05
EE32	-0.30	-0.08	-0.02	-0.12
EE36	-0.89	-0.12	-0.05	-0.22
EE 40	-1.14	-0.15	-0.03	-0.33

Source: GEM-E3

In E3 ME modelling, the impacts on GDP are positive, owing to the approach which does not assume that optimisation in markets has previously occurred. Consequently, investment in one particular sector does not automatically lead to a crowding out effect on investment in other sectors. If there is spare capacity in the baseline case, then it is possible for there to be an increase in investment in the scenarios without necessarily having a reduction in investment elsewhere.

There is an increase in GDP in all scenarios compared to baseline, mainly driven by the investment in energy efficiency that occurs after 2025. The model results suggest that these changes could be as high as 4.0% in EE40.

The table below confirms that the main driving force behind the increase in GDP is investment. The table also outlines the large scale of the energy-efficiency investment

[42] As explained in Annex VI, the policy scenarios analysed in this IA have assumed significant increase of expenditures for energy efficiency purposes especially in the period until 2030. These expenditures are assumed to be partly financed by economic agents (households and firms) and partly by economies' aggregate savings. Consequently, a fairly realistic approach has been adopted assuming that the financing of the energy efficiency expenditures from saving resources in the economy is effectively leveraged throughout the projection period (till 2050); this implies less pressure until 2030 and a smaller crowding out effect. Should a full funding of the energy efficiency expenditures was made through the closure with savings till 2030, the macroeconomic impacts would be found increasingly negative after 2030 and higher in magnitude.

required to achieve the reductions in final energy demand. Despite higher GDP, household expenditure in all scenarios is *lower* than in the reference case. The reason for this is that higher taxation rates are required to fund the investment undertaken by industry sectors – and that energy efficiency measures reduce energy costs.

Although there is no measure of welfare in E3ME, in these types of model a reduction in household expenditure is typically interpreted as being consistent with a loss of welfare. However, there are cases where the two do not necessarily move together: in this case, the investment in energy efficiency means that households can achieve the same level of comfort while spending less on energy.

Table X: EU28 Summary of Results, % difference from reference, 2030

	EE25	EE28	EE32	EE36	EE40
GDP	0.3	0.7	1.2	2.0	4.0
Consumer expenditure	0.0	-0.3	-1.2	-2.1	-4.5
Investment	1.2	3.5	8.3	13.8	29.4
Extra-EU exports	0.1	0.2	0.3	0.4	0.4
Extra-EU imports	0.2	0.3	0.7	1.1	2.5

Sources: E3ME

It is important to emphasise the assumption made in this modelling that revenues from auctioned ETS allowances are supposed to be recycled into financing the energy-efficiency investment. However, in all policy scenarios the revenues are not enough to cover the scale of the investment, leading to an increase in direct taxation to cover the investment spending. Although modest in the medium to high ambition cases, in the most ambitious scenario there would be noticeable increases in European tax rates. Essentially in the scenarios there is a shift from current expenditure to higher savings and investment.

2. Sectoral impacts

Looking at impacts by sector, it is clear that imposing higher efficiency standards drives consumption expenditures towards sectors producing energy efficient equipment (i.e. more efficient electrical appliances for households, retrofits, etc.) and savings towards the financing of energy efficiency projects (i.e. insulation to improve thermal integrity, etc.). Demand shifts from energy producing sectors towards sectors which provide inputs to energy efficiency projects. The direct positive effect of increased energy efficiency expenditures on domestic activity, especially for sectors producing and installing the energy efficient equipment, is further strengthened by the indirect effect, which is the increased intermediate demand for goods and services due to sectorial interconnections. In the GEM-E3 model and not the E3ME model, however, expenditures in energy efficiency projects exert crowding out effects on other investment projects in the GEM-E3 model that would have otherwise been undertaken.

Table 4 summarizes the effects on sectoral production in the alternative scenarios as simulated in GEM-E3 modelling. Sectors delivering to energy efficiency expenditures record increases in their production (particularly the construction sector).

Sectors with low exposure to foreign competition record relatively higher increases in their activity (i.e. construction and market services) while for sectors characterized by higher trade exposure (i.e. electric goods and chemicals) part of the increased demand is satisfied by imports, depending on the degree of exposure to foreign competition, thus the positive effect of increased expenditures on their activity is weakened. Demand for energy products falls in all alternative scenarios causing both domestic production and imports to decrease.

Table X: Impacts on production by sector in EU28 in the alternative scenarios

Cumulative % change from reference (2015-2050)	EE25	EE28	EE32	EE36	EE40
Agriculture	-0.10	-0.11	-0.90	-1.44	-0.80
Ferrous metals	1.41	2.60	2.99	5.63	9.14
Non-ferrous metals	0.63	1.41	2.03	2.94	3.85
Chemicals	0.46	-0.54	0.97	1.97	3.98
Paper and pulp	0.12	0.16	0.38	0.48	0.46
Non-metallic mineral	0.87	2.78	4.18	6.09	8.74
Electric goods	0.07	0.50	0.77	0.87	0.60
Equipment goods	0.64	1.05	1.73	1.69	1.66
Consumer goods industries	0.11	0.35	0.42	0.39	0.39
Construction	0.49	1.67	2.80	4.04	6.01
Transport	0.18	0.84	1.01	0.99	0.90
Services	0.06	0.18	0.40	0.37	0.36
Energy extraction and supply	-1.32	-5.06	-10.11	-11.41	-12.86

Source: GEM-E3 model

The results in E3ME modelling are different because of the underlying assumptions about investment financing. Table 5 shows the main impacts at broad sectoral level. As might be expected, the sectors that benefit the most in all the scenarios are the ones that produce investment goods, such as construction and engineering. The non-energy extraction sector is also expected to benefit, as it supplies the construction sector with raw materials.

The effects on other sectors are more complicated to interpret. Consumer goods producing sectors are the most affected by the tax increase needed to finance the energy-efficiency investment. On the other hand, distribution activity also benefits from the increased activity in

the investment sectors. Output in these sectors is expected to be higher, but by a smaller amount than in other sectors not so closely linked to consumer expenditure patterns.

The energy-efficiency savings are expected to lead to reduced use of electricity and gas, resulting in a fall in output in the sectors supplying them, and so output in the utilities sector is substantially lower than in the reference case.

Table X: EU28 Output, % difference from reference, 2030

	EE25	EE28	EE32	EE36	EE40
Agriculture	0.2	0.2	0.2	0.0	-0.2
Extraction Industries	-0.1	0.0	1.0	2.8	6.3
Basic manufacturing	0.4	0.8	1.8	3.1	6.8
Engineering and transport equipment	0.7	1.7	3.7	6.1	13.3
Utilities	-2.3	-5.4	-8.3	-11.4	-15.7
Construction	1.4	4.6	10.9	18.1	38
Distribution and retail	0.3	0.4	0.4	0.5	1.2
Transport	0.2	0.5	0.9	1.4	2.8
Communications, publishing and television	0.3	0.7	1.4	2.1	4.2
Business services	0.3	0.6	1.1	1.7	3.3
Public services	0.1	0.1	0.0	0.0	-0.3

Sources: E3ME

3. Employment effects

The baseline modelling based on GEM-E3 projects persisting unemployment (frictional unemployment under equilibrium conditions) in the EU which implies that unused labour resources exist and can be used in more labour-intensive scenarios with small effects on the equilibrium wage rates. This modelling assumption is more realistic than standard general equilibrium projections that may assume no labour resources availability in the future.

In general, the energy efficiency expenditures inherent to each policy scenarios induce increased employment for all scenario assumptions mostly in 2030 and less afterwards (see table X) without strong effects on wage rates (because of the assumption mentioned in the paragraph above). The positive labour impacts combined with negative impacts on GDP imply that the EU economy becomes more labour intensive under energy efficiency assumptions. The employment multiplier effect depends on the labour intensity of the sectors delivering inputs to energy efficiency projects (relatively high for sectors like market services, high-tech manufacturing) and the energy sectors (relatively low labour intensity) as well as on the share of domestically produced inputs to total inputs used in the production process (high shares of domestically produced inputs in the production process imply that an increase in the sectorial activity is associated with an increase in employment of sectors of domestic origin rather than that of sectors located outside the EU).

From the **GEM-E3** modelling results, it is clear that total labour demand and employment are affected to a greater extend by positive changes in the activity of the more labour intensive sectors of energy efficiency products and services as well as building renovation. The decreased labour demand in energy sectors is thus largely compensated.

Table X: Employment in EU28 in the alternative scenarios

% change from Reference	2030	2040	2050	Cumulative (2015-2050)
EE25	0.56	0.31	0.43	0.24
EE28	1.61	0.62	0.67	0.59
EE32	2.23	0.78	1.00	0.82
EE36	2.29	0.88	1.25	1.03
EE40	3.15	1.49	1.85	1.32

Source: GEM-E3 model

The time pattern of employment changes indicate strong positive effects at times of implementation of energy efficiency expenditures and small effects at times subsequent to implementation.

Changes in employment follow the changes in sectoral demand and production as a result of energy efficiency expenditures (see table X), particularly the increase in production of relatively labour intensive sectors (services sectors which provide inputs to energy efficiency projects) or sectors with significant forward and backward linkages with other sectors of the economy (construction sector).

Table X: Sectoral employment in EU28 in the alternative scenarios

Cumulative % change from reference (2015-2050)	EE25	EE28	EE32	EE35	EE40
Agriculture	-0.11	-0.16	-0.89	-1.23	-0.92
Ferrous metals	1.02	2.17	2.74	5.01	8.29
Non-ferrous metals	0.48	1.17	1.76	2.55	3.49
Chemicals	0.41	0.04	1.08	2.21	4.11
Paper and pulp	0.06	0.16	0.39	0.38	0.39
Non-metallic mineral	0.74	2.52	3.98	5.83	8.49
Electric goods	0.01	0.44	0.72	0.81	0.48
Equipment goods	0.43	0.85	1.49	1.44	1.37
Consumer Goods industries	0.05	0.28	0.36	0.36	0.28
Construction	0.46	1.57	2.74	3.99	5.93
Transport	0.13	0.51	0.75	0.73	0.81

Services	0.03	0.14	0.33	0.28	0.30
Energy extraction and supply	-1.81	-6.04	-13.86	-15.77	-17.63

Source: GEM-E3 model

In **E3ME**, employment is determined primarily by the level/growth of economic output analysed above and relative labour costs and consequently shows more pronounced effects than in GEM-E3 modelling. As presented in the table below, up until 2020 there is very little change in overall EU28 employment levels in the scenarios and even up to 2025 the changes are quite small. However, once the energy-efficiency investment starts to grow quickly after 2025, employment is expected to increase substantially. In the most ambitious scenario, the increase in employment levels could be up to 3.5% by 2030. These results are of course subject to more uncertainty and possible labour market constraints.

Table X: EU28 Employment, % difference from reference, 2030

	E3ME
EE25	0.1
EE28	0.2
EE32	0.3
EE35	0.5
EE40	1.3

Sources: E3ME

The outcomes for sectoral employment as presented in table 9 broadly follow those for sectoral output described above, with construction, engineering and their supply chains benefiting the most. The largest increase in employment is expected in the construction sector, on the assumption that a large share of the investment will require construction or installation activities. Relatively more modest increases are also projected in the engineering and transport equipment sector as well as basic manufacturing.

Employment in distribution and retail and business services is expected to fall, despite the increase in output in these sectors. The reason for this is that higher employment levels overall (mainly due to the relatively labour-intensive construction sector) and lower unemployment lead to increases in wage demands, a form of labour market crowding out. Employment in Utilities is also predicted to fall, in line with the projected fall in output in the sector.

Table X: EU28 Employment, % difference from reference, 2030

	EE25	EE28	EE32	EE35	EE40
Agriculture	0.1	-0.1	-0.5	-1.0	-2.9
Extraction industries	-0.3	-1.2	-1.1	-0.4	-1.7
Basic manufacturing	0.1	0.2	0.5	0.9	2.0
Engineering and transport equipment	0.3	0.5	1.0	1.6	3.4
Utilities	-1.2	-2.4	-6.2	-8.7	-10.1
Construction	0.6	2.1	5.0	8.5	17.9

Distribution and retail	0.0	-0.1	-0.4	-0.8	-1.7
Transport	0.1	0.1	0.1	0.2	0.1
Communications, publishing and television	0.1	0.2	0.4	0.6	1.3
Business services	0.2	0.1	-0.1	-0.2	-0.4
Public services	0.0	0.0	0.0	0.0	0.3

Sources: E3ME

5.3.4. Environmental impacts

As explained in Annex VI, all scenarios feature assumptions on polices which reduce non-CO_2 GHG emissions. The volume of reduction of these emissions has been fixed at a level equal to that achieved by the GHG40 scenario from the 2030 IA. While these policies do not belong to the domain of the energy efficiency (mainly agriculture and waste treatment are concerned), they are necessary in order to reach 40% GHG reduction in 2030, especially in scenarios with lower EE effort..

Total GHG reductions in 2030 for the modelling scenarios are in line with 40% GHG reduction target proposed in 2030 framework for EE25, EE28. While EE30 and EE35 overshoot this target slightly, reaching 41% and 42% respectively, for EE40 the overshooting is significant (45%) taking into account the ambitious EE policies. All scenarios (except EE40) reach in 2030 between 42-45.5% **reductions in the ETS sector** (in comparison to 2005) and in **non-ETS sectors** between 28-35% reductions (in comparison to 2005) – in line with the respective reductions referred to in the 2030 Communication.

With regard to **2050 emissions**, the scenarios are all consistent with deep decarbonisation in 2050 and show rather similar additional emission reductions to Reference for the ETS and non-ETS sectors, usually well over 70%.

Table 8: ETS and non-ETS emissions

Indicator *(figures are presented in a 2030/2050 format)*	Ref	Ref plus	Decarbonisation Scenarios					
			GHG40	EE25	EE28	EE30	EE35	EE40
Total GHG emissions (% to 1990)	-32.4 / -43.9	-33.4 / -45	-40.6 / -79.6	-40.3 / -76.3	-40.6 / -78	-41 / -78.6	-42.1 / -79.5	-44.9 / -80.2
ETS (% to 2005)	-36.1 / -59.3	-36.2 / -59.5	-43.3 / -87.1	-45.5 / -84.3	-43.2 / -85.7	-42.1 / -85.7	-41.8 / -85.8	-45.6 / -86.5
Non-ETS (% to 2005)	-20.3 / -22.9	-22.3 / -24.9	-30.5 / -70.3	-28.1 / -66.1	-30.5 / -68.3	-32.4 / -69.4	-34.8 / -71.2	-37.2 / -72.1

Source: PRIMES 2014

Some differences between the scenarios are visible in **sectoral GHG emission** reductions in comparison to 2005. Looking at scenarios that achieve close to 40% GHG reductions[43], in a 2030 perspective, the **power generation** (including district heating and CHP) and **tertiary** sectors are projected to experience the biggest reduction across all policy scenarios. For power generation, reductions range from -54 to -59% (wrt 2005) and reductions decrease as the ambition of EE policies increase (clearly influenced by ETS prices). For tertiary sector, reductions range from -43 to -67% (wrt 2005) and reductions increase together with the ambition of EE policies. In both cases, the reductions are significantly higher than those achieved by Reference+. In **residential sector**, the reductions are also significant, ranging

[43] For EE40 scenario the trend described below does not show because of higher GHG reduction.

from -31 to -53% (wrt 2005) and difference with the Reference+ is even bigger than for the power generation and tertiary sector. In **transport**, the reductions are smaller and only slightly deeper (between -17 and -18%) than in Reference+.

In a 2050 perspective, again only looking at scenarios that achieve close to 40% GHG reductions, emission reductions increase significantly across all sectors as they are all compatible with the 2050 GHG objective. The power sector remains with -95 to -98% reductions compared to 2005 the sector with the highest reductions. The transport sector sees with -61% to -64% the lowest reductions.

If changes in sectoral GHG emissions are compared to Reference+, the key insight in a 2030 perspective is that in all final energy demand sectors the reductions are increasing their magnitude in line with the level of ambition of the scenarios, except for the power generation sector where ambitious EE policies result in smaller reductions via lower ETS prices and the fact that majority of GHG reductions happen in non-ETS sector.

Table 9: Sectoral CO2 emission impacts compared to 2005

Indicator *(figures are presented in a 2030/2050 format)*	**Ref**	**Ref plus**	**Decarbonisation Scenarios**					
			GHG40	EE25	EE28	EE30	EE35	EE40
Power generation, CHP and district heating	-46.73 / -72.9	-46.68 / - 72.98	-56.53 / - 97.75	-58.9 / - 95.85	-54.91 / - 95.32	-54.5 / - 95.73	-53.97 / - 96.08	-59.96 / - 97.22
Industry (energy + processes) [44]	-22.48 / - 43.81	-22.7 / -44.16	-27.39 / - 77.76	-30.02 / - 72.52	-30.32 / - 77.13	-28.61 / - 76.23	-29.07 / - 75.72	-29.75 / - 75.97
Residential	-26.66 / - 34.09	-26.88 / -34.2	-34.12 / - 80.28	-30.96 / - 70.78	-37.48 / - 78.2	-43.75 / - 82.87	-53.1 / - 86.76	-62.91 / - 90.32
Tertiary [45]	-40.09 / - 48.35	-40.13 / -48.4	-48.19 / - 85.63	-43.14 / - 74.23	-55.7 / - 79.45	-60.72 / - 82.92	-66.64 / - 85.37	-73.02 / - 87.71
Transport	-11.63 / - 10.27	-11.77 / - 10.56	-13.56 / - 63.49	-16.52 / - 61.19	-16.85 / - 61.4	-17.31 / - 61.7	-17.51 / - 64.16	-17.43 / - 64.17

[44] Including energy industries, such as refineries and coke production.

[45] The tertiary sector includes the small energy-related emissions from agriculture.

Source: PRIMES 2014

Table 10: Sectoral CO2 emission impacts compared to Reference

Indicator *All indicators are presented as % increase/decrease in comparison to the Reference for 2030/2050*	**Ref plus**	**Decarbonisation Scenarios**					
		GHG40	EE25	EE28	EE30	EE35	EE40
Power generation, CHP and district heating	0.05 / -26.25	-9.8 / -51.02	-12.17 / -49.12	-8.18 / -48.59	-7.77 / -49	-7.24 / -49.35	-13.23 / -50.49
Industry (energy + processes)[46]	-0.22 / -21.67	-4.9 / -55.28	-7.54 / -50.04	-7.83 / -54.65	-6.12 / -53.75	-6.58 / -53.23	-7.26 / -53.49
Residential	-0.22 / -7.54	-7.47 / -53.63	-4.3 / -44.12	-10.82 / -51.54	-17.09 / -56.21	-26.45 / -60.11	-36.25 / -63.67
Tertiary[47]	-0.04 / -8.31	-8.11 / -45.55	-3.06 / -34.15	-15.61 / -39.36	-20.64 / -42.84	-26.56 / -45.28	-32.93 / -47.62
Transport	-0.13 / 1.07	-1.93 / -51.86	-4.89 / -49.56	-5.22 / -49.77	-5.68 / -50.06	-5.88 / -52.53	-5.8 / -52.54

Source: PRIMES 2014

5.3.5. *Competitiveness and Affordability of energy*

From the perspective of **affordability of energy**, the key aspects are both operational and capital expenditure related to energy use. Operational expenditure (cost) is clearly dependent on both energy prices (which are projected to rise in the longer term) and consumption volumes, the latter impacted by the efficiency of energy use. These expenditures need to be compared to available household income. Energy prices as such are of particular relevance for those consumers which have very low incomes or that, for other reasons, cannot take advantage of cost saving energy efficiency investments.

While fossil fuel prices are treated as exogenous in this modelling work, the **price of electricity** is not. The analysis in the chapter above indicates that most significant price increases already happen in the Reference scenario, mainly until 2020. After 2020, prices are rather stable in the Reference scenario. **Electricity price changes compared to the year 2010** are very small. For example, while average electricity price increase (compared to 2010 price) in Reference+ is 31%, it ranges between 32 and 35% in policy scenarios. **Electricity price changes compared to the Reference+** are also very small in 2030 ranging from 1% to 3% in the year 2030, with smallest increase in the EE40 scenario.

Table 11: Share of energy costs in household expenditure and energy intensive industries value added

Indicator	**Ref**	**Ref**	**Decarbonisation Scenarios**

[46] Including energy industries, such as refineries and coke production.

[47] The tertiary sector includes the small energy-related emissions from agriculture.

(figures are presented in a 2030/2050 format)		plus	GHG40	EE25	EE28	EE30	EE35	EE40
Share (%) of energy costs in energy intensive industries to value added[48]	44 / 45	44 / 45	42 / 54	44/49	44/52	43/51	44/50	XX
Share of energy related cost (including transport) in household expenditure (for Ref in %, 2010: 12,4%)	14.6/ 12.6	14.6/ 12.6	14.8 / 14.1	14.8/13.7	15.1/13.9	15.5/14.9	16.5/16.3	XX
Share of energy related cost (excluding transport) in household expenditure (for Ref in %, 2010: 7.5%)	9.3/8.0	9.3/8.0	9.4 / 8.7	9.4/8.4	9.7/8.6	10.1/9.5	11.1/11.0	XX
Avg. electricity price incr. compared to 2010 price (%)	30.8 / 30.1	30.9 / 30.1	33.3 / 36.2	35.1 / 38.1	32.7 / 37.6	32.4 / 35.2	31.8 / 35.3	35.1 / 35.5
Average electricity price change compared to ref. (percentage points)	n.a.	n.a.	1.9 / 4.7	3.2 / 6.1	1.4 / 5.8	1.2 / 3.9	0.8 / 4	3.2 / 4.2

Source: PRIMES 2014

5.4. Architecture of the 2030 policy framework

5.4.1 Overall architecture

Chapter 4 identified the following options:

I No action

II Indicative EU target coupled with specific EU policies and indicative MS targets

III Binding EU target coupled with specific EU policies and indicative MS targets

IV Binding MS targets

These options will be compared against the following criteria:

- Effectiveness (achievement of the objectives identified in Chapter 3)
- Economic efficiency (cost-effectiveness)
- Coherence (with the overall EU energy and climate policy framework and its objectives)

[48] Percentage of energy costs excl. auction payments / value added in energy intensive industries in PRIMES. For Reference Scenario corresponding value was 38.2% in 2010.

Experience with the renewable energy Directive shows that this approach can be a strong driver for national action: a target at Member State level can ensure political accountability and commitment to deliver results while providing flexibility to choose and apply the most suitable tools to achieve the target. On the other hand important synergies in policy making (e.g. common methodologies for establishing cost-optimal levels for building renovations) would be lost. The effectiveness of this approach remains uncertain, therefore. Regarding coherence this approach would run counter to recent proposals on governance. In addition, possible increases in administrative cost linked to fragmented EU action and potential harm to businesses operating across the internal market would limit the economic efficiency of this approach.

5.4.2 Formulation of a 2030 target

Chapter 4 identified the following options:

A. Consumption target

B. Intensity target

C. Hybrid approach

These approaches will be compared with regard to their effectiveness, efficiency and coherence, as well as their transparency and ease of monitoring (identified as key criteria for targets by the EU 2020 strategy[51]).

Energy **consumption** is the most straightforward option. It is directly related to long term decarbonisation objectives. This indicator is, however, directly influenced by the development of the economy. If growth turns out to be higher than anticipated, realising the target will require additional energy efficiency measures, potentially making them no longer cost-effective. If on the other hand growth is lower than anticipated, the target can be met without the energy efficiency improvements that were originally envisaged and therefore the cost-effective potential will not be realised.

Energy **intensity** is defined as a ratio between energy consumption and an indicator of economic activity (GDP, added value). Its use can eliminate the dependency of the target on the rate of economic development. On the other hand, changes in energy intensity can sometimes result from structural changes that do not reflect real improvements (e.g. a shift from energy-intensive industries to higher value-added ones). And energy consumption in some sectors is not closely linked to the development of the economy.

Thus, consumption and intensity indicators each have pros and cons. This may point to a **hybrid** indicator, adding together: (i) an absolute element for those sectors of the economy where the correlation between energy consumption and economic activity is low; and (ii) a relative component where this correlation is high.

As shown in Annex IV,

[51] European Commission 2010

- At the level of the whole economy, for a sample of 28 Member States over an 11 year period (2000-2011), the correlation between changes in primary energy consumption and changes in GDP changes is small (R^2 = 0.03). It is more pronounced for changes in final energy consumption (R^2 = 0.26);

- The correlation between changes in final residential energy consumption and GDP is small (R^2 = -0.03), as it is for the tertiary sector (0.02);

- In industry, by contrast, the correlation is higher (R^2 = 0.18

- In transport the correlation is highest (R^2 = 0.72)

On that basis a hybrid target could be calculated as a combination of two elements, one reflecting the contribution of sectors where economic activity is an important driver and another, the contribution of sectors where it is not.

5.5. The role of financing

Reaching the level of energy-savings considered in this impact assessment will require significant additional investments.

To enable the desired level of investment, it will be necessary to address the main identified drivers of energy efficiency investment. According to the Energy Efficiency Financial Institutions Group[52], these are the following:

- The benefits of energy efficient refurbishments of buildings and energy efficiency investments in SMEs and industry need to be captured and well-articulated, with evidence, to key financial decision makers (public authorities, buildings owners, managers, householders, CEOs and CFOs of companies). To achieve this, three requirements need to be met: (a) the full benefits of energy efficiency investments must be identified, measured and presented for each investment in ways in which key financial decision makers can understand and respond to; (b) the evidence and data must be easy to access and cost effective to compile and assess in investment decision making processes; (c) internal procedures, reporting and accounting systems should be adapted so as not to additionally handicap viable energy efficiency investments.

- Processes and standards for energy performance certificates, building codes and their enforcement need to be strengthened and improved. A step change in how energy efficiency potential is identified, measured, reported and verified is needed and achieving this is fundamental to unlocking the market at scale.

- Making it easy to get the right data to the right decision makers: There are too many hurdles between the relevant and credible data and the decision makers

[52] Energy Efficiency Financial Institutions Group Report (2014); http://ec.europa.eu/energy/efficiency/studies/doc/2014_fig_how_drive_finance_for_economy.pdf

who need it; and the processes and resources required to extract that data and qualify it appear specialist and costly. For energy efficiency investments in buildings to enter the mainstream, it must be as easy for a key property decision maker to understand and value the benefits of those investments as it is for other comparable decisions. The data structures must clearly enable the connection and validation of value increases (in the broadest sense) with energy efficiency investments[53].

- Standards should be developed for each element in the energy efficiency investment process, including legal contracts, underwriting processes, procurement procedures, adjudication, measurement, verification, reporting, energy performance (contracts and certificates) and insurance. The use of standardised MRV and legal documentation is particularly important to facilitate the bundling of investments for recycling to the bond market – creating a route to significant volumes of capital market finance.

- Priority and appropriate use of EU Funds (in particular ESIF) and ETS revenues through public-private financial instruments from 2014-2020 will boost investment volumes and help accelerate the engagement of private sector finance through scaled risk-sharing: Scalable models and successful case studies of dedicated credit lines, risk sharing facilities and on-bill repayment schemes abound. Member States should be encouraged to move away from traditional grant funding and look more to identifying the working models which best address the energy efficiency refurbishment investment needs in their buildings (as articulated in their National Buildings Refurbishment Strategies). ESIF 2014-2020 funding (and other sources such as ETS revenues) will be required to kick-start and complement national energy efficiency funds (EED Art 20) and energy supplier obligations (Art 7) to deliver Europe's 2020 targets and National Buildings Renovation Strategies (Art 4).

6. CONCLUSIONS

6.1. Policy options for 2020

The analysis suggests that the best approach for **achieving the 2020 target** is to focus on the implementation of existing legislation. This is based on the following premises:

- The gap to the 2020 target is not expected to exceed 2 percentage points;
- Proposing new legislation now would not have a significant effect by 2020 and could be disruptive;
- A better implementation of current legislation and policies can close the gap.

Efforts need to be focused on the proper implementation of the EED, improved implementation of the EPBD and strengthened enforcement of product regulations –

[53] Bullier, A., Sanchez, T., Le Teno, J. F., Carassus, J., Ernest, D., & Pancrazio, L. (2011). *Assessing green value: A key to investment in sustainable buildings.* Retrieved from: http://www.buildup.eu/sites/default/files/content/Assessing%20Green%20Value%20-%20Bullier,%20Sanchez,%20Le%20Teno,%20Carassus,%20Ernest%20and%20Pacrazio%20-%20ECEEE%202011.pdf

exploiting opportunities for improved financing, including from Structural and Investment Funds, to the full.

6.2. Ambition level 2030

6.2.1 Energy system impacts including security of supply

The analysis shows all scenarios show that energy efficiency policies reduce effectively energy consumption (both primary and final) and decrease the energy intensity as compared to the Reference scenario.

The different policy scenarios demonstrate some differences in terms of the consumption of various primary energy sources. Notably for solids, their share in 2030 does not change in more moderate scenarios (EE25 and EE28) in comparison to the Reference whereas for more ambitious scenarios (EE30, EE35 and E40) their share grows slightly. The shares of natural gas decline in all scenarios (in comparison to the Reference) with the declines more pronounced as the scenarios get more ambitious. The shares of renewables grow in all scenarios – driven by the RES target as proposed in 2030 framework and decarbonisation in longer term perspective.

Energy efficiency has a significant impact on security of supply and the level of gas imports in particular. Energy efficiency policies achieving 40% savings in 2030 result in lowering gas imports by 40% in comparison to 2010, whereas in the Reference+ the imports grow by 7% in that year. Already energy savings of 30% scenario achieve a 22% decrease. Net energy import decreases translate into savings in the energy fossil fuel imports bill. For the period 2011-2030 cumulative savings range from €240 billion to €552 billion and for the period 2031-2050 from € 3078 billion to € 4361 billion.

6.2.2 Economic impacts

Energy system costs increase in all scenarios compared to the Reference scenario. In terms of competitiveness, increased energy efficiency leads to average annual (2011-2030) energy system costs in policy scenarios that are between 0.01 and 0.8 percentage points of GDP higher than the Reference 2013 if modelled in the same was as in 2030 IA (on the assumption that energy efficiency policies do not reduce the element of energy system costs that is made up by market imperfections and failures– and of between 0.02 and 0.06 percentage points higher than the Reference 2013 if the opposite assumption is made.

The additional increases are higher in 2050 reflect the costs necessary to achieve the overarching decarbonisation objective, including the costs of energy efficiency policy. Regardless of the method of comparison, these additional increases are smaller than those resulting under the Reference scenario itself.

There is a general shift in the structure of costs with diminishing energy purchases and increasing capital costs and direct efficiency investments. Investments expenditure increases sharply in all scenarios - more significantly in more ambitious scenarios and again mostly in residential and tertiary sectors. For the period 2011-2030, the average

direct efficiency investments (calculated by applying standard annuities) are between €12 bn to €180 bn higher than for the Reference+. Again, the cost differences between scenarios vary according to the accounting method linked to the discount rates applied. If the monetary value of market failures and imperfections dismantled by relevant policies is taken into account the average direct efficiency investments (calculated by applying annuities) are between €11 bn and €144 bn higher than for the Reference+.

Electricity price changes compared to the Reference+ are also very small in 2030 ranging from 1% to 3% in the year 2030, with smallest increase in the EE40 scenario. The impact on fossil fuel prices could not be assessed as these are treated as exogenous in this modelling work.

The ETS price differs substantially across the various scenarios, reflecting the important contribution of energy efficiency to emission reductions in the ETS sectors. Under the two most ambitious scenarios, EE policies reduce both costs and incentives from the ETS itself for other types of abatement.

GDP impacts for scenarios reducing emissions by 40% GHG can be either (slightly) negative or positive with the main driver being the magnitude of investments. This depends to a large extent on the theoretical approach in modelling. In general-equilibrium modelling, the crowding out effect leads to slightly negative results in 2030 which later diminish. If no constraint on resources is assumed, the effects on GDP are clearly positive and increasing as the scenarios become more ambitious.

6.2.3 Social impacts

The overall net employment impacts, as for GDP, depend on theoretical approach to modelling which determines the impact of investment on economic growth, the use of revenue from carbon pricing and the employment level assumed in the baseline. In general, employment is positively impacted by using carbon pricing revenue to lower labour costs. The analysis also suggests that the employment effect will overall be more positive in scenarios with more ambitious energy efficiency policies reflecting the significant job-creation potential in these areas.

Affordability of energy for households is negatively affected under the Reference scenario, but is not significantly impacted compared to the Reference scenario in the EE25 and EE28 scenarios. The most ambitious scenarios lightly increase the share of energy-related costs in household budgets as energy efficiency improvements typically need investment resulting in capital cost increases in such scenarios. The extent to which households are able to proceed with such investment depends on the means of financing it.

6.2.4 Environmental impacts

In terms of sustainability and consistency with the other objectives of the energy and climate framework, all scenarios (except for EE40) demonstrate reduced GHG emissions compared to the Reference scenario in line with the GHG target proposed in 2030 framework and the decarbonisation objective. All scenarios are consistent with the 27% target for renewables.

Scenarios differ only very slightly with regard to respective reductions in ETS and non-ETs sectors as proposed in 2030 framework. In all scenarios, the reductions in ETS sectors are close to 43% (wrt 2005) and the reductions in non-ETS sectors are close to 30% (wrt 2005). Only the EE40 scenario diverges significantly from this pattern.

The balance of GHG reductions in the various sectors of the economy does not change between the scenarios as the mix of energy efficiency policies is not altered among the scenarios (it always follows the logic of current legislation and only the overall level of ambition intensifies). The highest reductions occur in the power generation sector (driven by ETS as proposed in 2030 framework) and in residential and tertiary sector (as the key policies often address specifically these two sectors).

6.3. Architecture of the 2030 policy framework

The 2020 target proved to be a useful element of the policy framework providing a benchmark for tracking progress and making policy adjustments; a signal to relevant actors, about the policy direction; and a basis for additional policy elements. A post-2020 policy framework without a target would not benefit from these elements.

A purely indicative target would be economically efficient and coherent with the 2030 energy and climate policy framework but its effectiveness would be limited. A binding target at EU level would have the benefits of the former while being more effective. National binding targets would be incoherent with the proposed energy and climate policy framework. Their effectiveness and economic efficiency is uncertain.

If a target was to be set a hybrid formulation would allow combining the benefits of a target formulated in absolute terms (clear benchmark and driver of energy savings beyond structural adjustments) and in intensity terms (automatic adjustments to the state of the economy). A fixed element of 37% and a GDP-proportionate element of 63% would be an appropriate split.

6.4. Financing

Significant energy efficiency improvements will require significant investments. These will have to be primarily privately financed although public investments, notably under the EU Structural Funds will continue to play a role, notably in leveraging private capital. The business case for investing in energy efficiency need therefore to become more apparent to the financial sector and this will entail a number of actions, such as establishing reliable procedures for measuring and verifying energy savings, developing standards for energy efficiency investment processes and providing technical assistance in order to make energy efficiency projects bankable.

The table below gives an overview of the main impacts of the different scenarios assessed in Chapter 5. All impacts are with respect to 2030 if not otherwise stated, while keeping in mind

that impacts and differences between scenarios may be quite different in a post 2030 perspective.

	Reference	Reference plus	GHG40	EE25	EE28	EE30	EE35	EE40
ENERGY SYSTEM IMPACTS	-							
Primary Energy Consumption (Mtoe)	1611 / 1630	1611 / 1632	1534 / 1393	1518 / 1517	1474 / 1380	1424 / 1286	1337 / 1196	1243 / 1129
- Solids share	10,8 / 7,6	10,8 / 7,6	10,1 / 9,5	9,6 / 9,8	10,8 / 9,4	11,3 / 9,3	12,9 / 9	12.4 / 9.2
- Oil share	32,3 / 30,5	31,9 / 29,8	32,8 / 13,5	32,1 / 13,6	32,5 / 14,5	33 / 15,3	34,2 / 15,6	36.2 / 16.4
- Natural gas share	24,6 / 24,3	25 / 25	22,5 / 17,9	22,9 / 20,3	21,8 / 19	21 / 18,3	19,2 / 18,3	18.5 / 17.6
- Nuclear share	12,5 / 13,2	12,5 / 13,2	13,1 / 18,1	12,5 / 17,1	12,7 / 17,4	12,6 / 17,1	11,8 / 16,5	11.1 / 15.8
- Renewables share	19,9 / 24,4	19,9 / 24,5	21,6 / 41	22,9 / 39,3	22,3 / 39,8	22,3 / 40,1	22 / 40,8	22.1 / 41.2
Energy Intensity (2010=100)	67 / 52	67 / 52	64 / 44	63 / 48	62 / 44	59 / 41	56 / 38	2804 / 3969
Renewables share in final consumption	24,4 / 28,7	24,4 / 28,7	26,5 / 51,4	28 / 49,2	27,7 / 50,1	27,7 / 50,7	27,4 / 51,7	9.8 / 10.3
Gross Electricity Generation (TWh)	3664 / 4339	3667 / 4347	3532 / 5040	3521 / 5378	3467 / 4935	3345 / 4560	3082 / 4267	19.1 / 19.1
- Gas share	19,5 / 17,3	19,5 / 17,2	15,3 / 12,5	14,8 / 13,1	14 / 12,3	13,1 / 11,2	10,2 / 11	0.3 / 10.2
- Nuclear share	21,8 / 21,3	21,8 / 21,3	22,6 / 21,6	21,4 / 20,7	21,3 / 20,9	21 / 20,7	20 / 19,7	1243 / 1129
- CCS share	0,45 / 6,9	0,45 / 6,88	0,77 / 14,72	0,72 / 15,6	0,51 / 13,65	0,27 / 11,83	0,29 / 10,64	12.4 / 9.2
SECURITY OF SUPPLY								
Import dependency	55,1 / 56,6	55,1 / 56,5	53,6 / 36,8	53 / 38,6	52,7 / 38	52,7 / 38,3	53,5 / 38,6	54.4 / 39.1
Net Energy Imports (2010=100)	96 / 101	96 / 101	89 / 56	87 / 64	84 / 57	82 / 54	78 / 51	74 / 49
Net Imports of Gas (2010=100)	105 / 122	107 / 125	91 / 74	91 / 92	84 / 78	78 / 69	67 / 65	60 / 59
Fossil Fuel Imports bill savings	n.a	-190 / -3404	-240 / -3078	-315 / -3491	-397 / -3798	-505 / -4145	-552 / -4361	-190 / -3404
ENVIRONMENTAL IMPACTS								
GHG reductions vs 1990	-32,4 / -43,9	-33,4 / -45	-40,6 / -79,6	-40,3 / -76,3	-40,6 / -78	-41 / -78,6	-42,1 / -79,5	-44.9 / -80.2
GHG emissions reduction in ETS Sectors vs 2005	-36,1 / -59,3	-36,2 / -59,5	-43,3 / -87,1	-45,5 / -84,3	-43,2 / -85,7	-42,1 / -85,7	-41,8 / -85,8	-45.6 / -86.5
GHG emissions reduction in non-ETS Sectors vs 2005	-20,3 / -22,9	-22,3 / -24,9	-30,5 / -70,3	-28,1 / -66,1	-30,5 / -68,3	-32,4 / -69,4	-34,8 / -71,2	-37.2 / -72.1
CO2 emission reductions vs 2005								
Power generation +District Heating	-46,73 / -72,9	-46,68 / -72,98	-56,53 / -97,75	-58,9 / -95,85	-54,91 / -95,32	-54,5 / -95,73	-53,97 / -96,08	-59.96 / -97.22
Industry	-22,48 / -43,81	-22,7 / -44,16	-27,39 / -77,76	-30,02 / -72,52	-30,32 / -77,13	-28,61 / -76,23	-29,07 / -75,72	-29.75 / -75.97
Residential, Services & Agriculture	-26,66 / -34,09	-26,88 / -34,2	-34,12 / -80,28	-30,96 / -70,78	-37,48 / -78,2	-43,75 / -82,87	-53,1 / -86,76	-62.91 / -90.32
Transport	-11,63 / -10,27	-11,77 / -	-13,56 / -	-16,52 / -	-16,85 / -61,4	-17,31 / -61,7	-17,51 / -64,16	-73.02 / -

		10,56	63,49	61,19				87.71
	Reference	**Reference plus**	**GHG40**	**EE25**	**EE28**	**EE30**	**EE35**	**EE40**
SYSTEM COSTS (2011-30/2011-2050)								
Standard approach – applying fixed for system costs calculation								
Total System Costs, avg annual (bn €)	2067 / 2520	2066 / 2519	2069 / 2727	2069 / 2657	2076 / 2701	2091 / 2820	2126 / 3016	2183 /3369
compared to reference (bn €)	na	-1/-1	2/207	2/137	9/181	24/300	59/496	116/849
Total System Costs as % of GDP (average annual)	14.3 / 13.03	14.29 / 13.02	14.31 / 14.1	14.31 / 13.74	14.36 / 13.97	14.46 / 14.58	14.71 / 15.59	15,1 /17,42
compared to reference (bn €)	n.a.	0/0	0.01 / 1.07	0.01 / 0.71	0.06 / 0.94	0.16 / 1.55	0.41 / 2.56	0,8 / 4,39
New approach – applying the same discount rates for decision-making and system costs calculation								
Total System Costs, avg annual (bn €)	2011 /2424	2009 /2423	2008 /2589	2008 /2535	2007 /2524	2012 /2578	2033 /2708	2075 /2958
compared to reference (bn €)	na	-2 / -1	-1 / 166	0 / -54	-1 / -11	5 / 54	21 / 130	42 / 250
Total System Costs as % of GDP (average annual)	13,91 /12,53	13,9 /12,53	13,89 /13,39	13,89 /13,1	13,88 /13,05	13,92 /13,33	14,06 /14	14,35 /15,29
compared to reference (bn €)	na	-0,01 / 0	-0,02 / 0,86	-0,02 / 0,57	-0,03 / 0,52	0,01 / 0,8	0,15 / 1,47	0,06 / 2,27
INVESTMENTS AND ENERGY PURCHASES								
Investment Expenditures , avg annual (bn €)	816 /949	817 /951	854 /1189	844 /1084	867 /1127	902 /1172	992 /1203	1147 /1211
compared to reference (bn €)	na	1/2	38/240	28/135	51/178	86/223	176/254	331/262
Energy Purchases, avg annual (bn €)	1454 /1586	1452 /1582	1436 /1394	1431 /1468	1416 /1370	1401 /1290	1378 /1206	1364 /1129
compared to reference (bn €)	na	-2 / -4	-18 / -192	-23 /-118	-38 / -216	-53 / -296	-76 / -380	-90 / -457
OTHER ECONOMIC IMPACTS								
Average Price of Electricity (€/MWh)	176 / 175	176 / 175	179 / 183	181 / 185	178 / 185	178 / 182	177 / 182	181 / 182
compared to reference (€/MWh)	na	0 / 0	3 / 8	5 / 10	2 / 10	2 / 7	1 / 7	5 / 7
ETS price (€/t of CO2-eq.)	35 / 100	35 / 100	40 / 264	42 / 250	33 / 220	25 / 180	13 / 160	6 / 165

Share (%) of energy costs in energy intensive industries to value added[54]	44 / 45	44 / 45	42 / 54	44/49	44/52	43/51	44/50	44/50
Share of energy related cost (including transport) in household expenditure (for Ref in %, 2010: 12,4%)	14.6/ 12.6	14.6/ 12.6	14.8 / 14.1	14.8/13.7	15.1/13.9	15.5/14.9	16.5/16.3	18.7 / 18.6

54 Percentage of energy costs excl. auction payments / value added in energy intensive industries in PRIMES. For Reference Scenario corresponding value was 38.2% in 2010.