EUROPEAN
COMMISSION

Brussels, XXX
[…](2014) XXX draft

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the Communication A policy framework for climate and energy in the period from 2020 up to 2030

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1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Organisation and timing

The preparations of the Impact Assessment (IA) for the 2030 framework for climate and energy policies formally started in April 2013 subsequent to the adoption of the Commission's Green Paper on the matter[1], but the IA builds on the update of the new Reference scenario (hereinafter "EU Reference Scenario 2013" or "Reference") used as the benchmark for the quantitative assessments, which started already in late 2011.

An interservice group (ISG) was established in February 2013 in view of preparing the Green Paper, and this group continued to meet to steer the work on the IA up to its finalisation. The ISG met 4 times for the purposes of preparing this IA; on 30 May 2013, the ISG met to discuss e.g. the work plan and the results of the EU Reference Scenario 2013; on 16 July the ISG met to discuss a first outline of the IA and first outcomes of the consultation launched by the Green Paper, on 23 September the group met to discuss policy options and preliminary results. The final draft IA was submitted to the ISG group on 18 October 2013.

The lead DGs are Climate Action (CLIMA) and Energy (ENER). The following DGs and services were invited to the Steering Group: Agriculture and Rural Development (AGRI), Budget (BUDG), Communication (COMM), Communications Networks, Content and Technology (CNECT), Competition (COMP), Economic and Financial Affairs (ECFIN), Education and Culture (EAC), Employment, Social Affairs and Inclusion (EMPL), Enlargement (ELARG), Enterprise and Industry (ENTR), Environment (ENV), EuropeAid Development & Cooperation (DEVCO), Health and Consumers (SANCO), Home Affairs (HOME), Humanitarian Aid and Civil Protection (ECHO), Internal Market and Services (MARKT), Joint Research Centre (JRC), Justice (JUST), Maritime Affairs and Fisheries (MARE), Mobility and Transport (MOVE), Regional Policy (REGIO), Research and Innovation (RTD), Secretariat-General (SG), Taxation and Customs Union (TAXUD), Trade (TRADE), Bureau of European Policy Advisers (BEPA), Legal Service (SJ) and European External Action Service (EEAS).

1.2. Consultation and expertise

1.2.1. Consultation

As a preparatory step for the development of the 2030 framework for climate and energy policies, the Green Paper was adopted on 27 March 2013[2]. It presents progress made and challenges under the current policy framework and sets out for consultation five key issues that the 2030 framework needs to address, namely: targets; coherence of instruments, competitiveness of the EU economy; security of supply; and acknowledgment of the varying capacity to act of Member States. In addition, the Green Paper consults on the main lessons learnt to date from the 2020 framework for climate and energy policies.

The Green Paper launched a public consultation of all interested parties which lasted until 2 July 2013. The Green Paper included a set of 22 questions on which the Commission sought viewpoints and input. Some 557 contributions from a broad spectrum of stakeholders including from 15 Member States were received. Given the very broad participation, the consultation offered insights into a broad range of stakeholder opinions. All of the Commission's minimum consultation standards were met. The full report presenting results of the public consultation is found in Annex 7.5 to this IA.

[1] COM(2013)169
[2] COM(2013)169

In addition to the public consultation itself, a high-level stakeholder conference was organised on the 2030 framework on 19 June 2013, with stakeholders and Member States represented as speakers and with more than 200 participants in the audience. The conference provided useful first-hand accounts on the major issues addressed by the consultation and was a valuable complement to the formal public consultation.

Box 1: Main findings of the public consultation

The public consultation revealed an almost universal support for the development of a common European framework for climate and energy policies.

Many stakeholders expect the EU to provide a 2030 framework to reduce uncertainty among investors, governments and citizens. Member States and stakeholders emphasized the need for climate and energy policy to continue to take into account the three prime objectives of energy policy: competitiveness, security of supply and sustainability.

On targets, there is a broad consensus among the various stakeholders on the need for a new GHG target, whereas there are diverging views on the appropriate ambition level. Stakeholders have mixed views on the need for renewables and energy savings targets.

On instruments, most stakeholders agree that the European Emission Trading Scheme (EU ETS) should remain the central instrument for the transition to a low carbon economy. There are mixed views on the extent to which a reform of the EU ETS is needed. Many stakeholders agree that additional policies and instruments can be utilised to reduce emissions for non-ETS sectors. Many stakeholders focus on the need for harmonization of policies across Europe to create a level playing field and avoid market distortion. The Internal Energy Market's benefits are widely recognised and this is seen as key to ensure competitive prices and security of supply. Higher interconnection capacity between Member States is considered fundamental to meet energy and climate objectives.

There is broad consensus among stakeholders that innovation is essential to ensure the flexibility and the security of the EU energy system and for the further development of cost-effective energy options.

On competitiveness, many stakeholders note that increased attention should be paid to competitiveness due to the economic crisis and changing international circumstances. The increasing cost of some climate and energy policies such as RES support needs to be contained. There is also a general consensus that public support schemes have to be revised to be more in line with changing costs of deploying renewables.

On distribution of efforts, it is widely held that a fair distribution of efforts for the non-ETS sectors is needed; that socio-economic and geographical differences between Member States have to be considered; and that financial instruments can play a key role to help Member States less able to act and to leverage private investment.

Member State Ministers in charge of energy and climate policy had a first exchange on the main issues addressed by the Green Paper at a joint session of the Informal Energy and Environment Councils in Dublin on 23 April 2013. The European Council of 22 May 2013 welcomed the Commission's Green Paper and stated they will return to this issue in March 2014.

The Commission also organised meetings between Member States' Director Generals in charge of energy policy (on 14 March 2013) and of climate policy (on 19 February 2013) to discuss the 2030 Framework prior to the adoption of the Green Paper.

1.2.2. *External expertise and contributions of Commission services*

In order to ensure a complete and thorough quantitative assessment of future impacts in the EU, the Commission contracted the National Technical University of Athens, IIASA and EuroCare to model EU scenarios. The energy system and CO2 emission modelling is based on the PRIMES model. The non-CO2 GHG emission modelling is based on the GAINS model, with additional input by the Joint Research Centre's Institute for Environment and Sustainability concerning air pollution. LULUCF emission modelling is based on the GLOBIOM-G4M models.

A comprehensive update of the Reference scenario was conducted between November 2011 and June 2013 in close cooperation between DGs ENER, CLIMA and MOVE and in association with the JRC. The macroeconomic assumptions for the EU Reference Scenario 2013 were consulted with and draw on work of DG ECFIN and the Economic Policy Committee. Extensive consultations during four meetings with experts from Member States on assumptions used and draft results took place to ensure appropriateness and quality with regard to Member State-specific results. Moreover, in order to improve transparency and to gain useful third party views on the methodology applied by the Commission, the PRIMES model was peer-reviewed in 2011 by a group of recognised modelling experts which concluded that the model is suitable for the purpose of complex energy system modelling.

Macroeconomic modelling, including impact of mitigation action by third countries, was performed using the GEM-E3 model, a general equilibrium model, maintained and used by the Joint Research Centre's Institute for Prospective Technological Studies (IPTS) and the E3MG model, a macro-econometric model run by Cambridge Econometrics. IPTS also contributed using the POLES model which is a global sectoral simulation model for the development of energy scenarios and global GHG emission pathways until 2050.

An empirical study assessing Carbon Leakage and Competitiveness was undertaken by Ecorys[3].

ICF GHK conducted a study analysing the employment impacts through macroeconomic modelling, using the E3ME model by Cambridge Econometrics, and by bottom up assessment for the power sector.

In parallel to the preparations of this IA, the Commission's services carried out an extensive analysis on energy prices and costs. This work was led by DG ENER with close involvement of other DGs, in particular DGs ENTR, ECFIN, EUROSTAT, CLIMA, COMP and TAXUD.

DG ECFIN conducted a study on economic aspects of energy and climate policies[4]. The report is composed of three chapters, investigating the evolution of electricity and natural gas markets across the EU, with a particular focus on the unit energy costs and the shale gas impact on the competitiveness of the EU economy, the impact of energy and climate policies on the energy and carbon prices, as well as the impact of renewable developments on trade.

DG ENTR has performed an assessment of the potential impacts of EU action in the context of international climate action on EU industrial sectors using the PACE model of ZEW (Zentrum für Europäische Wirtschaftsforschung).

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[3] Carbon Leakage Evidence Project: Factsheets for selected sectors, Ecorys, 2013. http://ec.europa.eu/clima/policies/ets/cap/leakage/docs/cl_evidence_factsheets_en.pdf

[4] Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission.

1.3. Opinion of the Impact Assessment Board (IAB)

The draft IA was submitted to the Impact Assessment Board (IAB) on 24 October and was discussed at the IAB hearing on 20 November 2013, subsequent to which the IAB asked for a revised submission. The IA was resubmitted on 12 December 2013. On 9 January 2014 a positive opinion was received from the IAB.

The board recommended to be clearer about the scope of this initiative, in particular explaining, and concentrating on, the decisions that are to be taken now.

The IA was adapted to address this. The Section on objectives was adapted making clear that the IA is supporting an initiative that will focus on the issue of climate and energy targets in a 2030 perspective, while giving general directions of future policy development without yet proposing the implementation measures that will require further assessments. One exception is the need to improve the functioning of the ETS which is confronted with a large surplus. For this policy initiative a separate Impact Assessment is prepared.

In relation to the current framework, the board asked to more clearly explain what the lessons learnt are (e.g. the contribution to GHG reduction, the coherence between the policy tools, the performance of ETS) and how these have been taken into account. The following important changes were made, but the board still recommended to be clearer on the general assessment of the performance of the key elements of the current framework.

The lessons learned Section (which is supported by an extensive annex) gives clearer insights on the costs related to existing renewable support schemes, the recent guidance given by the Commissions on this issue, the recent developments relating to aviation in the ETS, the role of EU targets in making progress on international action and interaction between targets and instruments. Also in the Section on problem definition a section was added to better recognise the challenges related to interaction of targets and instruments.

The board recommended that more information should be provided regarding the assumptions underlying the baseline scenario (i.e. the so called Reference scenario) and the options and that the report should discuss the extent to which the assumption that all existing policies will be fully implemented is realistic in light of existing experience.

The Section on evolution under current policies was significantly enhanced. A box was added to give a clear overview of the main assumptions and the text was updated to add significant additional information on what are the drivers of increased costs in this Reference scenario. In the Section on problem definition the challenges related to existing policies were revisited. The board still noted that more information could be provided on the extent to which the applied baseline scenario would require additional action. Regarding the baseline the board also noted that the assumptions concerning the use of auctioning in different sectors and the recycling of revenues could be improved, which was further clarified.

The board also asked that the key impacts and the trade-offs are made more clearly (e.g. between policy tools and with competitiveness). To address this the concluding section of the IA as well as the executive summary was extended to include a discussion focussing on the trade-offs between policy options, based on the findings of the extensive analysis of scenarios reflecting these policy options. The board still noted that more specific conclusions should be drawn regarding the most cost-efficient policy scenario and to which extent binding targets are proportionate to incremental costs.

The board also asked to better explain the distributional impacts in Member States. To meet this concern the Section on distributional impacts was enhanced by adding significant detail on the impact of scenarios at Member State level.

Finally, the board asked that the presentation of the report should be substantially improved by focussing on the core issues with stakeholders' views being included in the main report.

This was addressed by ensuring that problem definition, objectives and the concluding Section focussed clearer on the scope of this impact assessment, i.e. to support an initiative that will focus on the issue of climate and energy targets in a 2030 perspective. Given that it also aims to give general directions of future policy development, the main Section on analysing the impacts could not be shortened, even though the assessment of one policy option, i.e. the extension of the scope of the ETS, was moved to an Annex given that option requires more analysis before a general policy direction could be given on this options.

Building on the stakeholder opinions that were already described in detail in Annex 7.5 and the overview that was already included in Section 1.2. A discussion was added in the Section on current challenges on stakeholders opinion on the key aspect of this initiative, e.g. the targets and their interaction in a 2030 perspective. Also in the Section that discusses carbon leakage measures a specific Section was added on stakeholders perspectives.

2. PROBLEM DEFINITION

2.1. Policy context

2.1.1. State of play and general policy context

In the last 20 years, the EU has been successful in decoupling GHG emissions from economic growth. While GHG emissions in the EU 28 fell by 17% over the period 1990-2011, the overall economy grew by 45%[5]. This development is to a considerable extent due to a gradual improvement in the carbon intensity of the EU's energy mix, including due to higher shares of renewable energy, and to a decreasing energy intensity of the EU economy, thanks to energy efficiency measures taken across the economy including in industry, and also due to growth in many non-energy intensive sectors, in particular services, as well as to decreases in non-CO2 emissions, in particular in the agriculture and waste sectors.

In parallel to these developments, the EU has made significant progress towards the creation of internal energy markets in electricity and gas[6], though obstacles remain[7]. The EU is also making considerable progress in ensuring the security of energy supplies in the EU, although dependency on one or a limited number of source countries of natural gas in particular is still a concern for many Member States while other supply concerns are also emerging as the energy system is evolving[8]. At the same time, energy affordability for households and the impacts on competitiveness of EU energy prices for industry in an international comparison are of increasing concern for these energy consumers and for policy makers.

The Climate and Energy package adopted in 2009 presented an integrated approach based on climate and energy targets and a set of policies to implement them. Chapter 2 of the Commission's Green Paper on a 2030 framework for climate and energy policies together with Annex 1 of that Green Paper provide a comprehensive overview of the climate and

5 Kyoto progress report 2013 and its Staff working Document (COM(2013) 698 final, SWD(2013) 410 final). Emissions include international aviation emissions as reported under the Common Reporting Format to the UNFCCC.

6 Through Directives 2009/72/EC and 2009/73/EC. Already before these directives there were functioning internal markets for other energy products such as coal and oil products.

7 See Commission Communication "Making the internal energy market work", COM(2012) 663 final.

8 See e.g. European Commission, Directorate-General for Economic and Financial Affairs (2013), Member states' energy dependence: an indicator-based assessment, available from http://ec.europa.eu/economy_finance/publications/occasional_paper/2013/op145_en.htm

energy objectives and policies applicable in a 2020 perspective (see also Annex 7.4 and Section 2.2 below on lessons learnt). But 2020 is only an intermediate step towards a competitive and secure low carbon economy.

As regards climate change, the long term goal agreed in the context of the UNFCCC is to limit the global average temperature increase to below 2°C compared to pre-industrial levels, which guides the EU's climate action. In line with scientific findings reported by the International Panel on Climate Change (IPCC) in the fourth Assessment Report, the European Council stated in 2009 that the EU's objective, in the context of necessary reductions by developed countries as a group, is to reduce GHG emissions by 80-95% in 2050 compared to 1990. The European Council also endorsed the objective to ensure that global emissions reach a peak by 2020 and are reduced by at least 50% compared to 1990 in order to increase the chances of avoiding climate change.

The European Council has also recently addressed energy in a more holistic way: first in February 2011 when it requested that due consideration be given to fixing intermediary stages towards reaching the 2050 objective and stated for example that "safe, secure, sustainable and affordable energy contributing to European competitiveness remain a priority for Europe"; and again in May 2013 emphasising the importance of the internal energy market and in particular stating that the EU's energy policy "must ensure security of supply for households and companies at affordable and competitive prices and costs, in a safe and sustainable manner", amidst increasing concerns in this regard in many Member States and industry sectors.

2.1.2. 2050 Roadmaps and 2030 Green Paper

In order to provide a long term perspective on climate, energy and transport (a sector which accounts for a significant share of both GHG emissions and energy consumption), the Commission came forward with three initiatives in 2011 based on a consistent analytical framework: the *Roadmap for moving to a competitive low carbon economy in 2050*, the *Energy Roadmap 2050*, and the *Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system* (commonly referred to as the *Transport White Paper*)[9], which presented fundamental aspects of the transition to a low carbon economy, cost-efficient GHG emission reduction milestones for 2030, and "no-regret options" – i.e.: more energy efficiency, higher shares of renewable energy and energy infrastructure development - for the transition towards a competitive, sustainable and secure energy system

In reaction to these initiatives, the European Parliament underlined the necessity of clear climate and energy objectives for 2030, building on the Roadmaps[10]. The Council did not adopt conclusions on the Roadmaps, but Council Presidency conclusions underlined the broad agreement by all but one Member States on the core elements of the Roadmaps. In March 2013, the Commission came forward with a consultative Green Paper on a 2030 framework for climate and energy policies. On 22 May 2013, the European Council welcomed the Commission's Green Paper, recognised that significant investments in new and intelligent energy infrastructure are needed to secure the uninterrupted supply of energy at affordable prices, and that such investments are vital for jobs and sustainable growth and will help enhance competitiveness. The European Council recognised the importance to have a well-functioning carbon market and a predictable climate and energy policy framework post-2020 which is conducive to mobilising private capital and to bringing down costs for energy

[9] COM(2011)112, COM(2011)885, COM(2011)144

[10] European Parliament Resolution on a Roadmap for moving to a competitive low carbon economy in 2050 (2011/2095(INI))

investment. The European Council invited the Commission to come forward with more concrete proposals in time for the March 2014 European Council. The recently agreed 7th Environmental Action Programme states that the next step for the EU's climate and energy framework beyond 2020 is to provide a clear, legally-binding framework and target(s) to enable investments.

2.1.3. International policy context

While more than 110 countries, accounting for 85% of global emissions and including all major economies, have formally pledged to take action to mitigate climate change in the context of the UNFCCC, no new comprehensive international climate agreement has been achieved that ensures that the global community as such is on track to keep global warming below 2°C. The lack of such an agreement and the insufficient ambition of pledges, including by major economies, have prevented the EU from raising its 2020 GHG reduction target to 30%[11]. At the 2011 Durban UN climate conference, countries however agreed to start negotiations on a new global agreement, applicable to all contracting parties for the period beyond 2020, to be agreed at the UN climate conference in Paris in 2015.

2.2. Progress made, challenges encountered and lessons learnt from the 2020 framework

A detailed and comprehensive analysis of progress made, challenges encountered as well as lessons learnt and interactions between the EU's extensive climate and energy policies underpinning the 2020 targets was carried out. This analysis, supported by the responses to the public consultation, is a fundament of this impact assessment and is presented in detail in Annex 7.4 along with details of relevant evaluations where these are available. As regards energy efficiency, a more detailed assessment of progress made towards the 2020 targets and lessons learnt will be contained in the review that the Commission will carry out in 2014 as required by the Energy Efficiency Directive.

Some of the more salient conclusions of this analysis are summarised below.

2.2.1. General progress towards meeting 2020 headline targets for climate and energy

With a 17% reduction in 2011 compared to 1990[12], the EU28 as a whole is on track to meet and even exceed its 2020 GHG target of 20% compared to 1990. The 2020 cap for the sectors covered by the EU Emission Trading System (ETS) is expected to be met. The EU as a whole is also on track to meet the target for the non-ETS sectors. However, 13 Member States need to make additional efforts to meet their respective national 2020 targets under the Effort Sharing Decision, or make use of the flexibility mechanisms foreseen therein[13]. EU and national policies, high fossil fuel prices and reduced energy demand due to the economic crisis have contributed to GHG emission reductions.

As regards renewable energy, its share of gross final energy consumption was 12.7% in 2011 (compared to 8.5% in 2005). On aggregate, the EU 28 has met its interim target for 2011/2012, driven by Member States efforts to make progress towards the national targets in the Renewable Energy Directive. However, as the trajectory grows steeper, more efforts will

[11] The Climate and Energy Package included an unconditional -20% GHG target by 2020 compared to 1990 and a -30% conditional target in case of a sufficient ambitious comprehensive international climate agreement.

[12] Including international aviation as reported under the UNFCCC., see Staff Working Document accompanying the Kyoto Progress report 2013 (SWD(2013) 410 final)

[13] According to national projections submitted under the Monitoring Mechanism Decision in 2013, see Kyoto Progress report 2013 (COM(2013) 698 final)

still be needed from Member States in order to reach it[14] Many Member States need however to make additional efforts to meet their respective 2020 national targets, and recent evolutions such as for instance retroactive changes to support schemes is causing concern as to whether the overall EU target will be met[15].

The 2020 target of saving 20% of the EU's primary energy consumption (compared to projections made in 2007) is not legally binding for Member States, but significant progress has nevertheless been made. After years of growth, primary energy consumption peaked in 2005/2006 (at 1,825 Mtoe) and has been slightly decreasing since 2007 (to reach 1,730 Mtoe in 2011)[16], in part due to impacts from the economic crisis, but also due to improved energy intensity. Nevertheless, the EU is likely to miss its indicative energy savings target of 20% compared to 2007 baseline projections for 2020 under current policies. The EU Reference Scenario 2013 projects energy savings of some 17% in 2020 (see Section 2.3 below).

2.2.2. Implementation – climate policy

2.2.2.1. The EU Emission Trading System (ETS)

Since 2013 the new institutional framework with auctioning and EU-wide harmonised benchmarks for free allocation has been in place and constitutes a significant improvement compared to the previous trading periods that still had national based allocation plans.

The ETS has adapted flexibly to changed economic circumstances and lowered compliance cost for sectors covered by the ETS, in the context of a prolonged economic recession. However, as outlined in the Carbon Market report[17], the economic recession and the accelerated inflow of international credits have created a surplus of around 2 billion allowances since 2008. If unaddressed, this will have a long lasting effect on the ability of the ETS to incentivise low carbon investments. In combination with today's high gas to coal price ratio it can lead to carbon lock-in. Regulatory uncertainty on the way forward has reduced the confidence of market participants and in some cases is already leading to fragmentation of climate policies within the EU. The lower than expected ETS carbon prices and corresponding auctioning revenues are reducing the envisaged related redistribution effects.

Free allocation to energy intensive sectors and low carbon prices have resulted in a very low risk of carbon leakage at present[18]. State aid for electricity intensive industries in line with the related 2012 aid guidelines[19] can be an effective way of preventing indirect impacts but has given rise to concerns by some stakeholders regarding distortions of competition across Member States.

Aviation has been included since 2012 in the EU ETS. The scope also includes incoming and outgoing international flights in the EU. Third countries have been opposing that the EU

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[14] See the Commission Renewables Progress Report.

[15] Other reasons for concern include the failure to address barriers to the uptake of renewable energy: administrative burdens and delays still cause problems and raise project risk for renewable energy projects; slow infrastructure development, delays in connection, and grid operational rules that disadvantage renewable energy producers all continue and all need to be addressed by Member States in the implementation of the Renewable Energy Directive. Many Member States therefore need to make additional efforts to meet their respective national targets under the Renewable Energy Directive. More information in the Commission's "Renewable energy progress report", COM(2013) 175 final

[16] Primary energy consumption included non-energy uses which are not considered in the energy savings target for 2020. The figure excluding non-energy uses was 1706 Mtoe in 2006 and 1583 Mtoe in 2011.

[17] COM(2012) 652

[18] Carbon Leakage Evidence Project: Factsheets for selected sectors, Ecorys, 23 September 2013. http://ec.europa.eu/clima/policies/ets/cap/leakage/docs/cl_evidence_factsheets_en.pdf

[19] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52012XC0605(01):EN:NOT

includes flights of foreign operators in the EU ETS[20]. To provide negotiation time for agreement on a realistic timetable for the development of a global market-based measure (MBM) and on a framework for facilitating the comprehensive application of regional MBMs pending the application of the global MBM, international flights into and out of Europe in 2012 were temporarily exempted from enforcement[21]. In October 2013 the ICAO Assembly agreed to develop by 2016 an MBM addressing international aviation emissions and apply it by 2020. In response to this and to give further momentum to the global discussions, the Commission has proposed amending the EU ETS for the period 2014-2020 so that only the part of a flight that takes place in European regional airspace is covered by the EU ETS. This proposal is now being discussed by Council and Parliament.

2.2.2.2. The Effort Sharing Decision (Non ETS)

Member States' efforts are effectively supported by a series of measures at the EU level, including the regulation of CO2 emissions from passenger cars and vans, the Energy Performance of Buildings Directive, the Energy Efficiency Directive, the Renewable Energy Directive, the F-gas regulation and the eco-design framework setting minimum energy efficiency standards for a range of domestic and industrial appliances. Many Member States have also put in place national measures unrelated to EU initiatives contributing towards their effort sharing targets, such as CO2 and energy taxation, which also impacts energy end-price differentials between Member States and sectors.

Nevertheless, not all Member States are on track to meet their target, so the foreseen flexibilities may be important to ensure compliance. This was also highlighted in several responses to the consultation. However, access to international credits for compliance and possible overachievement at the overall EU level might impact potential prices of emission allocation transfers between Member States and reduce related distribution effects.

2.2.2.3. Fuel Quality Directive

The Fuel Quality Directive (FQD), as amended in 2009[22], introduced an obligation for fuel suppliers to reduce the life cycle greenhouse gas emissions from their supply of fuels used in road (and non-road mobile machinery) by 6% in 2020 from a 2010 baseline.

The methodological challenge is to ensure fuel suppliers can calculate life cycle emissions, incorporating an adequate level of accuracy but balancing the associated administrative burden. The development and evaluation of such a methodology is complex. In this context, an impact assessment considering a number of options has now been finalised but no decision on this has been taken yet.

Other major economies are reviewing proposals for or have adopted similar legislation, e.g. the US state of California. One benefit of such a policy is that it will apply equally to importers and domestic producers of fuels.

2.2.3. Progress on international action on climate change

In early 2007, the EU agreed on two headline targets for 2020 followed by the adoption of the climate and energy package in late 2008. It included a unilateral target to reduce GHG emissions by 20% by 2020 and a conditional of 30% depending on the level of ambition of other countries. As the world's largest economy, the EU was the first to bring proposals for an economy-wide target to the international negotiations. The EU's leadership had a significant

[20] See Commission Impact Assessment SWD(2013)430 final
[21] See Decision No 377/2013/EU of the European Parliament and of the Council
[22] Directive 2009/30/EC

impact on other countries, and all other major economies followed with their own pledges in the months ahead of the 2009 Climate Conference in Copenhagen. In the end, more than 90 developed and developing countries, including all major economies, representing more than 80% of global GHG emissions made 2020 pledges. The EU's unilateral target was instrumental in bringing forward these pledges by others. However, not all countries followed the EU's example in proposing a target range, and other countries did not take sufficiently ambitious targets to allow the EU to move to its 30% conditional target.

The pledges under the Copenhagen Accord and Cancun decisions have led to the development and implementation of a variety of national policies and measures, including carbon markets. While the EU ETS remains at present the largest functioning carbon market, others are being implemented and developed. For example, California and New Zealand have implemented carbon markets; Australia adopted its Carbon Pricing Mechanism legislation[23]; China is pushing ahead with the design of its seven emissions trading pilots some of which have already commenced; South Korea is developing its trading scheme.

Major economies have enhanced their fuel economy standards (US, China, Japan, and India is considering new policies) and some countries have undertaken significant reforms of their tax and subsidies to improve their energy security, with GHG emission benefits (Iran, Indonesia, South Africa, India). More than 100 countries have renewable energy policies, and especially fast-growing economies are developing support schemes to promote investments in renewable energy (from Philippines to China to Chile).

But neither the existing pledges nor initiated measures are delivering sufficient reductions by 2020 to be on track to prevent a dangerous 2º C rise of temperature. At the UN Climate conference in Durban, in 2011, all countries recognised the urgent need to act collectively with greater ambition. They agreed to negotiate by 2015 a global climate regime applicable to all for the period after 2020 as well as to enhance mitigation efforts to close the pre-2020 mitigation gap. The climate change conference in Warsaw in November 2013 invited all countries to prepare their contributions well in advance. In order to build sufficient global political momentum, this should allow for a first informal discussion at the UN Secretary General's Climate Summit on 23 September 2014. UN Secretary-General Ban-Ki-moon challenged Leaders to "bring bold pledges to set the world on a low-carbon path". After the first quarter of 2015, all pledged contributions should be discussed in a comprehensive manner in the international negotiations with a view of adopting the new climate agreement at the end of 2015.

2.2.4. Implementation – energy policy

2.2.4.1. Renewable energy policy

Substantial growth in renewable energy has been driven by the EU and Member State binding targets provided in the Renewable Energy Directive and the national support schemes to achieve those targets. Generally speaking, the EU has made satisfactory progress so far towards meeting the 20% target at the aggregate level, but many Member States must make additional efforts to meet their individual targets.

Most renewable energy sources are not yet fully cost-competitive compared to other energy sources. However, in the last five years renewable energy technologies have matured considerably and costs have come down, most notably for solar PV, and to a lesser extent for wind; and some renewable energy technologies for electricity generation are becoming competitive with conventional electricity generation.

23 The change of government in September 2013 has led to uncertainty with regard to continuation.

The increase of renewable energy sources has contributed to containing and even lowering electricity wholesale prices in many markets by shifting the merit order curve and substituting part of the generation of conventional thermal plants, which have higher marginal cost of production. However, this effect on wholesale prices has hardly been reflected in retail prices or translated into tangible benefits for consumers (especially not for household – those large industrial electricity consumers facing prices related to the wholesale market will have benefited). This is partly due to insufficient competition and partly due to the extra cost for renewables support schemes (typically passed on to final consumers, in some markets only to households) that can outweigh the reducing impact of renewables on wholesale prices on many markets[24]. Other studies suggest that the benefits of more electricity generation from e.g. wind power exceed the costs of supporting it.[25]

An ongoing study by the European Commission indicates that total expenditure on renewable support in the EU was 13.7 bn Euros in 2009, 18.6 bn in 2010, 30.1 bn in 2011 and 34.6 bn in 2012[26]; but trends vary across Member States and some costs are not reflected in the electricity bills but covered by public budgets, in particular in countries with strong elements of price regulation. On the other hand, the avoided costs of imported fuel saved thanks to the use of renewable energy are estimated to amount to around €30 billion in 2010. Given increasing production of renewable energy in the EU and a projected increase in fossil import prices, it is expected that avoided fuel costs will rise in the coming years[27].

Short to medium term cost-efficiency of renewables development has been affected by the choice of some Member States to support a wide range of technologies (although such an approach could reduce costs in the longer term as has been observed in the case of solar PV) and by national support schemes which in many Member States have not been flexible enough to adjust to changing circumstances (such as technology costs and level of development). On the other hand, changes to established support schemes can increase investor uncertainty, in particular if applied retroactively, and have contributed to the reduced investment levels experienced in 2012 and 2013. In addition, diverging Member State support schemes with exclusive focus on national production exclude benefits of further integration of the internal energy market. As regards biofuels, some national schemes raise questions of compatibility with EU rules and some of them have been subject to complaints at the WTO.

With the exception of Sweden and Norway, none of the cooperation mechanisms provided for in the Renewable Energy Directive have been made use of, and national support schemes are as regards electricity restricted to national production. This presents a further challenge to cost-efficient deployment across the EU and works against market integration. At the same time, higher shares of variable renewable energy in the electricity mix raise new concerns about grid adequacy and stability if grids are not adapted as necessary, and underline the need for further flexibility through market integration, grid interconnection, demand response,

[24] Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission. Possible other drivers behind this divergence between wholesale and retail prices are being analysed in the forthcoming Communication (or CSWD) on energy prices, competitiveness and social cohesion.

[25] See e.g. *Large-scale wind power integration and wholesale electricity trading benefit: Estimation via an ex post approach*, available at http://www.sciencedirect.com/science/article/pii/S0301421511009657#

[26] Another report by the Council of European Energy Regulators estimated that the support for renewable electricity produced in 18 European countries reached €25 billion in 2010, which was the equivalent of €9 per MWh of total final electricity consumption in these countries

[27] Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission.

back-up capacity, etc. It is clear that a "system view" must be addressed to fully integrate renewables in the energy market in a cost-effective manner.

In order to assist Member States in addressing these challenges, the Commission issued Guidance[28] on support schemes and cooperation mechanisms in November 2013, which if fully adhered to is expected to have a significantly positive impact on cost-efficiency, flexibility, market integration, and further sustainable development of renewable energy in the EU.

The merit order effect and priority access to the grid causing lower wholesale prices can affect revenues of conventional power plants, especially in Member States with rapid deployment of variable renewables. In some Member States, this raises the question of how to ensure adequate investment signals and generation adequacy. National capacity mechanisms are being considered by some Member States as a solution, but risk fragmenting the internal market[29].

Growth of renewables in the EU has contributed to a globalisation of the renewable energy sector. Many new markets have emerged across the globe, in some cases even bigger than the European market, but at the same time the European renewables industry has been faced with stronger competition. This has on the one hand contributed to lower technology costs in the EU and a continued strong export position of EU firms in particular in the wind sector, but has also resulted in difficult competitive positions and lower market shares for many EU companies in particular in the solar sector[30].

2.2.4.2. Renewable sub-target for transport

The share of renewables in transport reached 4.7% in 2010 compared to only 1.2% in 2005, to be compared with the 10% target in the Renewable Energy Directive. Member States support biofuels via mandatory blending obligations in transport fuels, tax exemptions or other support schemes. Progress towards meeting the renewables target for transport can contribute to lowering fuel import costs and in a context of increasing dependence on imports of fossil fuels, can improve security of supply[31]. On the other hand, from a strict GHG reductions perspective, current costs and support levels for 1st generation biofuels in the transport sector in some cases imply an abatement cost significantly higher than those of other transport options or in other sectors of the economy[32]. The Renewable Energy Directive requires the Commission to monitor a range of issues surrounding biofuels and bioliquids, including their impact on sustainability (see also Annex 7.4).

Since the adoption of the Renewable Energy Directive, the scientific evidence base regarding the GHG emission impacts associated with indirect land use change (ILUC) has grown. In response to the ILUC issue, the Commission proposed to limit the amount of food-based (1st generation) biofuels that can contribute to the relevant targets (including the 10 % renewables

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28 Communication 'Delivering the internal electricity market and making the most of public intervention', C(2013) 7243 final

29 Ibid.

30 Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission.

31 As regards transport, the avoided costs of imported fuels, replaced by biofuels, are estimated to amount to EUR 7.6 billion in 2010. European Commission - Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission.

32 This holds in particular if ILUC effects are also taken into account, see. e.g. the overview in Schroten, A., et al. (2012) Cost effectiveness of policies and options for decarbonising transport. Task 8 paper produced as part of a contract between European Commission Directorate-General Climate Action and AEA Technology plc;, www.eutransportghg2050.eu

target for transport) and has indicated that first generation biofuels with high estimated indirect land-use change emissions should not continue to receive public support after 2020[33]. However, as projections indicate that Europe will need considerable amounts of biofuels towards 2050, the Commission's proposal includes increased incentives for advanced biofuels that do not need land for their production, such as biofuels made from residues, algae and wastes (see also Annex 7.4). In order for the transport sector to decarbonise in a cost-effective and sustainable manner, technology developments of relatively small quantities of advanced renewable fuels going beyond R&D are necessary, in line with the Commission's proposal for limiting emissions from indirect land-use change.

2.2.4.3. Solid and gaseous biomass

The Commission is currently analysing the sustainability issues associated with increased use of solid and gaseous biomass for electricity, heating and cooling in the EU, with the view to consider whether additional EU action is needed and appropriate. While imports of wood pellets will increase up to 2030, most of the biomass for heating and power production being planned to be sourced domestically[34] and therefore it is subject to national and EU environmental and forest policies and regulations. According to existing scientific understanding, most of the biomass supply chains currently used in the EU provide significant carbon emission reductions compared to fossil fuels. Only a limited number of biomass feedstocks may have uncertain or potentially negative climate benefits. However, the comparisons depend partly on the methodological assumptions made in the relevant studies. The Commission is currently reviewing the scientific basis and possible safeguards and will take this into account in the above mentioned analysis.

2.2.4.4. Energy efficiency policy

As regards energy efficiency, the Energy Efficiency Directive (EED) requires the Commission to carry out in 2014 a detailed review of the 2020 approach. Some tentative conclusions can already be drawn today.

Despite the 20% energy savings target not being legally binding on Member States, it has provided significant momentum to the efforts to reduce energy consumption and intensity, and facilitated agreement on strong measures, in particular the EED.

Moreover, energy efficiency standards for a wide range of appliances and equipment have been agreed at the EU level and will lead to important energy savings. The estimated impact of the adopted ecodesign and labelling measures in terms of energy savings represents around 90 Mtoe in 2020. EU Regulations relating to CO2 and cars and CO2 and vans have led to an accelerated improvement of fuel efficiency of new cars and vans. CO2 emissions of new cars were reduced from 172 g per kilometre in 2000 to 136 g per kilometre in 2011.

The revised Energy Performance of Buildings Directive (EPBD) will ensure Member States apply minimum energy performance requirements for new buildings, but delays in implementation are a risk, which could seriously impact the extent to which the EU takes full advantage of the cost-effective savings potential in the buildings sector (equivalent to 65 Mtoe by 2020). The proper and timely implementation of the EPBD could contribute significantly to improvements in the standard of living of European citizens.

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33 Proposal for a directive amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable source, COM(2012)595

34 Commission own calculations on the basis of data from National Renewable Energy Action Plans (NREAPs), Eurostat and IEA 2010 (Global Wood Pellet Industry Market and Trade Study)

The Energy Efficiency Directive complements these regulations and directives. It is too soon to assess its functioning as it has not yet been transposed by Member States, but a first assessment will be made in the abovementioned 2014 review.

With regard to overall progress in the EU in terms of energy savings, the economic crisis has fully demonstrated the strong correlation between energy consumption and economic activity, especially in industry. This has led to concerns that an absolute savings target is not flexible enough to reflect the underlying dynamics of the EU economy (see also further details in Annex 7.4).

2.2.4.5. Energy prices and international developments in energy markets

While the gradual completion of the internal energy market has helped to keep EU wholesale electricity and gas prices in check, end-user prices for many business and households have increased significantly in both nominal and real terms over the last decade. The EU Reference Scenario 2013 suggests that this trend will continue also in the absence of new policies for a variety of reasons (see Section 2.3 and Annex 7.1) below.

Developments in international markets and exploitation of unconventional hydrocarbons has led to an increasing divergence of prices, most notably for natural gas in the EU compared to the USA where shale gas is now an increasingly important energy source and is considered by industrial stakeholders to be positively contributing to the US economy's competitive position. A the beginning of 2012, industry gas prices were some four times lower in the USA than in Europe, but the price differential has decreased over 2013 primarily due to due to higher US prices. Natural gas prices in the US may further increase as the cheapest shale gas basins are depleted. Shale gas can also impact electricity prices through lower costs of input fuels.

In comparison, average end-user electricity prices for EU industry are about twice that in the US[35] and substantially higher than those in many other OECD economies (notable is the exception of Japan where prices are higher than the EU average) and many major developing economies. Between 2005 and 2012, European industry experienced electricity price increases of 38% on average in real terms whereas the corresponding figure was -4% for the US and +16% for Japan[36]. However, the energy intensity of industry is substantially lower in the EU than in the US. Moreover, EU industries improved their energy intensity by 19% between 2001 and 2011 while over the same period the US industry improved it by only 9%[37].

This trend is driven by many factors other than the EU's climate and energy policies (for such impacts, see Annex 7.1). According to empirical estimates, fossil fuel prices still remain key drivers of electricity and natural gas end-user prices. Member State decisions on network tariffs, levies and taxes also have a significant impact on end user prices. These factors must be taken into account when designing new policies at EU and Member State level.

However, market opening and competition appear to have significant downward effects on prices for both households and industrial consumers. In the natural gas market, high import dependence and low diversification of imports, together with market failures can significantly contribute to increasing end-user prices. Taxes, tariffs and levies can also have an important impact. In the electricity market, support to less mature renewables technologies can result in higher electricity prices for both industry and household segments. Furthermore, in some

[35] International Energy Agency, Quarterly Statistics, 2nd quarter 2012. US prices not including tax.

[36] IEA: index 2005 = 100, Energy prices and taxes, Quarterly Statistics, 4th quarter 2012. European data relates to OECD members only

[37] Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission.

Member States, the burden has not been evenly shared across consumer segments, with exemptions for some industries and a correspondingly higher burden on households [38].

A dedicated study on EU energy prices and costs, including an international comparison, has been undertaken in parallel to the preparations of the 2030 framework; responding to a request from the European Council on 22 May 2013.

2.2.5. Interaction between headline targets and instruments

As foreseen already when the 2020 package was prepared and adopted, there is clearly an interaction between the headline targets.

First, measures to promote energy efficiency and renewable energy generally contribute to reductions in GHG emissions. The cost of reducing GHG emissions through such measures can be substantially different than the marginal cost of reducing emissions required to reach the cap in the ETS sector (reflected by the ETS price) but at the same time delivering additional benefits beyond GHG reductions, for instance in terms of synergies with resource efficiency. Such measures can also address innovation-related market failures for the energy transition. Specific efficiency measures addressing non-price barriers such as split incentives, high private discount rates, limited access to finance or imperfect information can be considered complementary to carbon pricing. Specific measures to promote renewable electricity or lower electricity consumption can be expected to lower the ETS carbon price. This has been confirmed by recent econometric analysis[39].

However, the impact of the achievement of the renewables target was taken into account in the design of the climate and energy package, with 2020 carbon prices at that time being projected lower due to the achievement of an ambitious RES target, but still projected to be well above current price levels. This lower than expected ETS price and the current surplus of allowances is largely driven by other factors such as the impacts on demand from the economic crisis and the increasing inflow of international credits in the system.

Second, measures to reduce GHG emissions (both at EU and national level) can in principle incentivise both renewables development and energy savings in and outside the ETS sectors. This said, ETS prices would have to be at significantly higher levels than those experienced over the last few years in order to have a substantial impact. In addition, the ETS price alone is not sufficient to provide incentives for developing innovative low carbon solutions and related infrastructures that are needed for the energy transition. Indications are that national measure such as energy and CO2 taxation have had a more tangible impact on energy consumption than the ETS to date.

Third, energy savings help to ensure progress towards higher shares of renewables, as lower energy consumption means a lower denominator in the ratio between consumption of renewables and gross final energy consumption and therefore a higher renewables share even without more renewables consumption. Reversely, non-thermal renewable energy typically has much lower transformation losses than conventional energy sources, lowering the primary energy consumption for any given final energy consumption. Higher shares of renewable energy can therefore help to make progress towards the energy savings target, as the target relates to primary energy consumption.

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[38] Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission.

[39] Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission.

A more detailed analysis of these interactions - as well as the lessons learnt from other aspects of the 2020 framework – can be found in Annex 7.4.

2.3. Evolution under current policies

2.3.1. The Reference Scenario

The EU Reference Scenario 2013 explores the consequences of current trends, including full implementation of policies adopted by late spring 2012. The Reference scenario has been developed through modelling with PRIMES, GAINS and other related models and benefited from the comments of Member States experts.

Key assumptions for the new EU Reference Scenario (see Annex 7.1 for details)

- GDP and population growth projections until 2050 are considered as given and mirror the joint work of DG ECFIN and the Economic Policy Committee. Recovering from the crisis (reflected by only 0.9% pa GDP growth in 2005-2010), EU 28 GDP is expected to rise 1.5% pa from 2010 to 2020, 1.6% in 2020-30 and 1.4% pa thereafter through 2050.
- Fossil fuel import prices are projected with a dedicated world energy system modelling exercise. They are all projected to increase by 50% or more in the period 2010-2030, most notably in the period 2010-2020. The oil price is projected to reach 121 $/barrel in 2030 and 143 $ in 2050 in constant 2010 prices. Gas prices are projected to rise strongly in the short term but decouple from oil prices somewhat after 2030. This price pattern reflects the fact that in 2010 prices were relatively low due the economic crisis. Moreover, the price projections assume no comprehensive global climate action that would contain price increases.
- Technology costs assumptions are based on extensive literature review and have additionally been checked by the Commission Services, notably the Joint Research Centre. They are dealt with in great detail (e.g. over 100 different technologies and their vintages for power generation). Technology costs and performance are assumed to improve over time, the pace depending on the maturity of individual technologies.

Key policies included in the reference scenario

- EU ETS Directive with the annual linear reduction factor of 1.74% continuing also post-2020.
- The Renewable Energy Directive (Directive 2009/28/EC): achievement of the legally binding national 2020 targets and the transport sub-targets, taking account of National Renewables Action Plans. RES subsidies are assumed to decline after 2020 – according to the information provided by the Member States while generic policies facilitating RES penetration are assumed to continue.
- Implementation of the Energy Efficiency Directive (Directive 2001/27/EU): The implementation of the Directive is modelled in significant detail (including notably the Energy Savings Obligation but also the presence of Energy Service Companies, public procurement provisions and other elements) but rather in conservative manner (since for the energy savings obligations there are several alternative measures possible), leading overall to energy savings of -17% in 2020 compared to the relevant baseline.
- GHG Effort Sharing Decision (Decision No 406/2009/EC) including achievement of the legally binding 2020 targets for non-ETS emissions at aggregated EU level, assuming use of transfer provisions between Member States.

- CO_2 standards for cars and vans regulations (Regulation No 443/2009 and No 510/2011). CO_2 standards for cars are assumed to be 95gCO_2/km as of 2020 and for vans 147gCO_2/km in line with current legislation. Standards are assumed constant after 2020.
- Fuel Quality Directive (Directive 2009/30/EC)
- Eco-design Framework Directive (Directive 2009/125/EC) and related Commission Regulations
- Energy Performance of Buildings Directive (Directive 2010/31/EU),
- the Grid expansion according to the latest 10 Year Development Plan from ENTSO-E
- Implementation of the F-Gas regulation (Regulation No. 2006/842/EC) and Landfill Directive (Directive 99/31/EC)
- Member States' specific plans on nuclear bans, phase-outs or expansions.
- Relevant national policies.

See Annex 7.1 for a comprehensive overview of these policies and assumptions.

The resulting projections show a decline in total GHG emissions[40] of 24% in 2020, 32 % in 2030 and 44 % in 2050 relative to 1990. The share of renewable energy would increase to respectively 21%, 24% and 29% in 2020, 2030 and 2050. Energy savings would continue to marginally increase up to 2035 but would then marginally reverse afterwards.

The EU would fall short of the milestone for 2030 of 40% domestic GHG emission reductions, despite a strong decoupling of energy consumption from economic growth and a major restructuring of the energy system towards renewable energy and maintaining a significant nuclear contribution, resulting in a reduction of energy related CO2 emissions by 31% compared to 1990.

With full implementation of current policies, the surplus in the ETS is projected to further increase to over 2.5 billion allowances by 2020. Between 2020 and 2050 the surplus in the ETS only gradually decrease due to longer term effects of present energy policies and the ETS price effects from the continuation of the linear factor of 1.74% per year after 2020. Consequently, ETS emissions are projected to fall by 36% compared to 2005, whereas according to the Low Carbon Economy Roadmap a cost-effective contribution of the ETS to the overall -40% GHG milestone would be around -45% compared to 2005 (ranging from -43% to -48%). Non-ETS emissions are projected to decrease by 20% between 2005 and 2030, mainly thanks to the continued impact of energy efficiency policies. This would be less than the cost effective reduction of around 30% (ranging from -24 to -36%) required to reach the overall -40% GHG milestone.

Analysis for the Low carbon economy roadmap also indicated that delaying efforts to reduce emissions post 2030 increases costs over time[41]. This indicates the need for additional policies addressing notably the period until 2030.

[40] These projections exclude emissions and absorptions from Land Use, Land Use Change and Forestry.
[41] SEC(2011)288, Section 5.2.4

2.3.2. *The EU's medium-to long-term security of energy supplies remains an issue*

In 2011, energy import dependence stood at 54%, with imports to an important extent coming from geopolitically instable regions. Thanks to strong renewables penetration, which counteracts the substantial decline of indigenous fossil fuel production, import dependence increases more slowly than projected in earlier analyses undertaken before the adoption of the climate/energy package. However, import dependence might still rise, reaching 55% in 2030 and 57% in 2050, despite the slight decline of total net energy imports, which decrease by 4% from 957 Mtoe 2010 to 921 Mtoe in 2030 not least due to expected significant increases in energy efficiency, translating to a downward trend in overall energy consumption. In the long term (2050), energy imports return to current levels. Energy imports continue to be dominated by oil and gas, for which geopolitical stability and diversification issues are most flagrant. Oil imports decline by only 7% by 2030 and gas imports, for which many Member States are dependent on a very limited number of supply countries and routes (with corresponding impacts on pricing), continue rising (5% between 2010 and 2030). Strongly declining net solid imports and rising biomass imports largely neutralise each other.

In spite of some increase in biomass imports, it is notably the penetration of RES that helps contain external energy dependence. RES also contribute to reducing the external energy bill of the EU. The Reference scenario also demonstrates the positive impact of energy savings / efficiency on containing import dependence for fossil fuels and the external energy bill. But fossil fuel import prices[42] are assumed to continue to increase from 2010 to 2030 for oil from 80 $ per boe to 121 $ (60€ to 93€), for gas from 38 € per boe to 65 € and for coal from 16€ per boe to 24€. Consequently the EU would be facing increasing outflows of expenditure for purchasing fossil fuels. The external fossil fuel bill of the EU would be rising in constant prices by around 50% from 2010 to 2030 and exceeds 2010 levels by around 80% in 2050, reaching around 500 billion € and 600 billion € (in 2010 prices) in 2030 and 2050, respectively. This, together with significant uncertainties associated with the potential of unconventional fossil fuel resources in the EU, suggests that present policies will lead to an EU economy more prone to experiences of high and volatile international energy prices in the future. This is of particular concern to energy intensive industries, which are currently confronted with competition from the US which benefits from much lower gas prices than the EU. Increase and diversification of supply routes can increase competitive pricing of fossil fuels, in particular for gas.

2.3.3. *Ensuring competitiveness with increasing energy costs*

Total energy system costs increase with 34.6% in the period 2010-2020, to reach around € 2112 billion in 2020. After 2020 the growth slows down, growing with only 10.7% up to 2030 reaching € 2338 billion. Compared to GDP, energy system costs amounted to 12.8% in 2010, and are projected to reach a peak in 2020 at 14.8%, falling thereafter to 14.0% in 2030 and to below 2010 levels (12.3%) by 2050 (see cost decomposition in Table 1).

Energy system costs used here is a wide metric capturing all costs related to investments for energy using equipment or investment helping to reduce energy consumption (direct energy efficiency investment) as well as fuel costs for the production, distribution and consumptions of energy economy wide including costs for energy imports. They represent therefore are relatively large ratio to GDP in the modelling[43].

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42 In constant €2010 prices.

43 It should be noted that this ratio to GDP is not a share in GDP, since large parts of the numerator (energy imports are not part of the denominator (GDP). Total system costs for the entire energy system include capital costs (for energy installations such as power plants and energy infrastructure, energy

A primary reason energy system costs increase is that a growing EU GDP, increasing by 35% over the period 2010-2030, demands ever more of useful energy services and this is met through increased energy consumption to the extent that it is not moderated/avoided through improved energy efficiency. Therefore and because of greater affordability with rising GDP, energy system costs need to be compared with GDP, resulting in a much more limited cost impact expressed per unit of GDP.

Moreover, rising energy system costs are also due to the need to replace ageing infrastructure and equipment to meet demand. Due to energy and climate policies implemented in the Reference as well as increasing fossil fuel prices, these investments are directed more and more towards efficient or carbon low technologies, which increase upfront investment costs but reduce fuel costs. The overall impact on costs of this combined set of drivers is estimated by the modelling of the Reference Scenario.

Overall this leads to increased investments both on the demand side (e.g. building insulation, replacing equipment with more efficient appliances) and on the supply side (refurbishment and new investments in power generation and transmission). Costs related to investments in the power sector, energy and transport equipment and direct efficiency investment such as thermal insulation explain around 60% of the total energy system cost increases until 2020.

High investments made in efficient production and demand technologies result in a slight decrease in final energy use in the EU in the period 2010-2030, in the context of an expanding economy, with at the same time a reduction of gross energy consumption by 9%.

Increasing fuel costs is the other important contributor to increasing system costs in Reference, mainly due to increasing prices for fossil fuels themselves. While investments in energy efficiency, renewables and to a small extent nuclear reduce fossil fuel quantities consumed in the period 2010-2020 by 11%, increasing fossil fuel prices (coal, oil and gas import prices in euro) are assumed to increase with respectively 41%, 48% and 62% from the crisis level of 2010 in the decade up to 2020) cause total costs for fossil fuels themselves by around 20%. This translates into notably higher fuel and electricity prices for end consumers and contributes significantly to increased system costs[44].

If the price of fossil fuels themselves would have been assumed not to increase after 2010 while keeping investments and fuel consumption as in Reference, than system costs as a % of GDP would only increase to 13.6% by 2020 and reduce back to 12.9% by 2030, or almost back to 2010 levels of 12.8%.

Fuel cost savings become more visible in later years, with the share of fuel costs, including those incurred in the electricity sector falling from 57% in 2010 to 45% in 2030 and 40% in 2050.

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. 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. They do not include any disutility costs associated with changed behaviour, nor the cost related to auctioning of allowances.

44 Diesel prices for private transport users increase 20 % from 2010 to 2020 and rise thereafter almost 4% per decade up to 2050; mainly driven by increasing oil import prices. Oil and gas prices for heating increase by 38% respectively 47% from 2010 to 2020. Heating oil prices continue to rise significantly thereafter (over 5% per decade up to 2050), while gas prices for households remain more or less at 2020 levels, mainly driven by the trends in oil and gas import prices, which see a decoupling of both prices only in the longer term..

ETS auction payments are already included in electricity and fuel purchase costs. They are deducted for the calculation of total system costs as the corresponding revenues raised and recycled back to the economy is not an extra cost from a societal perspective. Additional climate mitigation costs not related to energy only occur after 2030, reflecting mainly investments in applying CCS to industrial processes which become economic with the rising carbon prices in the reference.

Overall, there is a shift in the cost of energy from operational costs, notably fuel costs, to capital costs. Investment are triggered through a combination of the need to replace ageing equipment and to install more efficient equipment due to the impact of higher energy prices as well as the implementation of agreed legislation.

In assessing economic impacts it is important to note that higher capital expenditure creates income and employment in the EU for suppliers of low carbon and energy efficient technologies provided that the industrial leadership that the EU has enjoyed so far on such technologies is maintained, rather than using financial resources for paying for energy imports.

Table 1: Composition and drivers of system costs (ratio to GDP of individual cost components and total amount of energy system costs)

Composition of system costs	**2010**	**2020**	**2030**	**2050**	***% of total system costs***		***% of total cost increase***	
					2010	***2030***	***2010-2020***	***2010-2030***
Electricity costs	3,6%	4,1%	3,8%	3,3%	28%	27%	27%	25%
Of which fuel costs	1.1%	1.1%	0.9%	0.7%	8%	6.5%	4%	3%
Of which other costs	2.5%	3.1%	2.9%	2.6%	20%	20.5%	23%	22%
Fuel purchases (other than electricity)	6,2%	6,4%	5,4%	4,4%	48%	39%	28%	19%
Energy equipment (except for electricity)	2,4%	2,8%	3,2%	3,1%	19%	22%	19%	29%
Transport equipment (energy related part, incremental)	0,6%	1,2%	1,7%	1,7%	5%	12%	17%	27%
Direct efficiency investment cost (incremental)	0,0%	0,4%	0,3%	0,1%	0%	2%	10%	6%
Deducted ETS auction revenues	0,0%	-0,1%	-0,3%	-0,4%	0%	-2%	-2%	-6%
Non-energy related mitigation costs	0,0%	0,0%	0,0%	0,1%	0%	0%	0%	0%
Total (as % GDP)	12,8%	14,8%	14,0%	12,3%	100%	100%	100%	100%
Total (bn €)	1569	2112	2338	2700				

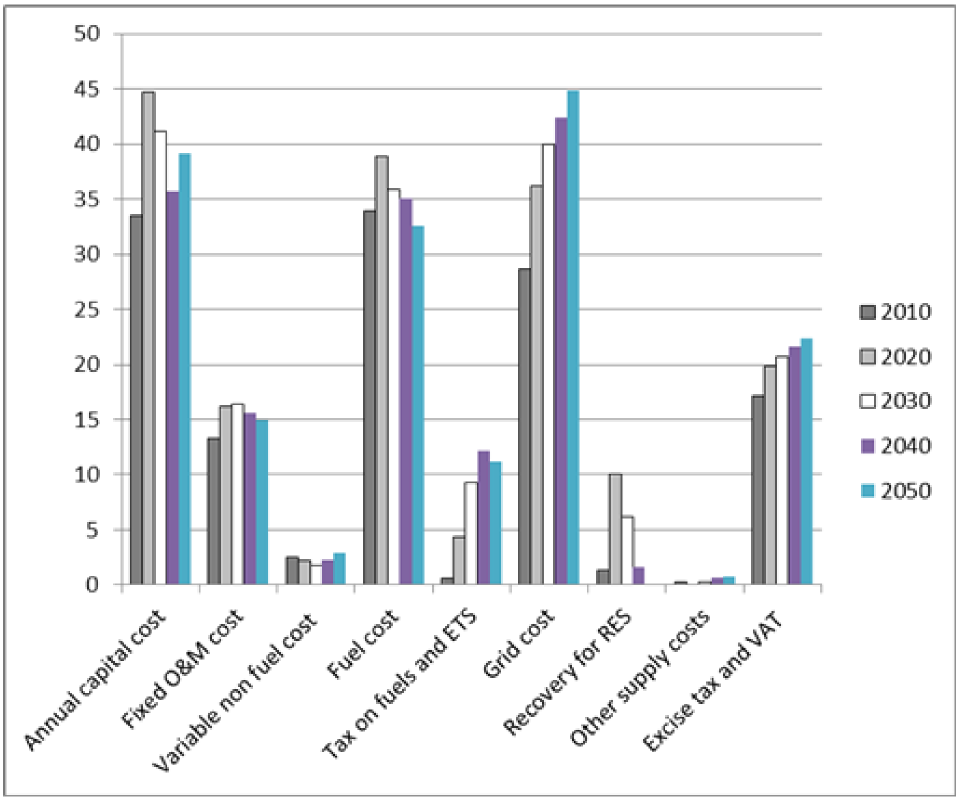
Source: PRIMES

Average electricity prices[45] are projected to increase by 31 percent in real terms between 2010 and 2030 in the Reference Scenario, from 131 to 172 €/Mwh (assuming in the modelling that all incurred costs are fully recovered via prices). The entire price increase is projected to

[45] Average price over all consumer types, including final consumers and energy branch.

happen up to 2020, while prices thereafter remain relatively stable up to 2050. The three largest components of average electricity prices are and are projected to remain capital costs, fuel costs and grid and other supply costs. The various components of electricity generation costs and prices up to 2050 are presented in Figure 1 below.

Figure 1: Average electricity generation costs and prices in the Reference Scenario (Euro'10 per MWh)



Source: PRIMES 2013

Generally speaking, the projected price increase is due to three factors: the projected price increase of fossil fuels, strong investment requirements to modernise energy infrastructure (generation as well as transmission and distribution), and current energy and climate policies on EU and Member State[46] level. For each of the categories there are several drivers.

EU fossil fuel prices are projected to increase strongly. Despite this, the fuel *cost* increase is contained in the short term only contributing with 12% of the price increase up to 2020 due to a decrease in fossil fuel consumption by 16% in the power sector. After 2020 fuel costs decrease due to renewables, energy efficiency and fuel switching.

Capital costs for power generation are projected to increase notably by 2020 in large part because of replacement of obsolete plants and significant renewables penetration with lower load factors. Also costs for additional back up capacity and after 2030 CCS investment increase. In total, capital costs associated with increased investments contribute 27% of the price increase up to 2020, but reduce to 19% of the price increase by 2030, further decreasing afterwards.

[46] The Reference Scenario considers Member States' National Renewable Action Plans which in some cases in 2020 go beyond what would be necessary to comply with EU energy and climate policy.

Grid and other supply costs are projected to increase also, in the short term for example due to the investment envisaged in the ENTSO-E ten year plan, and in the longer term for investment for off-shore wind power plant connections and grid extensions needed for cost-effective deployment of renewables and more decentralised supply, notably from renewables and CHP. The projected grid cost increase is also partly due to the need for smarter infrastructure to enable e.g. demand response. Grid and other supply costs represent 18% of the projected price increase by 2020 and 28% by 2030.

Renewables support via feed-in tariffs or similar measures is projected to peak in 2020 contributing to 21% of the projected cost increases until then, and thereafter gradually phase out in the longer run, except for very innovative technologies such as wave and tidal energy (this cost component is referred to RES recovery in the graph above).

Increasing carbon prices contribute gradually to increasing electricity prices up to 2040 after which the impact decreases slightly. With allowances prices at €11 and still largely freely allocated in 2010 they increase to € 35 with full auctioning in the power sector in 2030, contributing to 9% of the price increase up to 2020, and 20% by 2030.

The remainder of the price increase (some 10%) is due to fixed operation and maintenance costs as well as taxes. While taxes are projected to remain a significant part of future electricity prices, there relative share is expected to stay roughly the same up to 2030.

To the extent that these price increases are not fully compensated by fuel savings (e.g. from energy efficiency investment) and income increases, the resulting energy costs cause concerns with regard to the affordability of energy of vulnerable households and industries exposed to international competition. However electricity prices for industry increase less than for other sectors: 22% between 2010 and 2020. After 2020 prices for industry decrease significantly, so that total industrial electricity price increase 2010 to 2030 is limited to 10%.

2.3.4. Risk of delayed investments and high carbon lock in

Long investment cycles in particular in the energy, industrial and buildings sectors mean that most infrastructure and other capacity investments undertaken in the near term will still be in place in 2030 and beyond. As pointed out by stakeholders (such as the power sector), investors need a stable policy framework which corresponds to this time horizon. The EU's energy system needs significant investments to ensure its medium to long term viability and sustainability. This shift towards increased investments already starts in the projection in the EU Reference Scenario 2013, but the low-carbon economy and energy roadmaps indicated the need for an even larger shift.

Current policies do not ensure that these additional investments take place, and with projected ETS carbon prices of 10 €/tCO2 in 2020 and 14€/tCO2 in 2025, the large surplus in the ETS and no continuation of non-ETS targets, there may be even a significant risk that the investments required under current trends and policies do not occur if renewables or energy efficiency policies are not fully implemented and lead to a lock-in of high-carbon technologies and infrastructures increasing costs to achieve the longer term milestones of the low carbon roadmap[47].

In the projections of the EU Reference Scenario 2013, such risks are to some extent mitigated by the expected later increases in the ETS carbon price from 35 € in 2030 to 100 € in 2050, which would for example be high enough to trigger significant Carbon Capture and Storage (CCS) investment from 2040 onwards. While the CCS share in power generation reaches only

[47] See also IEA WEO 2012.

0.5% in 2030, it rises to 3.4% in 2040 and 6.9% in 2050. However, it is unclear to which extent investment decisions in practice take into account such a long time perspective with current low carbon prices and such a large surplus of allowances.

For more information regarding the EU Reference Scenario 2013, see Annex 7.1.

2.4. What is the problem the 2030 framework should contribute to address?

2.4.1. General problems

The medium to long term challenges in the area of climate and energy are complex and numerous. In consideration of the general objectives of EU action in these areas and the responses to the public consultation launched by the Green Paper (see Section 1.2 and Annex 7.5 for details), the main *general problems* the 2030 framework should *contribute* to addressing can be summarised as follows:

(1) The EU's present policies are not sufficient to reach the EU's long term climate objective in the context of necessary reductions by developed countries as a group to reduce GHG emissions by 80-95% in 2050 compared to 1990. In the context of international climate negotiations, the EU will need to come forward with a position, including its own ambition level ahead of 2015. This challenge is therefore interlinked with international climate change mitigation efforts.

(2) The EU's medium-to long-term security of energy supplies remain an issue due to a persisting energy import dependence on sometimes politically instable regions and reliance on fossil fuel usage which in the long term will be incompatible with the EU's climate objectives unless CCS would bring a solution to this dimension. Gradual depletion of the EU's conventional fossil fuel resources together with expectation of continued high and volatile fossil fuel import prices puts pressure on parts of EU industry.

(3) The EU's energy system needs significant investments in energy infrastructure and electricity generation to ensure its medium to long term viability and sustainability Long investment cycles mean that infrastructure funded in the near term will still be in place several decades from now. There are also other non-economic barriers and market failures e.g. with regard to renewables and energy efficiency. Authorities, regulators, energy system operators, investors and manufacturers of innovative low carbon technology therefore need urgently a clear and coherent climate and energy policy framework that creates predictability and reduced regulatory risk.

(4) Current policies aiming at achieving a more sustainable economy and energy system, which may reduce costs and avoid damages in the longer run, are expected to contribute to short to medium term cost increases, which give rise to concerns about the affordability of energy of households and the competitiveness of EU energy prices in an international context. Future policies must limit these concerns as much as possible. Moreover, different policies underpinning the energy and climate targets for 2020 need to be mutually supportive and limit as much as possible inefficiencies.

The abovementioned challenges are intrinsically interlinked with each other and with challenges at the international level, not the least in relation to international climate change mitigation efforts, increasing international competition for energy resources on global markets as global energy consumption increases, and energy price developments in some other major economies that impacts the competitiveness of in particular the EU's energy intensive industry sectors.

2.4.2. *Specific problem for this policy initiative*

As current projections (see Section 2.3) suggest that the EU is not on track to meet these challenges on the basis of already agreed policies and expected market developments, it is clear that policy initiatives are needed to ensure that the EU is on track towards meeting the fundamental objectives of EU climate and energy policies in the medium to long run. The unsatisfactory projected developments under the reference scenario are – generally speaking – due to a combination of two factors:

- There are no sufficiently clear EU climate and energy objectives for the period post 2020, and no comprehensive regulatory framework in place to ensure that the transformation towards a competitive, secure and sustainably energy system and economy is on par with long term objectives.
- In absence of such objectives and regulatory framework, the energy markets and investment decisions made on a commercial basis are under current projections *not* expected to lead to the necessary transition.

In this context, it should also be recalled that the reference scenario itself assumes that all policies already agreed to at the EU and national level will be respected and adhered to, which still will require continued additional efforts. For example, some Member States are not on track to meet their obligations under the Effort Sharing Decision, but EU-wide the non ETS target is expected to be overachieved. On renewable energy, so far the EU has made satisfactory progress towards the renewable target, but many Member States must make additional efforts to meet their RES target. It is yet to be seen how Member States implement the Energy Efficiency Directive.

The 2050 Roadmaps illustrate the key options and pathways towards a competitive, secure and sustainable energy system and economy in a 2050 perspective, but are in themselves not setting the adequate objectives and policies for the period after 2020. More concrete objectives are needed to steer policy and investment over the next decades. In this context, the Low Carbon Economy Roadmap presents a 40% GHG reduction milestone in 2030, and the Energy Roadmap 2050 states that "*the next step is to define the 2030 policy framework, reasonably foreseeable and the focus of most current investors*".

Therefore, the problem this specific initiative aims to address is the lack of objectives or definite policy framework in place to steer climate and energy policies in a 2030 perspective.

2.4.3. *Current challenges serving as guiding principles*

As explained in Section 3 below, the purpose of the policy initiative underpinned by this Impact analysis is primarily to propose target(s) and objectives for climate and energy policies in a 2030 perspectives, and to provide the general direction of policy development to meet these objectives. Already at this stage, but also when preparing future specific proposals for implementation (outside the scope of this policy initiative), the following principles should be respected, building on concerns and challenges under the current policy framework:

- Climate and energy objectives are met in a cost-effective way through policies that take into account the affordability of energy, competitiveness and the importance of the internal market in energy.
- Policies are complementary and are internally coherent with each other
- Policies deliver a strong investment signal without compromising the competitiveness of business and flexibility for Member States.

- Climate action is encouraged internationally and able to adapt to changing circumstances.
- Concerns about the risk of future carbon leakage are addressed in case EU efforts are not matched by third country efforts.
- The different capacities and circumstances of Member States and consumer groups are taken into account, without distorting competition or market integration.
- The EU's medium- to long-term security of energy supplies is addressed.

Striking the balance between these principles will remain challenging due to the multiple interactions. Examples include:

- Both renewables policies and energy efficiency policies can have a tangible impact on security of energy supplies and competitiveness due to reduced exposure to volatile and sometimes unreliable fossil fuel supply. At the same time, such policies can have a reducing impact on the price signal in the ETS, and pose challenges in terms of ensuring coherence with climate policies.
- Meeting climate policies in a cost effective way may have less positive impacts on security of supply (at least import dependency) due to e.g. abatement cost advantages of fuel switching compared to domestic options for low-carbon energy sources.
- Meeting energy objectives (such as for renewables) in a cost effective way on the aggregate EU level may lead to disproportionate impacts on the relatively poorer Member States. At the same time, internal market rules as well as subsidiarity need to be respected and taken into account in policy design.

A preliminary assessment of the means of addressing these and other challenges is made in Section 5, on the basis of which more detailed assessments will be carried out when preparing future legislative proposals.

2.4.4. Stakeholders views regarding the challenges related to targets and instruments and their interactions

Stakeholders across the board typically have expressed strong support for the development of a common European energy policy, and are against national policies that fragment the market. The EU ETS and EU legislation on the Internal Energy Market are seen as two central aspects for future EU climate and energy policies. There is a broad agreement among stakeholders and Member States that the EU should agree on a 2030 target for GHG emissions, while there are diverging views on what the appropriate ambition level should be and how to relate to international developments in the climate change area.

Regarding interaction of targets and instruments, general business organizations, energy intensive companies and utilities typically argue that what they consider "overlapping" targets for energy efficiency, RES and GHG distort the effectiveness of the policies and leading to increased costs, with a preference towards a single GHG target approach. NGOs and many sectoral industry federations, such as technology providers, energy efficiency and renewables industries instead typically argue that a three-target approach is preferable as they complement each other and ensure broader progress in the energy sector. Renewable energy companies are for a Renewables target while recognising that the functioning RES support schemes needs to be improved. Member Stats typically recognise the important role of both renewables and energy efficiency, but there are different views on whether the necessary progress in a 2030 perspective would necessitate dedicated targets.

2.5. Who is affected

Climate and energy policies affect everyone, citizens and companies alike. Whereas the impacts on the energy sector itself, energy intensive sectors and major GHG emitting sectors currently not covered by the ETS such as agriculture and transport[48] are obvious, the 2050 Roadmaps (supported by the quantitative analysis in later Sections of this IA) suggest that total investment needs actually are highest in end use sectors such as transport and housing, often related to the need for more energy efficient technologies. Therefore this transition of the energy system towards a low carbon economy will affect all Europeans and all sectors of the economy.

Member States, including regions and local communities, will also be affected. In addition, there is a third country dimension, in particular vis-à-vis energy supply countries and the relation with international climate negotiations.

2.6. The EU's right to act and EU added-value

Climate change is a trans-boundary problem. Coordination of climate action both at global and European level is therefore necessary and EU action is justified on grounds of subsidiarity. Articles 191 to 193 of the TFEU confirm and further specify EU competencies in the area of climate change. Many of the policy options have an important internal market dimension and many of the required investments and infrastructures have an important European dimension. The objectives can therefore be better achieved by an EU framework for action.

As regards energy, Member States are increasingly interdependent on each other in ensuring secure, sustainable and competitive access to energy. Moreover, the cost of the transition of the energy system will be lower if Member States cooperate in meeting jointly established targets. For these reasons, the energy challenges of the future are clearly on an EU (if not global) scale, and could therefore not be addressed effectively and efficiently through Member State measures alone. Article 194 TFEU specifies the EU's right to act in the energy domain.

However, the role of Member State action within this framework will remain crucial and the responsibility for continued progress up to 2030 is shared, as was demonstrated in the climate and energy package for 2020. All future EU action in this regard will respect both Art. 192 and 194 of the TFEU. The importance of the principle of subsidiarity becomes especially important when specific policies to meet the overall objectives for 2030 are formulated. Such policies must strike the balance between the need to fully acknowledge differences between Member States (including regional and local aspects) on the one hand, and the need to ensure a level playing-field, cost-efficiency and undistorted competition and markets on the EU level, on another hand.

The proportionality of the proposed framework is ensured by striking the balance between objectives of competitiveness, security of supply and sustainability. The proportionality of the initiative should also consider the long term benefits of the proposed course of action up to 2030 (including the prospects of contributing to energy security, global climate change mitigation and sustainable growth), and not only be based on short to medium term impacts. This said, it is expected that the policy initiative will take into account the significant efforts

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[48] While these sectors will be more affected by the specific policies put in place than the overall setting of 2030 targets, the general framework has a significant indirect impact as it sets the relative share of GHG emission reductions to be achieved by each major sector of the economy.

needed already under already agreed policies, the economic reality in the EU, and potential adverse impacts on specific industries and consumer groups.

3. Scope and Objectives

3.1. Scope and context of the initiative

3.1.1. Scope

The policy initiative underpinned by this Impact Assessment is only the first step to a comprehensive and detailed solution to energy and climate challenges in a 2030 perspective. As such, the policy initiative focuses on the broad objectives of the 2030 Framework and some key implementation aspects; in particular the issue of climate and energy targets in a 2030 perspective and how they interact. It is also expected to propose the *general direction of policy development* in specific areas; such as internal energy market, supply diversification, the ETS cap, including approach to issues such as the existing large surplus or carbon leakage, and the role of agriculture and transport in the transition towards a more competitive, secure and sustainable energy system and EU economy.

On this basis, the policy options evaluated in this Impact Assessment focus on the target setting as such, and to a lesser extent on other means of ensuring progress towards meeting the abovementioned challenges. This Impact Assessment includes a first assessment of the implementation approach to meet the 2030 objectives for climate and energy policies, but it should be underlined that the specific implementation measures will require further assessments. This would be done in a second step once there is agreement on the general approach to the 2030 framework, through dedicated impact assessments. One concrete policy implementation that is envisaged already now is the proposal for a structural measure to improve the functioning of the ETS which is confronted with a large surplus. This proposal is however supported by a separate Impact Assessment.

3.1.2. Context

The Commission's 2050 Roadmaps published in 2011 (the Low carbon Economy Roadmap, the Energy Roadmap 2050 and the Transport White Paper) illustrate the options and consequences of the transition towards a competitive and secure low carbon economy, energy system and transport sector. These roadmaps are all compatible with the EU's agreed objective to reduce GHG emissions by 80-95% in 2050 compared to 1990, in the context of necessary reductions by developed countries as a group to limit global warming to below 2°C. The Low Carbon Economy Roadmap gives an indication of the cost effective milestones for GHG reductions in the longer term context and the Energy Roadmap indicated the needed change to the energy system in a 2030 perspective[49], but they did not propose specific EU targets or objectives for 2030. Moreover, the scenarios underpinning the Energy Roadmap 2050 were based on the assumption that EU efforts to reduce GHG emissions in line with the 80 to 95% objective would be made in the context of global mitigation efforts.

Given that the EU must be ready to make a strong contribution to an international climate agreement in 2015, it is necessary to urgently establish objectives for EU climate and energy policies in a 2030 perspective that are both in the EU's own interest and that would facilitate a successful conclusion of an international agreement, considering more efforts if a comprehensive and fair international climate agreement is reached. At the same time, and

[49] The assessment of the Energy Roadmap assumed global climate action and thus decreasing fossil fuel prices in-line with this action.

irrespectively of global action to mitigate climate change, the transition of the EU's energy system is necessary to ensure long-term competitiveness and security of energy supplies.

3.2. Objectives

In this context and following from the scope presented in Section 3.1, the objectives of the initiative are:

3.2.1. General objectives

To ensure progress towards:

- A competitive, sustainable and secure EU energy system in the medium to long run;
- The EU's objective to reduce GHG emissions by 80-95% in 2050 compared to 1990, in the context of necessary reductions by developed countries as a group to limit global warming to below 2°C.

3.2.2. Specific objectives

- To provide more predictability and certainty for Member States and investors and reduced regulatory risk as regards the objectives of EU climate and energy policy in a 2030 perspective.
- To agree on the general direction of policies needed to meet climate and energy objectives in in a 2030 perspective.
- To agree on an EU position as regards 2030 GHG reductions in view of the international climate negotiations.

3.2.3. Operational objectives

The operational objectives for a 2030 climate and energy policy framework are to:

- Propose coherent headline target(s) for climate and energy at the EU level to steer climate and energy policy in a 2030 perspective.
- Propose key indicators for the competitiveness of the energy system and security of energy supply, as appropriate associated with aspirational objectives, to keep track of progress over time and get a clear basis for policy response.
- Propose the general direction of the appropriate design of future concrete policies needed to meet 2030 objectives:

The third operational objective must already at this stage consider how future implementation can contribute to equitable effort across the EU; improve the functioning of the internal market; ensure a level playing field; provide appropriate investment signals in the energy sector; contribute to competitive and affordable pricing of energy; diversify indigenous as well as imported energy supplies; and develop measures to prevent the risk of carbon leakage.

3.3. Coherence with other policies

As outlined, the aim of the initiative is to develop a coherent framework for climate and energy policies up to 2030. The work continues the integrated approach pioneered by the climate and energy package and taken up in the Europe 2020 headline targets. It builds on the 2050 Roadmaps developed under the Europe 2020 Resource efficient Europe flagship initiative. Not many other current policies are characterised by a similar long term perspective, which extends beyond the multi-annual financial framework 2014 to 2020. In general, coherence with related other policies is therefore addressed when specific issues are discussed, such as the competitiveness of energy prices and the costs link to industrial policy,

the affordability of energy links to social cohesion, improvements in air quality and the extent of use of biomass link to environmental policies, certain aspects of renewables and efficiency target and policy design related to transport policies, security of energy supply links to external policies, including trade policies etc.

4. POLICY OPTIONS

The 2020 Climate and Energy package introduced mandatory targets for greenhouse gas emissions reduction (-20% in 2020 compared to 1990) and for renewable energy (20% of total final energy consumption and a 10% target of transport fuel consumption in 2020). In addition, a 20 % energy savings target was established (compared to baseline projections made in 2007 for the year 2020). This last target is not legally binding on Member States, but various measures both on the EU and national level have been put in place to contribute to achieving this objective. A central question for the 2030 framework is the extent to which such targets should be defined for 2030, and if so at which level and what should be the accompanying legal and policy measures.

Specifically in the energy sector, reducing GHG emissions requires changing the energy mix towards less carbon intensive energy sources and consuming less energy through more energy efficiency and changes in demand patterns. On the one hand, energy efficiency and renewable energy policies interact with the EU ETS. On the other hand, together with policies to reduce non-CO2 emissions, energy efficiency and renewable targets are also the principal tools to effectively reduce emissions in the non-ETS sectors and to respond to some challenges relating to security of supply and competitiveness. It is therefore important to assess how targets and measures for GHG reductions, energy efficiency and renewable energy interact in a 2030 perspective as well as to assess what their effects will be on a 2050 time horizon.

Hence, the main policy options analysed in this Impact Assessment consist of different combinations of energy and climate targets and to some extent also implementing policies, with sub-options where relevant, with their effects presented in 2030 and 2050. For selected policy options related to the implementation of these targets, a first illustration is given of their impacts. Legislative proposals in this regard would be subject to separate Impact Assessments.

In addition to climate and energy targets for 2030, other indicators or aspirational objectives (if not targets) more directly relating to the competitiveness and security of supply objectives of EU energy policy could be considered in a 2030 perspective. Such indicators and objectives would help to keep track on developments and to provide a good basis for policy initiatives and later a benchmark to measure progress achieved. Such options have not explicitly been subject to the scenario analysis, although the scenarios give guidance on some important aspects, and are instead discussed in a qualitative way in Section 5.2.

4.1. Policy options for headline targets and measures

The responses to the public consultation launched by the Green Paper and the on-going dialogue with Member States, the European parliament and stakeholders make clear that there is a broad agreement around the need for a 2030 targets for GHG reductions, with diverging views on what the appropriate ambition level should be and how to relate to international developments in the climate change area. Views are diverging among both Member States and stakeholders on the need for 2030 targets for the other two areas covered by the 2020 targets, namely renewables and energy efficiency.

Moreover, it is clear from the public consultation that the EU must ensure progress also towards other aspects of EU energy objectives, but few advocate hard targets in this regard (see also Section 4.3 below on these aspects).

4.1.1. Basic policy options for targets and ambition levels

Due to the multitude of possible combinations and ambition levels a selection was necessary when defining the policy options for this Impact Assessment. On the basis of i) the various views expressed in the response to the public consultation, ii) the need to ensure a coherent and compatible combination of targets, policies and levels of ambition, and iii) milestones from the Low Carbon Economy and Energy 2050 Roadmaps, and iv) the responses to the public consultation launched by the Green Paper, the policy options and considered assessed by this Impact Assessment are:

1. A sole GHG target, including elements of supporting renewables and energy efficiency policies:
2. A GHG target combined with explicit (additional to the reference scenario) energy efficiency measures and elements of supporting renewables policies:
3. A GHG target combined with a pre-set renewables target and explicit additional energy efficiency measures:

For each of these options, sub-options considered related to the ambition level of the targets and measures are:

A. GHG targets of between 35 and 45 % (reductions compared to 1990 GHG emissions levels).

B. Pre-set RES targets[50] of 30 and 35% (or no pre-set[51] target) as a share of gross final energy consumption.

C. Different level of ambition (moderate, ambitious and very ambitious) for energy efficiency policies (additional to those already present in the Reference scenario).

Renewables and energy efficiency in the policy options

Without prejudice to the level or sector(s) that a renewables targets could be applied to, the policy options are based on the assumption that such a target would apply to gross final energy consumption, with the aim to identify the differences between scenarios with pre-defined RES targets and scenarios where renewables development would be driven by a GHG target alone. There are no pre-defined sub-targets for sectors such as electricity, heating and cooling, and transport and the RES share in these sectors a result of model optimisation. In case of political preference for other approaches, the underlying analysis thus provides information on what the coherent and appropriate level of e.g. sub-targets for electricity/ heating and cooling/ transport could be.

No explicit energy efficiency target has been considered as a policy option given that the discussion about achieving the 2020 energy efficiency target will only be possible in 2014 when Member States report on the implementation of the EED and given also that the discussions are on-going about the metric which would be best suited for benchmarking the

[50] The Commission proposal on Indirect Land Use Change (ILUC, COM (2012) 595 final) is not reflected in the scenarios and subsequent analysis.

[51] No specific option for a renewables target below 30% has been defined, but a renewables target could in principle be set at a lower level, for instance by formalising the renewables share that is projected to result from a 2030 framework driven by a sole GHG target.

progress in energy efficiency. Instead, the contribution from energy efficiency follows a bottom-up approach by assessing the impacts of specific energy efficiency measures. In addition, the different levels of ambition of energy efficiency policies give indications on their respective impacts.

4.1.2. Scenario analysis to assess policy options for targets and measures

4.1.2.1. General approach

In order to quantitatively assess the impacts of the policy options for targets and ambition level, a series of *scenarios* have been developed, reflecting a comprehensive and consistent set of combinations of options 1 to 3 and their sub-options A to C.

The selected, representative scenarios – illustrating the implications and trade-offs of the policy options presented above – have been generated and analysed (in Section 5) primarily through economic modelling.

Their impacts are compared to the Reference scenario, in order to get a clear and consistent presentation of their costs and benefits. Where appropriate, some numbers are also compared to the current situation.

As explained in detail in Section 2.3 and Annex 7.1, the Reference scenario provides a projection of expected developments under already agreed policies up to 2050.

The assessed scenarios are characterised according to whether they are based on *reference conditions* (i.e. the same conditions as in the Reference scenario where there are no additional climate and energy policies than those already agreed and decarbonisation in 2050 is not achieved) or on the *enabling conditions,* which the analysis supporting the 2050 Energy and Low Carbon Economy Roadmaps demonstrated as essential for the long term transformation.

The scenarios based on reference conditions achieve the respective policy targets for 2030 but are not supposed to achieve after 2030 the necessary additional system changes to achieve a long term GHG reductions in line with the milestones of the Low Carbon Economy Roadmap. Conversely, scenario based on enabling conditions are supposed to continue after 2030 bringing about the necessary system changes to further reduce GHG emissions in-line with the 2050 objectives.

Box 2: Enabling conditions

Enabling conditions stem from an assumption of strong policy commitment to deeply reduce GHG emissions in a 2050 perspective. They are delivered by broad policy efforts that promote innovation and ensure the necessary infrastructure investments occur in due time, as well as specific sectoral policies, which are assumed to remove market failures and barriers to efficient energy consumption, RES penetration and GHG reductions.

In the context of strong GHG reduction commitments and the dedicated polices, the enabling conditions presuppose effective structural changes in all sectors of economy, timely and effective market coordination as well as public acceptance. While these enabling conditions are in particular affecting energy system changes closer to 2050, they already start to have an effect as of 2030. The role of these conditions is to set the framework so that specific policy measures in areas such as energy, industry, transport, agriculture, environment and climate policies can work smoothly in a co-ordinated way for achieving deep GHG reductions in a timely manner, while working towards the other objectives of these sectoral policies, such as competitiveness and energy security. Enabling conditions were underlying the GHG reduction scenarios of the Low Carbon Economy and Energy roadmaps 2050.

The enabling conditions were modelled by altering modelling parameters with respect to those included in the Reference conditions. The enabling conditions are assumptions that act independently of carbon prices/values or economic or regulatory incentives for renewables and energy efficiency. The enabling conditions mainly relate to energy infrastructure development, R&D and innovation, electrification of transport and reduction of energy demand, for which timely market coordination and public acceptance of certain technologies will be prerequisites. These enabling conditions are often itself related to policies. A more detailed description is included in Annex 7.2

Main enabling conditions include:

- Development at large scale of intelligent grids and metering as well as management systems for recharging of car batteries to facilitate demand response in power markets.
- Development of infrastructure to harvest decentralised as well as remote RES for power generation; this is produced by a streamlining of permitting procedures, higher investment, timely availability of technology and appropriate price signal by smart and net metering.
- Development of carbon transportation and storage infrastructure as well as public acceptance of the technology that leads to the faster development of CCS.
- Technological progress enabling mix of hydrogen and bio-gas in gas supply and possibility to use hydrogen-based storage.
- Development of electric vehicles battery technology combined with development of battery recharging infrastructure and public acceptance of electric vehicles leading to transport electrification.
- Accelerated innovation in biofuels in particular enabling strong emission reduction in transport activities for which electrification is not possible.
- Vigorous implementation of the EED, extension and tightening of eco-design and labelling requirements together with slightly higher consumer uptake and slightly faster development of technologies (because economic agents act in anticipation of decarbonisation).
- Vigorous implementation of EPBD - overcoming market barriers to energy efficiency in buildings; renovations continue to be undertaken in an energy efficient manner even if no specific regulatory obligations were implemented at EU level after 2020 - because national energy efficiency policies will be continued and economic agents believe that energy efficient renovated buildings will continue to have a significantly higher value on the real estate market.
- Stronger uptake of heating equipment and of efficient appliances technology in the domestic sector reflecting increased public acceptance and stronger innovation lowering perceived costs.
- The acceptance and adoption of best available techniques in industry and in combustion applications mainly after 2030.
- Facilitated access to finance (access to credit, favourable tax regime, better access to risk guarantees and financing available from Structural Funds and EIB).

Important synergies exist between specific enabling conditions.

It has to be taken into account that the implementation of such enabling conditions is not a given and depends on different assumptions about the commitment of the EU to tackle climate change, improve its energy security and develop a sustainable and competitive energy system. The establishment of a 2030 framework is a concrete step towards establishing such longer term commitment. It will need to be seen to what extent this framework, and the enabling conditions that could come with it, will depend on global efforts compatible with the

internationally agreed objective to limit atmospheric warming to below 2°C in a 2050 perspective.

Scenarios reflecting strong long term EU commitment compatible with 2050 objectives therefore include "enabling conditions" which facilitate the transition, consistent with the Low Carbon Economy Roadmap and the Energy 2050 Roadmap. The enabling conditions supporting such scenarios should be understood as efforts across the economy to ensure that the transition towards a low carbon economy in a 2050 perspective goes smoothly.

As it is not certain that the "enabling conditions" will materialise, some policy scenarios excluding such conditions have also been assessed (i.e. modelled with the same conditions as in the Reference scenario). These are less ambitious scenarios which may achieve significant progress in a 2030 perspective, but do not achieve in the longer term the transformation towards a low carbon economy with the current model setup.

Analysing scenarios with and without enabling conditions can also illustrate the impacts on costs by 2030 and the benefits of implementing such enabling conditions.

A more detailed description is included in Annex 7.2.

4.1.2.2. Scenarios assessed

A large number of scenarios have been analysed, out of which seven, representing a comprehensive sub-set, have been retained for more detailed assessment. Table 2 provides an overview of these seven scenarios (and the reference scenario). The assumed 2030 GHG target and, if applicable, pre-set renewables target follows from the scenario design itself. Between brackets the resulting projected values are given of GHG reductions and RES share for those scenarios that do not pre-set a target, as well as the energy savings achieved.

Table 2: Scenarios to assess main policy options with respect to targets and measures[52]

Scenario	*GHG reduction in 2030 (wrt 1990)*	*RES 2030 (% final En. Cons.)*	*Energy Savings in 2030*[53]
Reference Scenario	*-32.4%*	*24.4%*	*-21.0%*
Reference scenario conditions			
GHG35/EE®	35%	No pre-set target (25.5%)	No pre-set target (-24.4%)
GHG37®	(37%)	No pre-set target (24.7%)	No pre-set target (-22.9%)
GHG40®	40%	No pre-set target (25.5%)	No pre-set target (-24.4%)
Enabling conditions			
GHG40	40%	No pre-set target (26.5%)	No pre-set target (-25.1%)
GHG40/EE	40%	No pre-set target (26.4%)	No pre-set target (-29.3%)

52 "®" indicates that the scenario does not include "enabling conditions". Moreover, "EE" indicates the presence of explicit energy efficiency policies (at various levels of ambition) in the scenario, whereas the absence of EE means that the scenario does not include such energy efficiency policies but are based on "carbon values" providing a price signal driving GHG reductions (also achieving higher levels of energy efficiency improvements or RES deployment than Reference).

53 Evaluated against the 2007 Baseline projections for 2030

GHG40/ EE/RES30	40%	30%	No pre-set target (-30.1%)
GHG45/ EE/RES35	45%	35%	No pre-set target (-33.7%)

The specific policies and measures included in each of these scenarios are further described below supported by further detail in Annex 7.2 and 7.3.

It shall be noted that the focus of this Impact Assessment is the 2030 perspective, but that most of the strategic choices for 2030 have significant impacts on development *after* 2030. Therefore, the analysis of these scenarios in subsequent Sections spans the period from today up to 2050. In this context, and under *the current modelling set-up*, the scenarios with reference conditions are not compatible with the EU's objective to reduce GHG emissions by 80-95% in 2050 compared to 1990, in the context of necessary reductions by developed countries as a group to limit global warming to below 2 degrees C.

Table 3: Overview of main assumptions of scenarios assessed

GHG35/EE®
This scenario is set in **reference conditions** – it does not achieve GHG emission reductions in line with the Roadmaps in a 2050 perspective.
General description: This scenario presents a modest ambition in terms of GHG emission reduction and is mainly driven by explicit moderate energy efficiency policies that ensure progress by addressing market imperfections and failures.
GHG policies: 35% reduction target. As a result, the ETS cap for stationary sources would stay as in the current legislation with the linear reduction factor (LRF) of 1.74% of the average annual allocation during phase 2 (excluding aviation). This is equivalent to an annual reduction of around 38 million allowances.
EE policies: moderate, explicit EE policies (represented through the Energy Efficiency Values (EEVs)[54], continuation and strengthening of the eco-design regulations, as well as improvements in industrial processes through best available technologies) are the main driver, they are the same as the Reference conditions until 2020 and after 2020 continue at higher level of intensity (than in the Reference scenario), they do not accelerate after 2030 as the scenario is not supposed to deliver the long term GHG reductions of 80% by 2050. EE policies also include stringent CO_2 standards for passenger cars (80gCO_2/km in 2030 and 25gCO_2/km in 2050).
RES policies: There is no pre-set RES target and consequently no dedicated policy in support of RES (in addition to the Reference scenario), increased RES share of 25.5% is mostly achieved through the ETS. EE polices contribute to higher shares of RES as they reduce total energy consumption

[54] Energy Efficiency Values (EEVs) are modelling variables similar to carbon values, but placing a shadow value on energy and are used in two ways in the PRIMES model: (a) reflecting certain concrete energy efficiency policies, e.g. as the shadow prices of the energy efficiency obligation, thermal integrity of buildings obligation, etc. (b) after 2030 the carbon value in GHG only scenarios triggers also increases in energy efficiency.

GHG37®
This scenario is set in **reference conditions** – it does not achieve GHG emission reductions in line with the Roadmaps in a 2050 perspective.
General description: This scenario presents a modest ambition in terms of GHG emission reduction. It is based on the assumption of equalisation of marginal abatement cost of GHG emissions across the economy (throughout the projection period) and driven uniquely by equalising simulated carbon values in the non-ETS sectors to the ETS carbon price from the Reference Scenario. This, and other scenarios based on a GHG target only, represents a modelling least cost approach to reduce GHG emissions economy-wide without yet defining the additional policies through which this would be achieved (in the non-ETS sector). Carbon pricing incentivises GHG emission reductions, through fuel switching including RES penetration, through improving energy efficiency and by reducing non-energy related emissions.
GHG policies: ETS prices are the same as in Reference scenario, carbon values in the non-ETS are raised to match ETS carbon prices in Reference. The projected result is a GHG reduction of 37% relative to 1990.
EE policies: There are no additional EE policies compared to the Reference scenario. In the long term, the EEVs are slightly higher than in the Reference scenario to reflect the energy efficiency effect of the carbon value (see also Section 5.1.4.1 on economic impacts). CO_2 standards for passenger cars do not change from the Reference (i.e. 95g CO2/km as from 2020 and throughout the projection period).
RES policies: There is no pre-set RES target and consequently no dedicated policy in support of RES (in addition to the Reference scenario), increased RES share of 24.7% is achieved by introduction of carbon value in the non-ETS.

GHG40®
This scenario is set in **reference conditions** – it does not achieve GHG emission reductions in line with the Roadmaps in a 2050 perspective.
General description: This scenario presents a medium ambition in terms of GHG emission reduction. It is based on the assumption of equalisation of marginal abatement cost of GHG emissions across the economy (throughout the projection period) and driven uniquely by the increasing carbon price in the ETS and simulated carbon values as described for scenario GHG37. Carbon pricing incentivises GHG emission reductions, through fuel switching including RES penetration, through improving energy efficiency and by reducing non-energy related emission.
GHG policies: **achievement of 40% and 80% reduction targets in respectively 2030 and 2050**, met through economy wide equalisation of carbon prices and values. This implies a

tightening of the linear reduction factor in the ETS (see Section 5.4.1)
EE policies: There are no additional EE policies compared to the Reference scenario. In the long term, the EEVs are slightly higher than in the Reference scenario to reflect the energy efficiency effect of the carbon value. CO_2 standards for passenger cars do not change from the Reference (i.e. 95g CO2/km as from 2020 and throughout the projection period).
RES policies: There is no pre-set RES target and consequently no dedicated policy in support of RES (in addition to the Reference scenario), increased RES share of 25.5% is mostly achieved in the ETS sectors.

GHG40
This scenario is set in **enabling conditions** – it does achieve GHG emission reductions in line with the Roadmaps in a 2050 perspective. This implies a tightening of the linear reduction factor in the ETS (see Section 5.4.1)
General description: This scenario presents a medium ambition in terms of GHG emission reduction that meets in 2030 a 40% GHG reduction, and in 2050 a 80% GHG reduction compared to 1990 levels. It is based on the assumption of equalisation of marginal abatement cost of GHG emissions across the economy driven by increasing carbon prices and simulated carbon values as described for scenario GHG37. In addition, as of 2035, more stringent CO_2 standards for passenger cars apply to simulate electrification. Carbon pricing incentivise fuel shifts and GHG emission reductions it has also a pull effect on RES penetration and increase of energy efficiency.
GHG policies: achievement of 40% and 80% reduction targets in respectively 2030 and 2050 through equalisation of increasing carbon prices and values
EE policies: There are no additional EE policies compared to the Reference scenario. In the long term, the EEVs are higher than in the Reference scenario to reflect the energy efficiency effect of the carbon value. Stringent CO_2 standards for passenger cars: 95gCO_2/km in 2030 and 25gCO_2/km in 2050.
RES policies: There is no pre-set RES target and consequently no dedicated policy in support of RES (in addition to the Reference scenario), increased RES share of 26.5% is mostly achieved in the ETS sectors.

GHG40/EE
This scenario is set in **enabling conditions** – it does achieve GHG emission reductions in line with the Roadmaps in a 2050 perspective.
General description: This scenario presents a medium ambition in terms of GHG emission reduction and is mainly driven by explicit ambitious energy efficiency policies that ensure

progress by addressing market imperfections and failures. Beyond concrete EE policies, carbon pricing continues to incentivise fuel shifts, energy savings and non-energy related emission reductions.
GHG policies: achievement of 40% reduction target in 2030, equalisation of overall cumulative GHG emissions up to 2050 to projections of GHG40 scenario with overall ETS emissions approximating cumulative ETS emissions GHG40[55]. This implies a tightening of the linear reduction factor in the ETS (see Section 5.4.1)
EE policies: are ambitious, they go beyond enabling conditions (see Box 2 above). **Exhaustive list is provided in Annex 7.3, key elements are:** • Measures speeding up the buildings renovation rate which attains on average (2020-2050) 1.69%[56] • Energy management systems introduced gradually over time. • Extended and more ambitious energy efficiency obligations. The average annual energy savings in 2020-2030 amount to a 2.0% savings per year. • The measures above are most strongly driven by EEVs to trigger energy savings. The average EEV from 261€/toe in 2020 to 693€/toe in 2030 further increasing to 2108€/toe in 2050. • The efficiency standards for products driven by Eco-design Regulations are continuously tightened, broadened and extended to not yet regulated products to cover all energy product categories represented in the model. • Additional support for smart grids and efficiency standards for power networks • Wide deployment of CHP and district heating/cooling • Stringent CO_2 standards for passenger cars: 70gCO_2/km in 2030 and 25gCO_2/km in 2050 • Other additional transport related measures as reflected in the White Paper on Transport.
RES policies: There is no pre-set RES target and consequently no dedicated policy in support of RES (in addition to the Reference scenario), increased RES share of 26.4% is mostly achieved in the ETS sectors. EE polices contribute to higher shares of RES as they reduce total energy consumption.

GHG40/EE/RES30
This scenario is set in **enabling conditions** – it does achieve GHG emission reductions in line with the Roadmaps in a 2050 perspective. This implies a tightening of the linear reduction factor in the ETS (see Section 5.4.1)
General description: This scenario presents a medium ambition in terms of GHG emission reduction and is mainly driven by explicit ambitious energy efficiency policies and pre-set RES target that ensure progress by addressing market imperfections and failures.

[55] This is consistent with a linear reduction factor from 2021 onwards equal to -2.4% applied to all ETS sectors so as to meet in 2050 an ETS cap of -90% compared to 2005 (which was the reduction projected for the Roadmap for moving towards a competitive low carbon economy in 2050).

[56] In the Reference scenario the average renovation rate is 1.18%.

Beyond concrete EE policies, carbon pricing continues to incentivise fuel shifts, energy savings and non-energy related emission reductions.
GHG policies: achievement of 40% reduction target in 2030, equalisation of overall cumulative GHG emissions up to 2050 to projections of GHG40 scenario with overall ETS emissions approximating cumulative ETS emissions GHG40[57].
EE policies are ambitious (identical to those in GHG40/EE, including CO_2 standards for passenger cars).
RES policies: There is a pre-set RES target of 30% and in modelling RES values[58] are applied in order to represent the policies necessary to achieve this target. The average RES values rise from 49€/MWh in 2020 to 56€/MWh in 2030 and decline to 36€/MWh in 2050. EE polices contribute to higher shares of RES as they reduce total energy consumption.

GHG45/EE/RES35
This scenario is set in **enabling conditions** – it does achieve GHG emission reductions in line with the Roadmaps in a 2050 perspective.
General description: This scenario presents a high ambition in terms of GHG emission reduction and is mainly driven by explicit and very ambitious energy efficiency policies and pre-set RES target that ensure progress by addressing market imperfections and failures. Beyond concrete EE policies, carbon pricing continues to incentivise fuel shifts, energy savings and non-energy related emission reductions.
GHG policies: achievement of 45% reduction target in 2030, equalisation of overall cumulative GHG emissions up to 2050 to projections of GHG40 scenario with overall ETS emissions approximating cumulative ETS emissions GHG40[59]. This implies a tightening of the linear reduction factor in the ETS (see Section 5.4.1)
EE policies: are very ambitious, they go beyond enabling conditions. Exhaustive list is provided in Annex 7.3 and the key elements are: • Measures speeding up the buildings renovation rate which attains on average (2020 to 2050) 1.78%. • Energy management systems introduced gradually over time and present in all new constructions as of 2015. • Extended and more ambitious energy efficiency obligations. The average annual energy savings in 2020-2030 amount to a 2.3% savings per year. • The measures above are most strongly driven by EEVs to trigger energy savings. The average EEV from 261€/toe in 2020 to 793€/toe in 2030 further increasing to

57 See footnote 55.

58 RES values are modelling variables similar to carbon values used in the PRIMES model to representing unidentified policies related to RES, necessary to achieve the RES target.

59 See footnote 55.

2285€/toe in 2050. • The efficiency standards for products driven by Eco-design Regulations are continuously tightened, broadened and extended to not yet regulated products to cover all energy product categories represented in the model. • Additional support for smart grids and efficiency standards for power networks • Wide deployment of CHP and district heating/cooling • Stringent CO_2 standards for passenger cars: 70gCO_2/km in 2030 and 17gCO_2/km in 2050 • Other additional transport related measures as reflected in the White Paper on Transport.
RES policies: There is a pre-set RES target of 35% and in modelling RES values are applied in order to represent the policies necessary to achieve this target. The average RES values rise from 49€/MWh in 2020 to 142€/MWh in 2030 and decline to 27€/MWh in 2050. EE polices contribute to higher shares of RES as they reduce total energy consumption.

4.1.2.3. Scenarios discarded for detailed assessment

All potential scenarios without an explicit GHG reduction target for 2030 were discarded at the outset as there is a broad consensus among Member States and stakeholders that such a target is necessary (see Annex 7.5), although there are different views on the suitable level of ambition and extent to which this target should be conditional on international developments in the climate field.

All scenarios based on GHG reductions in the EU below 35% and above 45% were discarded at an early stage. The Reference scenario itself results in a 32% reduction. A 45% reduction domestically is assessed as an upper range taking into account reduction pathways assessed in the Commission's Low-carbon Roadmap as regards the cost-efficient trajectory towards meeting the 2050 objectives.

A scenario mainly driven by a 45% GHG target and moderate EE and RES policies was analysed but is not evaluated in full in Section 5 in order to keep the number of scenarios assessed manageable. Many of the differential effects can be assessed by comparing the different 40% scenarios. It shows that it would be possible to reach 45% emission reductions in the EU at lower costs and with lower co-benefits as in the GHG45/EE/RES35 scenario.

A scenario driven by very ambitious levels of renewables and energy efficiency, but with a continuation of the current reduction factor in the ETS was analysed but is not evaluated in full in Section 5, in part as this approach would result in continuing increases of the surplus of allowances in the EU ETS up to 2030 and would therefore seriously undermine the future relevance of the ETS in providing the right incentives for low-carbon investment; and in part as it results in unwarranted system cost increases by not taking advantage of other cost-efficient abatement potential in the non-ETS sectors or fuel switching. At the same time, this scenario shows that it is possible to achieve 40% GHG reductions in 2030 through renewables and energy efficiency policies rather than a strengthening of the ETS, while such an approach appears insufficient to meet the EU's 2050 objective for GHG reductions.

Several scenarios including RES shares above 35% were also analysed but not in full as such scenarios would result in GHG reductions of more than 45% in a 2030 perspective, or would need significant displacement of nuclear incompatible with Member State plans or increased coal use, etc. to stay consistent with the GHG reduction range. Moreover, no scenario with predefined RES levels in specific sectors of the economy was analysed, but all scenarios

provide information on a sector level which could inform potential discussions on the need or not for renewables targets covering sub-sectors of the economy.

No scenario with predefined absolute energy savings objectives for 2030 were analysed in detail as a target-setting in this regard (also considering a potential change to the metric used for comparison) would have to be analysed once the approach to energy savings in a 2020 perspective becomes clear[60]; but all scenarios include various levels of ambition with regard to energy efficiency, giving indications that would be consistent with other parameters and which could feed into discussions on target-setting in this regard on the political level.

Scenarios with only GHG and renewables targets and without additional ambitious energy efficiency policies have been analysed but not retained as the combined scenario GHG target + RES target + ambitious EE policies is a better reflection on potential future policies and their interaction.

4.1.3. Interaction with international climate policies

To achieve the stabilisation of atmospheric GHG concentrations at a sufficiently low level to be in line with the 2ºC objective, IPCC AR4 concluded that on the basis of present scientific estimations, developed countries would need to take a GHG emission reduction target within the range of 80 to 95% below 1990 levels by 2050[61]. The IPCC did not specify the contributions that individual developed countries or regions would need to bring to the group for achieving this aggregate level of emission reductions of 80% to 95%, nor the emission reductions delivered through access to the international carbon market.

The Impact Assessment accompanying the Communication 'A Roadmap for moving to a competitive low carbon economy in 2050'[62] assessed how much of this target would need to be met domestically, to contribute sufficiently to this overall target, assuming gradual equalisation of carbon prices across countries and sectors globally (for more information see Section 5.1 of that impact assessment). The Roadmap concluded that the transition towards a competitive low carbon economy in line with limiting a temperature increase to 2ºC (which necessitates strong climate action at the global level), means that the EU should prepare for reductions in its *domestic* emissions of 80% by 2050 compared to 1990, and that a cost effective pathway towards this 80% GHG reduction would require reductions by 2030 of 40% below 1990 levels.

This said, the Roadmap did not explicitly distinguish between unilateral EU action and EU action within the context of a fair and legally binding international agreement, where commitments have to be individually ambitious, fair and in accordance with responsibilities and capabilities; and collectively sufficient to stay on track to meet the below 2°C objective.

On this basis, two main policy options can be considered:

(1) *One* GHG target: no distinguishing between a unilateral EU GHG reduction ambition level and a (higher) level in case EU action is within the context of a fair and balanced international climate change agreement.

(2) *Dual* GHG targets: a unilateral EU GHG reduction ambition level and a (higher) level in case EU action is within the context of a fair and balanced international climate change agreement.

60 Pending until the 2014 review stipulated by the Energy Efficiency Directive.

61 IPCC, 4th Assessment Report, Climate Change 2007: Working Group III: Mitigation of Climate Change, chapter 13.3.3 Proposals for climate change agreements, box 13.7.

62 SEC(2011) 288 final

For both options, sub-options relate to the level of the respective GHG targets for 2030 and the role of international offsets in the EU.

4.2. Policy options for meeting headline targets

In addition to the overall approach and ambition level as regards GHG, RES and EE presented in Section 4.1, the 2030 framework should also be as concrete as possible on the approach to meeting such ambition levels. This includes notably the functioning of the ETS, the approach to the sectors not covered by the ETS, as well as the implementation approach to meeting a potential 2030 target for RES and the implementation approach to EE.

4.2.1. ETS

The functioning of the EU ETS was characterised in the last two years of phase 2 (2008-2012) by a large build-up of surplus allowances, with the economic crisis resulting in emissions levels below the foreseen cap and the inflow of a large amount of international credits as major causes, resulting in a supply/demand imbalance.

To improve the orderly functioning of the carbon market, the Commission has proposed "backloading" (postponing) some of the auction volumes into the latter part of phase 3 (2013 – 2020). The proposal is currently discussed by Council and Parliament. While backloading would address the surplus in the short term, it would not affect the structural surplus, which is projected to continue up to and beyond 2020.

To address this, the Commission adopted a Carbon Market Report in November 2012 listing six possible measures for structural reform of the ETS. Three of them are especially important also within a 2030 context, i.e. a revision of the annual linear reduction factor, extension of the scope of the EU ETS to other sectors, and access to international credits. These options are addressed in Section 5.

Furthermore, up to 2020 specific measures exist in the EU ETS to address carbon leakage. They are: i) free allocation of allowances to sectors deemed to be exposed to high carbon costs and/or global competition, ii) for the most electricity intensive sectors, the possibility for Member States to grant state aid to compensate for indirect impacts on electricity prices, iii) limited access to international credits. Section 5 therefore addresses policy options regarding the continuation and form of carbon leakage provisions post 2020.

4.2.2. Sectors not covered by the ETS

GHG emissions reductions in the sectors not covered by the ETS are presently regulated up to 2020 through the Effort Sharing Decision, defining a national target for every Member State.

The 2030 framework will need to assess if and how the definition of 2030 targets can contribute to the fair distribution of efforts in a cost-efficient manner, in a way consistent with dedicated EU energy efficiency policies, and while safeguarding the internal market.

Furthermore, at present the emissions and absorptions from the land use, land use change and forestry sectors (LULUCF) are not included in the reduction targets in the current Effort Sharing Decision. In this context, Council and Parliament have indeed expressed the request that all sectors should contribute to cost-effective emissions reductions. It needs to be assessed how LULUCF can be integrated into the 2030 framework, taking note of the important role of agriculture, both in terms of its large soil-based carbon pool, as well as in terms of representing the most important sectoral source for non CO_2 GHG emissions.

4.2.3. *Options for meeting a potential RES target*

This IA does not provide a detailed assessment of the various means of meeting a potential RES objective in a 2030 perspective, but the main options for general approach to meeting a RES objective are evaluated in a more horizontal manner.

Such options include:

(1) Continuation of Member State specific targets and support schemes.

(2) As option i) but with non-discriminatory treatment of renewables coming from other Member States in national support schemes or strong coordination between Member States, possibly under the condition that there is sufficient transmission capacity between the Member States involved, and

(3) A gradual Europeanization of the approach to ensuring progress towards a 2030 objective.

4.2.4. *Options for meeting a potential EE target*

For reasons referred to in Section 5.8, this Impact Assessment does not define or evaluate in detail potential implementation approaches to meeting a potential energy efficiency / savings target for 2030.

4.3. Options for other targets or indicators for aspects relating to competitiveness of the energy system and security of energy supplies

The responses to the public consultation make clear that many stakeholders consider that targets and objectives for GHG reductions, RES shares and EE may be sufficient for ensuring progress towards an environmentally sustainable energy system, but not for progress with regard to the competitiveness of the EU energy system and security of energy supplies; and that other targets or indicators relating to these areas therefore should be established as part of the 2030 framework. Three main options can be envisaged in this regard:

(1) No such targets or indicators are set.

(2) Other 2030 targets for other aspects of competitiveness and security of supply are set, and treated in an equal manner as potential targets for GHG, RES and EE.

(3) No other such targets are set, but relevant indicators are defined to keep track of progress over time and to provide a knowledge basis for policy action; potentially associated with aspirational objectives in a 2030 perspective.

Candidates for such indicators are presented in the context of evaluating these options in Section 5.2.

5. ANALYSIS OF IMPACTS:

5.1. Options for targets and measures

5.1.1. *Methodology*

5.1.1.1. Impacts assessed

This Section assesses impacts of each of the main scenarios representing the basis for policy options as defined in Section 4, supported as appropriate by other scenarios not assessed in full detail. It focuses on the broad impacts of those options, and to a lesser extent on the impacts of specific measures that could be put in place to meet the ambition levels inherent in each of the scenarios / policy options. While specific EE measures in most scenarios including

"enabling policies" (see Section 4) are represented in more detail than non-ETS GHG reduction policies and RES policies, where mainly the cost efficient achievement of targets are being considered, an in-depth evaluation of concrete measures to reach yet to be agreed targets and ambition levels has to be left to more specialised IAs once the broad policy directions have been agreed on. The impacts of more strategic choices assessed are:

(1) Environmental impacts (see Section 5.1.2)

(2) Energy system impacts (non-economic) (see Section 5.1.3)

(3) Economic impacts (see Section 5.1.4)

(4) Social impacts (see Section 5.1.5)

In assessing these impacts, focus is put on 2030, but an outlook for 2050 is also provided in order to address adequately the long term impacts of the policy choices for 2030. This is particularly important as there are long lead times for energy investments as well as very long life-times, for example, for power plants (20-50 years or more), grids and other energy infrastructure. Much of the current infrastructure and nearly all the new ones constructed based on 2030 policies will still be in place after 2030 and largely also in 2050.

Environmental impacts assessed are primarily those related to GHG emissions, direct land use and various air pollutant emissions. This includes the split of GHG emission reductions across sectors of the EU economy, in particular between the energy system and other GHG emissions, the split between various economic sectors (e.g. electricity generation, transport, residential / tertiary sector, industry and agriculture), as well as the split between GHG reductions in sectors within and outside the ETS at the aggregate level.

Energy system impacts (non-economic) concern notably energy consumption and supply. For the supply side, an important concern is security of supplies which involves issues of managing external dependency through diversification of fuels, which consequently will enable the diversification of production /import regions and transit routes. The assessment of energy system impacts also deals with issues relating to the balance between various energy sources including specific renewables technologies in various sectors, energy consumption and intensities, infrastructure development, import dependence, possible savings in energy imports, structural change to electricity generation, heating and cooling, development of combined heat and power (CHP) and carbon capture and sequestration (CCS).

Economic impacts assessed include such impacts within and outside the energy system, as well on the macro-economic level. Impacts addressed are notably overall system costs including long-term cost efficiency and its sub-components (fuel, investments etc.), electricity prices, the ETS price, implicit abatement cost in the non-ETS sector, the role of energy costs for energy intensive industries, etc.; whereas macro-economic impacts focus on GDP impacts as well as an assessment of impacts in a globalised economy on EU energy intensive industries that are subject to international competition, from more ambitious climate and energy policies.

Social impacts assessed are primarily those relating to employment, using different analytical tools and focusing mainly on the effect of carbon pricing revenues, as well as energy efficiency and renewables policies; and affordability for households, in particular vulnerable households which are particularly impacted by fuel and electricity price increases. It also includes health impacts related to the reductions of pollutant emissions treated under environmental impacts.

5.1.1.2. Modelling approach

All impacts relating to the energy system and important parts of economic impacts and the resulting impacts on CO2 emissions are mainly assessed by modelling of various scenarios using the PRIMES model. This analysis is extended to non-CO2 GHG and air pollutant emissions by linking the PRIMES and GAINS models along with linkages to more specialised transport modelling (PRIMES-TREMOVE), agricultural and land use models (CAPRI, GLOBIOM/G4M), which also allow covering of impacts on LULUCF emissions. While transport modelling feeds directly into energy system modelling, the GHG mitigation potentials from non-CO_2 emissions concern mainly activities outside the energy system, and are modelled in a fully consistent way.

A fundamental analytical modelling question relates to the broad strategic choices with respect to a long term policy strategy for which 2030 could be a milestone. As discussed in Section 4, the energy and climate modelling with PRIMES, for helping to assess impacts, needs to differ notably with respect to the main long term policy thrust, which influences strongly in the long term how various policies can interact taking account of acceptance issues. As discussed in Section 4, energy and climate policy making for 2030 can be embedded in "enabling policies" or not. The inclusion of these policies assumes that the objectives assessed are part of a strong, comprehensive and long term GHG reduction strategy. This would also be facilitated by strong global action. In practice, the enabling policies ensure the availability of necessary infrastructure, progress in R&D and innovation and broad social acceptance of technologies which enable decarbonisation and facilitate the development and deployment of notably renewables and electro-mobility options (see Annex 7.2 for more information on the differences between Reference and enabling policies).

Another important modelling question is the degree of concreteness of policy modelling. i.e. the extent to which GHG and energy consumption reductions in the non-ETS sector as well as the achievement of renewables targets are driven solely by carbon (in the non-ETS), renewable and efficiency values without suggesting how this would be achieved in practice, or more by the simulation of more concrete policies. This aspect has important implications for assessing energy system impacts as well as economic impacts.

Direct comparison between the various scenarios is compounded by substantial differences between them on many dimensions. Differences between scenarios can best be understood through a comparison of pairs of scenarios that differ only with respect to the issue under investigation:

- First, scenarios with *enabling policies* result over time in lower system costs and price impacts. This highlights the benefits and importance of such enabling policies for the transition, in particular post 2030. Until 2030, the impact of the enabling policies is relatively small. So the effect is transparent and results can be compared, results post 2030, however, are only directly comparable between scenarios with enabling policies, because for all these the same carbon budget constraint consistent with the EU's 2050 climate objective is assumed. In scenarios with Reference setting, reductions are not achieved in-line with this long term transformation, which also should be considered in comparing scenarios in a 2030 perspective. Moreover, the EU Reference Scenario 2013 (with which policy options / scenarios are compared), does not include such assumptions about enabling settings.
- Second, scenarios are to various extents stylised to achieve a transformation cost-effectively in GHG emission abatement terms. The way to achieve the cost-efficient transformation differs between scenarios with only GHG targets and the scenarios with GHG targets and specific energy efficiency policies.

a) For the scenarios with only GHG targets the approach aims at an optimal split of GHG reductions between ETS and non-ETS sectors, based on the equalization of the marginal abatement cost in these two sectors through the use of the ETS carbon prices and the non-ETS carbon values.

b) For the scenarios with GHG targets and specific energy efficiency policies, energy efficiency measures, often extensions of existing legislation, are additionally considered compared to the GHG targets only approach. In these scenarios specific EE policies substitute largely for carbon values and RES targets contribute towards lowering emissions in ETS and non-ETS sectors.

More specifically, the use of carbon values rather than concrete energy efficiency policies in the non-ETS sectors lead to cost efficient GHG reductions which could only be achieved in reality by an extension of the ETS to cover the entire economy[63], while concrete policy measures still would be needed to address market failures. Also the use of renewable values leads to cost efficient introduction of renewables throughout the EU economy (which may or may not be the case depending on implementation approach). Whereas the EU ETS is a concrete policy tool, achieving set objectives in other sectors and with respect to other targets will require concrete policies that must be put in place to realise these transformations. Scenarios based on concrete EE measures aim to reflect the need for concrete policies that remove barriers to EE due to market failures, split incentives and imperfect information among market actors. On this basis, the use of carbon, renewables and energy efficiency values rather than specific policies may underestimate the cost of reaching set objectives unless the theoretical cost-optimisation can be achieved in reality, requiring an extensive set of policies[64] that improve the functioning of energy markets and the pass-through of price signals, remove the barriers to energy efficiency and facilitate investment in low carbon technologies, such as nuclear and CCS. Comparability between scenarios with more extensive use of such "values" in so far as they do not reflect concrete policies and assume perfect functioning markets, and those that to a greater extent are based on concrete policies would therefore be reduced, in particular as concrete policies are needed to address market failures.

- Third, to allow for comparison between scenarios under enabling settings that achieve the long term objective towards a low carbon economy, total emission budgets where kept similar over the projection period, using the following methodology:

  a) The scenario with only a 40% GHG emission reduction target aimed at determining the optimal distribution of emission reduction across sectors, notably the ETS and non-ETS while meeting the GHG reduction targets of 40% and 80% in 2030 and 2050.

  b) The scenarios with GHG targets and specific energy efficiency policies (as well as additional RES targets) build on the scenario with only a 40% GHG emission reduction target, assuming for each period the ETS cap derived in (a) above for comparability reasons, as well as meeting the respective GHG reduction targets in 2030 and 2050. Moreover, due to the different focus of the modelling in these scenarios, more emphasis was placed in economic modelling of the ETS market[65].

63 Or a carbon tax in the non-ETS sector that would exactly mimic the price movements of the ETS. Contrary to the carbon value though, a carbon tax would act on the consumer's budget.

64 For example requirements for the extension of the scope of the EU ETS to other sectors can be found in Annex 7.8.

65 The PRIMES model simulates emission reductions in ETS sectors as a response to current and future ETS prices, by performing an inter-temporal equilibrium in ETS market, taking into account risk-averse

To assess the complex interaction between sectors at the aggregate macro-economic level, the GEM-E3 and the E3MG models are used (see Section 5.1.4.2 and 5.3), with GEM-E3 being a general equilibrium model and E3MG a macro-econometric model. Both models assess the impact of a 40% domestic GHG reduction in the EU based on the equalisation of marginal abatement costs through the use of "carbon values" and compared to a Reference scenario (based on the PRIMES EU Reference Scenario 2013). This analysis assumes that third countries implement policies to achieve their 2020 pledges in the context of the UNFCCC but do so in a conservative manner. The impacts of more than 40% GHG emissions reductions in a 2030 perspective coupled with potential recognition of international offsets in the ETS are also assessed through these models (see Section 5.3). This modelling set up does not allow assessing the impacts of specific renewables objectives or energy efficiency policies beyond those resulting from the "pull-effect" of a GHG target[66].

Social and in particular employment effects are also primarily analysed using the same macro-economic models and scenarios that are used to consider macro-economic impacts, focused on the impact of achieving a GHG target only. Furthermore, the E3ME model was adapted to assess in addition to the achievement of GHG reductions, also the impact of achieving higher energy efficiency in relation to the building sector and higher renewables penetration, but only limited to the power sector. The quantitative modelling of employment effects is enhanced by other more qualitative means of assessing such impacts, as well as by a dedicated study looking at employment impacts of the scenarios in the Commission's Energy Roadmap 2050.

5.1.1.3. Qualitative assessment of key aspects

In addition to the quantitative assessment of impacts based on modelling, this Impact Assessment is also based on important qualitative assessments of various potential aspects of the 2030 framework. Such analysis draws heavily from the results of the public consultation launched by the Green Paper, and the extensive analysis of progress made and lessons learnt under the 2020 framework (see Section 2.2 and Annex 7.4). Qualitative assessments are particularly important for Sections 5.4 to 5.8 containing possible implementing measures to meet set objectives for 2030; as well as for Section 5.2 which contains options for additional indicators and / or aspirational objectives more directly relating to the competitiveness of the energy system and the security of energy supplies.

5.1.2. Environmental impacts

This Section first analyses how the overall GHG emission impacts are distributed between sectors covered by the EU ETS and non-ETS sectors currently covered by the Effort Sharing Decision. Then it assesses sectoral GHG emission impacts, with a focus of explanations on GHG emissions other than energy related CO2 emissions, followed by a summary of sectoral GHG emission impacts. CO2 emissions from energy are discussed in Section 5.1.3. Furthermore, this Section assesses impacts on emissions and absorptions from Land Use, Land Use Change and Forestry (LULUCF) as well as impacts on air pollution, including health impacts.

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behaviour of market agents which leads to the banking of allowances; perfect foresight of the carbon price progression in the period 2020-50 and that no borrowing from the future is permitted.

66 These models reduce GHG emissions on the basis of carbon price constraints. This allows assessing different carbon pricing tools such as emission trading with free allocation or auctioning or simply a carbon tax, and assess the effects of how revenues are used. The tools are less well equipped to assess a whole set of specific energy efficiency policies and have less detail regarding the options for renewables penetration than for instance an energy focussed model like PRIMES, which explains why such aspects were not modelled in GEM-E3 and the E3MG.

5.1.2.1. Total GHG reductions and ETS vs. non-ETS emission reductions

Total GHG reductions for the modelling scenarios are of course broadly in-line with the assumed targets as listed in Table 2, differing a little for some scenarios, because the model is run iteratively until the emission pathway reaches the desired GHG targets. Only the GHG37 scenario is different, in that it only assumes carbon values in the non ETS to be equalised to those of the ETS in Reference, resulting in GHG reductions of 37% compared to 1990.

Between 2005 and 2030, ETS emissions decrease in the Reference scenario significantly more than non-ETS emissions, given that the ETS linear reduction factor continues post 2020 under the ETS Directive, while some key policies impacting the non-ETS sectors currently agreed upon do not include such a gradual tightening. Correspondingly, additional decreases in the 37% GHG reduction scenario under Reference settings, which re-establishes carbon price equalisation, are significantly higher in the non-ETS compared to the ETS.

Differences between the different 40% GHG reduction scenarios under enabling policies are significant. In the scenario mainly driven by ETS carbon prices and carbon values in the non-ETS sectors, the additional emission reductions in ETS and non-ETS sectors compared to reference are in 2030 very similar (with 11% and 13% reductions). The lowest additional GHG reductions in the ETS of only 3% are realised in the scenario where non-ETS GHG reductions are achieved mainly through ambitious additional energy efficiency measures, resulting in much higher GHG reductions in the non-ETS sectors of up to 18% more compared to reference. The scenario results also show that higher levels or dedicated renewables policies typically increase GHG reductions more in the ETS in relative terms, because cost-efficient RES potentials are higher within than outside the ETS (notably in the power sector). Adding a RES target of 30% to the above-mentioned ambitious EE policies scenario, leads to further 4% ETS emission reductions and a decrease of non-ETS emission reductions. The 45% GHG reduction scenario shows higher reductions compared to reference in ETS as in non-ETS sectors, strongly driven by the 35% RES target.

Nevertheless, if emission reductions in 2030 are compared to 2005, the base year of current EU GHG legislation, they are across all scenarios higher in the ETS sectors than in the non-ETS sectors. The policy options that achieve a 40% overall GHG reduction result in reductions compared to 2005 in ETS of between -38% to -43%, further decreasing to -49% in the 45% scenario, and in the non-ETS sectors of between -30% to -35%[67].

With regard to 2050 emissions, the scenarios consistent with the 2050 GHG objective (i.e. those with "enabling settings") show rather similar additional emission reductions to Reference for the ETS and non-ETS sectors, usually well over 60%. That the 45% GHG reduction scenario shows the lowest additional reductions reflects simply the comparability condition of having the same carbon budget constraint over the entire period up to 2050, so that higher 2030 reductions imply lower efforts later.

Compared to 2005, in scenarios under enabling policies that achieve a 40% overall GHG reduction in 2030, ETS sector 2050 emission reductions are beyond 85% and still considerably higher than non-ETS sector reductions, which are between 70 and 72%, confirming roughly the dimensions indicated by the low carbon economy roadmap.

[67] Compared to the scenarios made for the 2050 Low Carbon Economy roadmap, this is a range of reductions in the ETS that is broader and has a lower end (-43 to -48% in the Low carbon Roadmap), while the range of reductions for the non- ETS is a bit smaller and start at higher levels (-27 to -36% in the Low Carbon Economy Roadmap). The different lower ends are mainly due to the inclusion of more energy efficiency policies in all 40% scenarios, but also by higher projected oil and gas import prices as in the roadmap, which foster non-ETS emission reductions.

Table 4: ETS and non-ETS emissions

Scenarios with enabling policies (compatible with 2050 GHG objectives):

Indicator	"ETS + Carbon val." 2030 / 2050	"ETS + concrete EE measures + RES val.[68]" 2030 / 2050		
	GHG40	GHG40EE	GHG40EERES30	GHG45EE RES35
Total GHG emissions (% to 1990)	-40.6 / -79.6	-40.3 / -80.1	-40.7 / -80.0	-45.1 / -77.5
ETS sectors emissions (% dif. to reference)	-11.2 / -68.4	-2.9 / -66.0	-7.2 / -65.2	-20.6 / -54.6
Non-ETS sectors emissions (% dif. to reference)	-12.8 / -61.4	-18.0 / -63.7	-16.1 / -64.0	-17.6 / -62.3
ETS (% to 2005; Ref: -36.1/-59.3%)	-43.3 / -87.1	-37.9 / -86.2	-40.7 / -85.8	-49.3 / -81.5
Non-ETS (% to 2005, Ref: -20.3/-22.9%)	-30.5 / -70.3	-34.7 / -72.0	-33.1 / -72.2	-34.3 / -70.9

Scenarios with reference settings (not compatible with 2050 GHG objectives):

Indicator	"Reference settings , ETS + carbon values" 2030 / 2050		
	Concrete EE measures	ETS + Carbon value	
	GHG35	GHG37	GHG40
Total GHG emissions (% to 1990)	-35.4 / -54.1	-37.0 / -53.4	-40.4 / -56.2
ETS sectors emissions (% dif. to reference)	-0.8 / -7.6	-2.2 / -3.7	-9.7 / -14.2
Non-ETS sectors emissions (% dif. to reference)	-7.0 / -23.2	-10.2 / -23.1	-13.4 / -25.5
ETS (% to 2005; Ref: -36.1/-59.3%)	-36.6 / -62.4	-37.5 / -60.8	-42.3 / -65.1
Non-ETS (% to 2005, Ref: -20.3/-22.9%))	-25.9 /-40.8	-28.4 / -40.7	-31.0 / -42.6

Source: PRIMES 2014.

The main conclusions from this Section are that achieving emissions reductions by focussing relatively more on energy efficiency policies for any given level of GHG reductions reduces emissions in the non-ETS more and thus reduces the reductions needed in the ETS. A high level of renewable energy to the contrary increases reductions more in the ETS, resulting in less needed reductions in the non-ETS to achieve a certain GHG target. Furthermore, compared to reference, typically the non ETS sectors reduce more, which is logical given that the ETS cap continues after 2020, whereas in the non ETS sectors such continued tightening does not exist, although specific policies continue to have effect.

68 GHG40EE uses the same RES value as in the reference scenario.

5.1.2.2. Non-CO2 and non-energy related CO2 GHG emissions

Table 5 shows the expected development of non-CO2 GHG emissions and CO2 emissions not related to energy or land use. Non-CO2 emissions are modelled with the GAINS model, with mitigation cost curves for technical emission reductions beyond Reference introduced in the PRIMES model.

In the Reference scenario, total non-CO2 GHG emissions decline by nearly 20% in 2030 compared to 2005. The reduction in agricultural non-CO2 GHG emissions, which are more than half of all non-CO2 emissions, is 4% in the same period. The reduction in other non-CO2 sectors is 36%. In the Reference scenario, non-CO2 emissions decrease because of EU waste policy, national bans on landfill of biodegradable waste, EU and national regulations to reduce F-gas emissions, inclusion of mainly certain industrial emissions (mainly N_20) in the ETS, and national subsidies for anaerobic digesters enabling energy recovery.

The Table shows significant further non-CO2 GHG emissions compared to Reference and compared to 2005 reductions across all policy scenarios. For the scenarios that achieve 40% GHG reductions, the reduction is lowest in the option with a 30% RES share and ambitious EE policies, with only 33% non-CO2 GHG reductions by 2030 compared to 2005. In general, reductions are lowest in options that have ambitious EE policies and higher RES targets, given that in these options higher energy savings and energy-related CO2 reductions reduce the need for reductions from non-CO2 GHG to achieve the same overall reduction of aggregated GHG emissions. Instead, the highest reductions are achieved in case of a 40% GHG target only in Reference settings, reducing non-CO2 emissions by 29% compared to Reference and 43% compared to 2005[69].

Agricultural sector emissions follow a similar pattern but reductions are smaller since the potential to reduce emissions at the projected carbon values is more limited. As a result, the reduction of agricultural non-CO2 emissions (CH4 and N2O) ranges between 19% and 28% in 2030 compared to 2005 for the scenarios that achieve 40% GHG reductions. The GAINS model only focuses on technical emission reduction options. The PRIMES model implements these technical emission reduction options as long as the associated cost per ton of GHG reduced is below the carbon value introduced in the non-ETS or ETS. In reality of course it will require the introduction of concrete policies to achieve these reductions now simulated through a carbon value incentive. This was for example already the case in some of the other non-CO2 sectors with the inclusion of industry non-CO2 emissions in the ETS and with the currently on-going review of the F-gas regulation, for which estimated 2030 reductions[70] are in line with the cost-effective potential simulated by mitigation cost curves and carbon price incentives. The recent reform of the Common Agricultural Policy contains provisions which could be used by Member States to foster such emission reductions.

The extent to which the technical options assumed in the modelling reduce non-CO2 emissions in a cost-effective way depends also on technical progress achieved. On the one hand some technical options such as the use of propionate precursors may not be financially viable at the carbon values modelled. On the other hand genetic improvements through breeding programmes and diet changes are being applied or ready to be applied on farms and financially viable and some technologies (e.g. diet changes) might be able to reduce more

69 Typical means to reduce non CO2 emissions are farm scale anaerobic digestion, diet changes for animals and selective breeding to control methane emissions of cows, doubling of control frequency of gas distribution networks and the use of alternatives for F-gases in various applications (foams and fire extinguishers e.g.).

70 SWD(2012) 364

than assumed[71]. In developing the 2030 framework, further work will be needed to assess mitigation options and the practical implementation in policy terms.

The modelling did not consider behavioural changes that result in changes in diet, which would have mitigation potential[72]. A certain change in diet patterns in developed countries is already perceptible and could be confirmed by 2030. Even without explicit changes of the food patterns, potential mitigation measures could impact food production prices and thus have consequences on the demand and supply of European agriculture, which will require further examination.

Non-energy related CO2 emissions are to a large extent (around 75%) covered by the EU ETS, in particular process emissions in the metal, cement and chemicals industries. They decline in the Reference scenario by 15% in 2030 compared to 2005, mainly driven by the continuation of the annual reduction factor in the ETS and the projected ETS price of €35 that results from it. Emissions decrease further only in policy options with higher carbon prices resulting from scenarios driven uniquely by a GHG target, with a maximum among the scenarios analysed of 7% compared to Reference and 21% emission reductions between 2005 and 2030 in the policy scenario with 40% GHG emission reductions and renewables and efficiency policies as in Reference settings[73]. In scenarios with both ambitious RES and EE policies, the necessary effort to reduce non-energy related CO2 emissions is lower (as the ETS in total needs to reduce less), reflected in a lower carbon price and carbon value, leading to increasing non-energy CO2 emissions compared to Reference and to stable non-energy related CO2 emissions in 2030 compared to 2005.

Table 5: Non-CO2 and non-energy related GHG emissions in the EU28 in 2030 (MtCO2eq.)

	2005		2030						
		Refe-rence	GHG35 (*ref setting*)	GHG37 (*ref setting)*	GHG40 (*ref setting*)	GHG40	GHG40 EE	GHG40 EERES 30	GHG45 EERES 35
			GHG emission reduction vs Reference 2030 (%)						
Total non-CO2	903	728	-10	-24	-29	-26	-22	-17	-19
Non Agriculture	422	268	-13	-27	-38	-28	-25	-19	-20
Agriculture	481	460	-9	-22	-25	-24	-21	-15	-18
Non-energy related CO2	280	240	9	-6	-7	-7	12	18	17
			GHG emission reduction vs 2005 (%)						
Total non-CO2		-19	-28	-38	-43	-40	-38	-33	-35
Non Agriculture		-36	-45	-54	-61	-55	-52	-49	-49

71 See O'Mara et. al. (2007) Climate Change – Estimation of emissions from greenhouse gas from agriculture and strategies for their reduction, synthesis report. Environmental Protection Agency, Wexford, Ireland, p.8. and O' Mara (2013) Mitigating farm livestock greenhouse gas emissions in the EU (i.e. p 18), http://unfccc.int/files/methods_and_science/mitigation/application/pdf/eu_omara.pdf

72 A recent study on behavioural mitigation options has shown that relevant behavioural mitigation potentials exist in the food domain, e.g. shifts to a more healthy diet or reduced animal protein intake (Faber et al. 2012, see http://ec.europa.eu/clima/policies/roadmap/docs/main_report_en.pdf). However, there are a number of barriers to realise these potentials with specific policies, including limited EU competences. The additional potential which could be addressed by specific policies in the EU is estimated at 40 Mt CO2eq.

73 A scenario with 45% GHG reductions and moderate RES and efficiency policies shows larger non-energy related CO2 emission of 9% compared to Reference and 22% compared to 2005,

Agriculture		-5	-13	-25	-28	-28	-25	-19	-22
Non-energy related CO2		-15	-7	-20	-21	-20	-4	0	0
Carbon price (€/tCO2)		35 € in ETS 0 € in non-ETS	27 € in ETS 1 € in non-ETS	35 €	53 €	40 €	22 €	11 €	15 €

Source: GAINS, PRIMES, CAPRI

The main conclusions of this Section are that for non-CO_2 emissions, the highest reduction potential by 2030 is in the non-agricultural sectors, even though most of these reductions are already achieved in the Reference scenario, for instance due to inclusion of an important share of the non-agriculture N_2O emissions in the ETS, which can be reduced at low cost. Non-energy related CO_2 emissions reduce least. Scenarios with ambitious EE and RES policies typically result in higher reductions from CO_2 in the energy system, requiring less reductions of non-CO_2 emission sources, such as from agriculture.

5.1.2.3. Summary of sectoral GHG emission impacts

Table 6 compares sectoral GHG emission reductions to 2005. In a 2030 perspective, the power CO_2 sector (including district heating and CHP) is projected, to experience the biggest reduction across all policy scenarios, ranging from -48 to -66%. A significant part of these reductions, -47%, is already achieved in Reference (for a detailed explanation of sectoral trends in the Reference scenario see Annex 7.1). Above average reductions of -36 to -61% and -36 to -49%, respectively, are also seen in the broad group of non-agricultural non-CO_2 sectors and in the residential and tertiary CO_2 sector (mainly heating and cooling of buildings and some other fuel uses, including in agriculture, given that emissions of electrical appliances and lighting are indirect and hence covered under the power sector). In the industry CO_2 sector, which includes refineries and covers energy-related and process-related emissions, and in the agriculture non-CO_2 sector, the reductions between 2005 and 2030 are below average and range from -23 to -31% and -13 to -28%, respectively. The lowest emission reductions are projected in the transport CO_2 sector, ranging from -12 to -20%. Sectoral reduction differences in 2030 between Reference settings and enabling policies are small, as can be seen by comparing the GHG40 scenarios in both settings.

In a 2050 perspective, emission reductions increase significantly across all sectors in the scenarios compatible with the 2050 GHG objective. The power sector remains with -90 to -98% reductions compared to 2005 the sector with the highest reductions. The agriculture sector sees with -45% to -53% the lowest reductions.

If changes in sectoral GHG emissions are compared to Reference (Table 7) the key insight in a 2030 perspective is that sectoral emission impacts of the additional policy options vary considerably depending on whether the main drivers of emission reductions are carbon prices, energy efficiency measures or are a combination of both with RES targets. This can be illustrated by comparing the different 40% GHG reduction scenarios. The highest additional reductions compared to the Reference Scenario are projected to occur in the non-agricultural non-CO2 sector, the residential and tertiary sector and in the agriculture sector. In the scenario where carbon prices and carbon values are the main drivers of change, the power sector also reduces emissions significantly, and in this scenario more than the residential and tertiary sector. In scenarios primarily driven by explicit energy efficiency measures, the additional reduction efforts of the power sector become the smallest of all sectors. Explicit RES targets results in additional reductions in the power sector, leading to lower GHG reductions in all non-CO2 sectors. Industry and transport remain across all scenarios the sectors with the

smallest additional reductions compared to Reference, with a stronger contribution of transport in the scenarios with ambitions EE policies.

In a 2050 perspective, the differences between different scenarios consistent with the 2050 GHG objective (i.e. those with enabling policies) reduce considerably. The power sector then shows the biggest additional reductions compared to Reference across most scenarios, followed by the buildings sector (residential & tertiary). Transport, industry, other non-CO2 sectors and agriculture also contribute significantly, in decreasing order.

Table 6: Sectoral GHG emission impacts compared to 2005

Scenarios with enabling settings (compatible with 2050 GHG objectives):

GHG emission reductions compared to 2005	**2030 / 2050**	**"Carbon val." 2030 / 2050**	**"Concrete EE measures" 2030 / 2050**		
	Reference	GHG40	GHG40EE	GHG40EERES 30	GHG45EERES 35
Power generation, CHP and district heating (CO2)	-46.7/ -72.9	-56.5 / -97.7	-48.4 / -96.1	-53.3 / -95.3	-65.6 / -89.8
Industry (energy + processes) (CO2)[74]	-22.5 / -43.8	-27.4 / -77.8	-26.3 / -78.3	-27.1 / -79.7	-30.9 / -76.3
Residential &tertiary (mainly buildings) (CO2)[75]	-31.4 / -39.1	-39.1 / -82.2	-49.0 / -88.1	-47.3 / -87.8	-48.5 / -87.1
Transport (CO2)	-11.6 / -10.3	-13.6 / -63.5	-19.6 / -64.0	-19.4 / -63.7	-19.5 / -65.3
Agriculture (non-CO2)	-4.5 / -3.4	-27.6 / -52.6	-24.5 / -52.6	-18.9 / -52.6	-21.8 / -45.4
Other non-CO2 sectors	-36.4 / -35.3	-54.5 / -70.9	-52.4 / -69.3	-48.7 / -69.3	-49.2 / -68.2

Scenarios with reference settings (not compatible with 2050 GHG objectives):

Indicator	**2030 / 2050**	**"Reference settings, carbon values or concrete EE measures (GHG35)" 2030 / 2050**		
	Reference	GHG35®	GHG37®	GHG40®
Power generation, CHP and district heating (CO2)	-46.7/ -72.9	-48.0 / -73.9	-48.5 / -74.4	-54.9 / -80.5
Industry (energy + processes) (CO2)	-22.5 / -43.8	-22.6 / -50.8	-24.1 / -47.4	-26.9 / -49.3
Residential & tertiary (mainly buildings) (CO2)	-31.4 / -39.1	-35.8 / -47.0	-37.6 / -52.5	-40.7 / -54.9
Transport (CO2)	-11.6 / -10.3	-15.3 / -39.6	-11.6 / -11.5	-11.7 / -12.6
Agriculture (non-CO2)	-4.5 / -3.4	-12.7 / -16.7	-25.1 / -50.3	-27.8 / -52.6
Other non-CO2 sectors	-36.4 / -35.3	-44.9 / -46.6	-53.6 / -67.4	-60.6 / -69.3

Source: PRIMES, GAINS, CAPRI.

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74 Including energy industries, such as refineries and coke production.

75 The tertiary sector includes the small energy-related emissions from agriculture.

Table 7: Sectoral GHG emission impacts compared to Reference

Scenarios with enabling policies (compatible with 2050 GHG objectives):

Indicator	**"Carbon val." 2030 / 2050**	**"Concrete EE measures" 2030 / 2050**		
All indicators are presented as % increase/decrease in comparison to the Reference	GHG40	GHG40EE	GHG40EERES30	GHG45EERES35
Power generation, CHP and district heating (CO2)	-18.4 / -91.7	-3.1 / -85.5	-12.4 / -82.5	-35.5 / -62.4
Industry (energy + processes) (CO2)	-6.3 / -60.4	-5.0 / -61.4	-6.0 / -63.8	-10.9 / -57.8
Residential & tertiary (mainly buildings) (CO2)	-11.2 / -70.7	-25.6 / -80.5	-23.2 / -80.0	-25.0 / -78.8
Transport (CO2)	-2.2 / -59.3	-9.0 / -59.8	-8.8 / -59.6	-8.9 / -61.3
Agriculture (non-CO2)	-24.2 / -50.9	-21.0 / -50.9	-15.1 / -50.9	-18.2 / -43.5
Other non-CO2 sectors	-28.4 / -55.0	-25.1 / -52.6	-19.3 / -52.5	-20.1 / -50.9

Scenarios with reference settings (not compatible with 2050 GHG objectives):

Indicator	**"Reference settings, carbon values or concrete EE policies (GHG35)" 2030 / 2050**		
All indicators are presented as % increase / decrease in comparison to the Reference	GHG35	GHG37	GHG40
Power generation, CHP and district heating (CO2)	-2.4 / -3.6	-3.3 / -5.4	-15.4 / -27.9
Industry (energy + processes) (CO2)	-0.2 / -12.4	-2.1 / -6.4	-5.7 / -9.7
Residential & tertiary (mainly buildings) (CO2)	-6.5 / -13	-9.0 / 22.1	-13.6 / -26.0
Transport (CO2)	-4.1 / -32.7	0.1 / -1.4	-0.1 / -2.6
Agriculture (non-CO2)	-8.7 / -13.8	-21.7 / -48.5	-24.5 / -50.9
Other non-CO2 sectors	-13.4 / -17.4	-27.0 / -49.7	-38.0 / -52.6

Source: PRIMES, GAINS, CAPRI.

The main conclusions of this Section are that all sectors need to contribute to GHG reductions, with the power sector typically reducing the most and the transport and agricultural sectors typically reducing the least compared to 2005 levels. Compared to the Reference scenario, reductions in the power sector are less outspoken, with the power sector already reducing a significant amount in the reference scenario. At the same time, sectoral contributions are more pronounced for the residential and tertiary sectors (mainly buildings), as well as emission reductions of non-CO2, largely due to the fact that these sectors reduce emissions relatively less in the Reference scenario.

5.1.2.4. GHG emissions related to land use and land use changes (LULUCF)

LULUCF is at present a net sink in the EU. In the reference scenario this LULUCF sink for the EU28 is expected to gradually decline from 239 $MtCO_2$ in 2005 to around 216 $MtCO_2$ in 2030. This is the result of different trends among which the development of the forest sector is the most important one. Notably overall timber demand (energy & non-energy) increases with 17% between 2005 and 2030 and the impact of a skewed age class distribution in European forests means that the growth increment will be gradually reduced and a higher share of trees reaches maturity. Energy wood demand increases by some 40% in the same period.

Table 8 shows the impacts on biomass demand and supply of representative policy options as estimated with the PRIMES model.

Scenarios without explicit RES target of 30% or 35% do not show a significant increase in demand for biomass for energy purposes or biofuels compared to reference. Some even show a decrease, notably in the scenario with 40% GHG reductions and ambitious EE demand is lower than reference.

Instead demand for biomass for energy purposes increases notably in the scenarios with higher RES target. In the option with 45% GHG reduction 35% RES share and very ambitious EE policy demand increases most to 223 Mtoe.

Most demand is met through domestic production, with imports being limited. In the GHG40/EE scenario demand and imports of bioenergy reduce most compared to reference. In the GHG45/EE/RES35 scenario demand increases most, with 45 Mtoe, of which 34 Mtoe is met through domestic production and the remainder with increased imports.

Table 8: Biomass demand for energy purposes

	2005	2030							
		Ref	GHG 35EE	GHG 37	GHG 40 ref	GHG 40	GHG 40 EE	GHG 40EE RES30	GHG45 EE RES35
Domestic production biomass feedstock (Mtoe)	87	194	191	192	193	203	191	213	231
of which: forestry	33	48	48	49	49	49	48	49	51
of which: crops	4	65	62	63	64	69	59	78	92
of which: agricultural residues	12	16	16	16	16	16	16	16	17
of which: waste	28	47	47	48	47	47	47	48	49
of which: other (i.e. black liquor)	9	17	17	17	17	21	21	22	21
Net imports biomass feedstock (Mtoe)	1	4	3	3	4	2	1	2	5
Processing losses of feedstock (Mtoe)	2	40	39	40	39	42	40	43	45
Bioenergy production (Mtoe)	85	157	155	156	158	163	153	172	191
Net imports of bioenergy (Mtoe)	0	21	20	21	22	19	14	20	32
Demand biomass(Mtoe)	85	178	175	177	180	182	166	192	223

Source: PRIMES.

The estimated changes in domestic production of biomass where used as input in the GLOBIOM/G4M model to assess the impacts on the LULUCF sink. It should be noted that

uncertainties related to the monitoring of the LULUCF sink (both emissions and absorptions) are larger than in other sectors.

What is the most notable outcome from these projections is that most of the additional demand for biomass production in the EU is met through increases in production from fast rotating plantation wood, classified as a perennial crop, and only by small increases in harvest from existing forest area. The land use changes to meet the increased biomass demand are represented in Table 9. The main change in 2030 is the increase in cropland area (for perennials) compared to the reference for the GHG40 scenario as well as the scenarios with specific RES target. The increasing share of perennials increases total agricultural production in the EU, but results in a decrease in available cropland for other uses, affecting imports and exports of agricultural commodities.

The biggest indirect impact across scenarios can be observed on the cereal market in the 45% GHG scenario with EE and RES policies where net exports decrease by 1.5% of total production compared to the Reference. Other commodities (livestock, forestry) remain more or less stable. Total cropland area increases by 2 million ha but part of the increase in perennial area (3 million ha) takes place on conventional cropland, reducing its availability for other purposes. The effect on the net trade balance is limited as demand for 1st generation biofuels decreases (-1.2 Mtoe) which spares land for other uses. On the supply side change in management systems in the crop and livestock sector and reallocation of production help compensate for decrease in available cropland area.

Table 9: Land use changes EU28 (million hectares)

Areas (million hectares)	2005	2030							
		Ref	GHG 35EE	GHG 37	GHG 40 ref	GHG 40	GHG 40 EE	GHG 40EE RES30	GHG45 EE RES35
Forest land	138	146	146	146	146	146	146	146	146
Cropland	100	105	105	105	106	106	105	106	107
of which: cropland for perennials (including plantation wood)	0	7	7	7	8	9	7	10	12
of which: cropland other crops	100	98	98	98	98	97	98	96	95
Grassland	62	62	62	62	62	62	62	62	62
Wetlands, settlements, other land	73	75	75	75	75	75	75	75	75
Other Natural Vegetation	73	59	59	59	59	58	60	58	58
TOTAL LAND	446	446	446	446	446	446	446	446	446

Source: GLOBIOM/G4M (rounded to millions)

In the reference the sink decreases to 214 $MtCO_2$. In most scenarios the impact on the sink is small, and in the GHG 40 scenarios with ambitious EE policies the sink even slightly increases. In the 45% GHG with ambitious EE and RES policies the sink decreases by 7 $MtCO_2$ to 207 $MtCO_2$ compared to the reference. In the latter scenario, increases of harvest removals of forest wood to meet biomass demand (from 620 million m^3 in reference to 623 million m^3), translates in reduction of the forest management sink from -126 $MtCO_2$ in reference to -116 $MtCO_2$. This negative effect on the forest sink is partially compensated by the increases in plantation wood (perennial crop, not harvested every year) which has a positive effect on the amount of carbon stored in the soil compared to other crops normally

planted on cropland. Therefore cropland emissions in that case are lower compared to the reference and as a result the net impact of this option on the LULUCF sink is limited compared to the reference. In the 40% GHG cases the LULUCF sink does not differ significantly from the reference with the sink increasing a bit in the GHG 40% + EE compared to reference.

Table 10: Impact on LULUCF sink

	2005	2030							
		Ref	GHG 35EE	GHG 37	GHG 40 ref	GHG 40	GHG 40 EE	GHG 40EE RES30	GHG45 EE RES35
Total harvest removal (million m^3)	529.4	620.3	620.2	620.5	620.5	620.9	616.5	620.5	6230.3
of which forest wood for energy (million m^3)	76.8	108.2	108.1	108.4	108.4	109.2	106.4	108.4	119.4
Plantation wood used for energy (million m^3)	136	98.2	94.2	107.8	120.6	130.7	102.7	131.2	168.5
LULUCF ($MtCO_2$)	-239.1	-214.1	-212.5	-211.7	-211.0	-212.3	-214.6	-214.5	-207.3
Of which:									
Total forest land	-315.7	-207.6	-206.2	-205.6	-205.6	-205.5	-210.5	-205.9	-196.3
of which forest management	-340.2	-126.4	-125.2	-124.9	-124.9	-124.5	-129.3	-125.0	-115.5
of which afforestation/reforestation	-26.6	-93.5	-93.3	-93.1	-93.0	-93.3	-93.3	-93.3	-93.2
of which deforestation	51.1	12.3	12.3	12.3	12.3	12.2	12.1	12.3	12.4
Total cropland	35.7	14.4	14.8	15.1	15.8	14.1	15.2	12.6	9.9
Total grassland	5.9	-4.9	-4.9	-5.0	-5.0	-5.0	-4.8	-5.1	-5.0
Harvested Wood Products	-9.4	-60.8	-61.0	-61.0	-61.0	-60.7	-59.3	-60.8	-60.7
Wetlands, settlements, other land	44	45	45	45	45	45	45	45	45

Source: GLOBIOM/G4M, based on PRIMES biomass demand

The main conclusions of this Section are that overall the impacts on the LULUCF sink seem limited if increased demand for bio-energy is met largely through increased use of energy crops. This would imply a significant expansion of cropland for bio-energy (increase of cropland with some 10% compared to 2005, and would be larger if the development of second generation biofuels would not decrease demand for first generation biofuels). The eventual impact on GHG emissions would depend in part on the energy crops used and farming practices applied and their impacts on soil carbon, which will need further analysis. This will have knock-on effects on other policy domains, including impacts on available land for other purposes.

If in reality increased demand is rather met through increased imports, or if increased demand is rather met through higher rates of harvest removals of forest wood, the negative impact on

the sink, be it directly or indirectly through Indirect Land Use Changes, might be higher than estimated in this assessment, while at the same time the expansion of cropland could be more limited.

5.1.2.5. Air Pollution

For this analysis the same methodology, based on the GAINS model was used as in the impact assessment for the roadmap to a competitive carbon economy. Table 11 shows that the different options to reduce GHG emissions in 2030 all reduce emissions of $PM_{2.5}$, SO_2 and NO_X compared to the reference scenario, but that such reductions are significantly larger in scenarios including ambitious EE policies and higher RES targets, reducing fossil fuel consumption and combustion.

The reduction in air pollution has positive impacts on human health. The Option with a 40% GHG reduction with moderate EE and RES policies reduces the number of life year lost due to lower $PM_{2.5}$ concentrations (a result of lower $PM_{2.5}$, SO2 and NOX emissions) by some 4 million in 2030. Whereas the option with 40% GHG reduction, ambitious EE policies and a 30% RES target reduces impacts of $PM_{2.5}$ concentrations by 11 million life years lost the option with a 45% GHG target, ambitious EE policies and a 35% RES target even reduces impacts by 13 million life years lost. Impacts for the GHG35® and GH37® are lower. Similar positive impacts occur also for mortality due to ozone, but are very small in relative terms.

The reduction in mortality can also be valued economically. The Table shows that a 40% GHG reduction with moderate EE and RES policies reduces health damage due to air pollution by €4.8 to 11.1 billion compared to the reference[76]. This is mainly from lower concentrations of $PM_{2.5}$ that result from the joint impact of reduction in SO2, NOX and $PM_{2.5}$ emissions. In the options with ambitious EE and RES policies, reductions in health damage are higher: 12.6 to 29.2 billion €/year for the option with a 40% GHG target, ambitious EE policies and a 30% RES target and by €15 to nearly 35 billion/year for the option with a 45% GHG reduction, ambitious EE policies and a 35% RES target. These health benefits are lower for the less ambitious options in Reference settings which reduce GHG emissions by 35% or 37%.

Because of lower emissions air pollution, costs to control them are lower as well, between €0.7 billion to €7 billion/year depending on the option assessed.

In addition forest, catchment and ecosystems areas where acidification and eutrophication exceed critical loads are reduced. Other morbidity (health effects) and damage to crops are also reduced (e.g. lower ground level ozone emissions), but these benefits have not been quantified in this impact assessment. Furthermore, damage to materials, crops and sensitive ecosystems (due to acidification, excess nitrogen deposition and ground level ozone) are also expected to be reduced. The forest area not exposed to acidification exceeding critical loads is expected to be 1800 km^2 higher for the option with a single 40% GHG target , 3900 km^2 for the option with a 40% GHG target and ambitious EE policies, 3640 km^2 in the option with a 40% GHG target, ambitious EE policies and a 30% RES target. The area increases to 4590 km^2 for the option 45% GHG reductions, 35% RES and ambitious EE policies. A comparable improvement occurs for the area of natural ecosystems exposed to excessive nitrogen loads. For the option with equal carbon values and a 37% GHG reduction the exposed area decreases with 2840 km^2, in option GHG40 with 2171 km^2 whereas for the option with 45% GHG

[76] The range results from the use of a high and low valuation of mortality (value of life year lost), also used for the Thematic Strategy on Air Pollution.

reductions, 35% RES and ambitious EE policies this area decreases with 4287 km^2. For the other options with ambitious EE policies the area protected is comparable to the latter.

Table 11: Impacts on air pollution and air pollution control costs in 2030 (change compared to the reference)

2030	GHG 35EE	GHG 37	GHG 40 ref	GHG 40	GHG 40 EE	GHG 40EE RES30	GHG45EE RES35
SO2 (kton)	-4	-71	-168	-100	-140	-143	-266
NOX (kton)	-125	-60	-128	-193	-328	-326	-371
PM (kton)	-27	-26	-42	-25	-115	-97	-91
Health impacts (mln life years lost due to PM2.5)	-2.5	-3.0	-5.7	-4.2	-11.5	-10.9	-13.0
Premature deaths ozone (cases per year)	-178	-68	-132	-233	-455	-450	-455
Monetary damage health PM2.5 (bn€/yr). Low estimate	-2.9	-3.5	-6.6	-4.8	-13.3	-12.6	-15.0
Monetary damage health PM2.5 (bn€/yr). High estimate	-6.6	-8.1	-15.1	-11.0	-30.6	-29.1	-34.5
Monetary damage health ozone (bn€/year): Low estimate	-0.01	0.00	-0.01	-0.01	-0.03	-0.03	-0.03
Monetary damage health ozone (bn€/year): High estimate	-0.01	-0.01	-0.02	-0.03	-0.06	-0.06	-0.06
Air pollution control costs (€2010 bn/yr)	-0.9	-0.7	-2.0	-2.4	-4.1	-4.1	-7.0
SUM reduced pollution control costs & damage reduction (€bn/yr)	3.8 to 7.6	4.2 to 8.8	8.6 to 17.1	7.2 to 13.5	17.4 to 34.8	16.7 to 33.2	21.9 to 41.5

Source: IIASA (2013) based on GAINS for emissions, health impacts and air pollution control costs (in €2010). Benefit valuation uses valuation of mortality (value of life year lost) used for the Thematic Strategy on Air Pollution €57700 to 133000 per life year lost.

In conclusion, all policy options analysed generally come with very significant reductions of sulphur oxide, while reductions of particulate matter and nitrogen oxides are much more pronounced in scenarios with ambitious energy efficiency policies. The related health benefits are also present across scenarios, but much more pronounced in scenarios including ambitious energy efficiency policies and renewables shares.

5.1.3. *Energy system impacts*

Primary energy consumption[77] is reduced in all scenarios analysed. While consumption reductions happen under all scenarios (2 to 15% in 2030 and 5 to 32% in 2050 in comparison to the Reference scenario), much higher reductions are achieved in scenarios with the enabling setting, especially if they are coupled with ambitious or very ambitious energy efficiency policies. While the renewables targets obviously change the relative importance of each energy source in the system, they also result in further reductions in primary energy consumption thanks to high efficiency of RES in electricity production. Importantly, the reduction in primary energy consumption does not come from a decrease of GDP or value added of different sectors but primarily from technological improvements in industrial

[77] Gross Inland Consumption according to Eurostat convention

processes in power generation (supply side) and on the demand side (also coupled with change in consumer behaviour).

In the Reference scenario, energy savings fall short of the 20% reduction target in 2020 but in 2030 a 21% reduction is achieved (compared to the increasing 2007 baseline projections). For the policy scenarios the savings in 2030 range from 23% to 34% and are the highest under the enabling setting a 45% GHG reduction target with ambitious EE and a 35% RES target.

As a result of reduced primary energy consumption, the energy intensity of the EU economy is reduced under all scenarios and most significantly under a 45% GHG target coupled with very ambitious EE policies and RES target. Among the scenarios resulting from 40% GHG reductions in 2030, energy intensity is reduced the most in scenarios which contain additional RES target and energy efficiency policies.

The policy scenarios demonstrate significant differences in terms of the consumption of various primary energy sources. The Table 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 all scenarios, although compared to Reference 2030 there is a limited increase in the scenario under a 40% GHG target coupled with ambitious EE policies and a more significant increase in the scenario under 35% GHG target coupled with EE policies. The situation changes after 2030, with the scenario under the sole 40% GHG target seeing highest increases in solid fuels consumption as of 2040 with significant CCS development counterbalancing the associated CO2 emissions. Small increases in the scenario under 35% GHG target coupled with EE policies finish in 2040 and later on the consumption decreases. Conversely, the scenarios with renewables targets result in the highest decreases of solid fuel consumption by 2050 (up to 38% by 2050 in absolute terms in comparison to the Reference scenario).

The absolute consumption of nuclear energy resulting from economic modelling for all countries allowing use of this technology decreases in 2030 in all policy scenarios, ranging from a 0.2% reduction under the scenario driven by a sole 40% GHG target to strong decreases in scenarios with renewables targets (as much as -59% for the scenario with a 45% GHG target coupled with strong EE policies and 35% RES target). In 2050 the corresponding range is from + 17% (scenario driven by sole 40% GHG reductions in 2030) to - 58% (for the most ambitious scenario including 35% RES target).

Oil consumption decreases in all scenarios, but much faster in those with enabling setting reflecting the facilitation of transport electrification with such enabling policies. Natural gas absolute consumption also declines in all scenarios (in general less sharply than oil) but slightly more under the scenarios featuring renewables targets, as the displacement of gas by renewables is not fully compensated by the increased need for gas as backup generation to variable renewables. By 2050 in all scenarios under the enabling setting, natural gas becomes the main fossil fuel.

Consumption of RES grows in 2030 in most scenarios. The growth is naturally the strongest under scenarios with explicit RES targets. In 2050, there is very strong RES growth across all scenarios in enabling settings, all achieving reductions of around 80% GHG. Concerning specifically RES consumption[78], their growth is to some extent driven by the GHG targets (present in all scenarios analysed) but it can be further boosted in the presence of the

[78] The development of RES is measured with RES share in final energy consumption – in line with the 2020 RES target.

dedicated RES targets. Enabling setting presupposing the necessary grid improvements also facilitate RES penetration. Finally, increased RES strengthens the effects of EE through increased efficiency.

Without a dedicated RES target for 2030, the pull effect of GHG reduction is projected to lead to RES shares ranging from 25% to 27% in 2030 and from 30% to 51% in 2050. While RES shares increase alongside the ambition on GHG reductions, it has to be noted that higher ETS prices needed for more ambitious GHG cuts would not only trigger more RES investment, but also lead to fuel switching and more energy efficiency investment. The overall RES share in 2030 would translate into RES-Electricity shares between 43 % and 47%. RES-Heating & Cooling develops in parallel with the overall RES share, while RES-Transport would reach between 12% and 14%.

A 30% RES target on the basis of 40% GHG reduction would entail a RES-E share of 53% in 2030. Again RES-H&C rises similar to overall RES, while RES-T shares increases would be no different from scenarios without a RES target. The presence of ambitious energy efficiency policies results in some reduction in RES penetration mostly in electricity and to a smaller extent in heating and cooling.

A 35% RES target in the context of 45% GHG cuts would in 2030 lead to a two third contribution from RES to electricity, slightly over one third RES contribution to heating and cooling demand while RES-T shares would be16%.

The changes in the energy mix translate accordingly in the power generation capacity installed for different fuels: by 2030 all scenarios see a slight reduction in the installed capacity of solids, except from the scenario driven by 40% GHG target coupled with ambitious EE policies, where it remains stable. By 2050 this reverses only for the scenario driven by a 40% GHG target, seeing power generation capacity for solids increase, with mitigation occurring through CCS. Similarly, this scenario is also the only one that experiences significant increases in nuclear capacity from 2030 to 2050 whereas these capacities decline in all other scenarios. On the other hand, capacity clearly increases for renewables in all scenarios with enabling settings, whereas for gas it decreases for all scenarios. Regarding the **investment in power generation capacity**, there are no such clear trends as for installed capacity since investments have very long time horizons and only partially react to policies and changing fuel prices. A general trend can be distinguished that investments in power generation from renewables increase (in comparison to the Reference scenario) strongly in all scenarios in enabling setting whereas investments in gas-fired power generation decrease for all of the scenarios. For solids, no specific pattern can be distinguished apart from the strong decline in investments under all scenarios featuring a RES target.

Closely linked with energy consumption and energy mix is the issue of import dependency. **Net energy imports** decrease significantly (in comparison to the Reference) for all scenarios already in 2030 but the trend is even more pronounced in 2050. The decreases are more significant for scenarios under the enabling setting since these are based on the assumption of adequate development of infrastructure for domestically produced renewables. While the scenario driven by a 40% GHG target demonstrates a reduction of net imports by 7% in 2030 and 45% in 2050 (compared to the Reference scenario), the scenario combining 40 % GHG reductions, 30% RES and ambitious energy efficiency policies brings a 16% decrease in net imports in 2030 and 53% in 2050. The scenario with the highest ambition for GHG, RES and EE measures makes an even more pronounced difference in 2030 but towards the end of the projected period the differences with other scenarios become smaller reflecting the fact that all scenarios in enabling setting reflect the same carbon budget constraint.

Import dependence is in the short term much less affected by policy choices and there are little differences between scenarios in 2030with respect to the reference scenario and present levels. In 2050, however, the Reference scenario and scenarios in reference setting still have 51-57% import dependence whereas all other scenarios decrease it to below 40%, due to the higher use of renewables across scenarios and the lower use of, mainly imported, fossil fuels. While RES targets foster the domestic production of renewable energy sources, they also reduce overall energy consumption because of their high efficiency (including compared to other indigenous sources). Consequently, no lower import dependence is demonstrated in scenarios with explicit RES targets compared with those without as import dependence is measured in relative terms[79].

As regards the net imports for specific fuels, fossil fuels imports decline for all the scenarios under the enabling setting throughout the projection period. Solids imports decline for all scenarios but in the most pronounced manner in the scenarios with RES targets, which represent much stronger reductions of the fossil fuel import bill. On this basis, it is clear that while RES does not necessarily impact import dependence as such, it has a positive impact on the imports of fossil fuels in absolute terms. RES imports grow throughout the projection period for all scenarios and there are additional increases in imports that would be accountable to RES targets.

Net energy import decreases translate into savings in the energy fossil fuel imports bill. Whereas savings (calculated as a cumulative value over a 20 year period) are very limited for scenarios in Reference settings, with enabling settings they range from € 190 billion to € 550 billion in 2030 and from € 3404 billion to € 4425 billion in 2050. 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 12: Impacts on primary energy consumption in 2030 and 2050.

Scenarios with enabling settings (compatible with 2050 GHG objectives):

		"Carbon val." 2030 / 2050	**"Concrete EE measures" 2030 / 2050**		
	Reference	GHG40	GHG40EE	GHG40EE RES30	GHG45EE RES35
Primary Energy Consumption (Mtoe)	1,611 / 1,630	1,534 / 1,393	1,448 / 1,183	1,433 / 1,125	1,364 / 1,102
Energy Savings (*evaluated against the 2007 Baseline projections for 2030)*	-21.0 / n.a.	-25.1 / n.a.	-29.3 / n.a.	-30.1 / n.a.	-33.7 / n.a.
Energy Intensity (2010 = 100) *(primary energy to GDP)*	67 / 52	64 / 44	60 / 38	60 / 36	57 / 35
- Industry[80]	81 / 68	78 / 55	74 / 48	73 / 47	72 / 46

79 Due to higher efficiency levels, the difference between primary and final energy consumption of (non-thermal) RES is smaller compared with e.g. fossil fuel based energy consumption. This means that for any given final energy consumption, higher shares of RES means lower primary energy consumption, which is the denominator in the import dependency ratio. This ratio of import dependency also considers some replacement of nuclear with RES, and nuclear energy generated on EU soil is considered domestic irrespectively of the origin of Uranium etc.

80 Measured as energy consumption / value added

- Residential[81]	72 / 54	67 / 40	60 / 29	61 / 29	60 / 29
- Tertiary[82]	65 / 49	59 / 34	51 / 26	52 / 26	50 / 27
- Transport[83]	71 / 56	70 / 44	66 / 43	66 / 43	66 / 42
Primary Energy Consumption in Reference and % change compared to Reference	1611 / 1630	-4.8 / -14.5	-10.2 / -27.4	-11.1 / -31.0	-15.4 / -32.4
- Solid fuels	174 / 124	-10.8 / 7.2	2.9 / -11.9	-0.9 / -38.4	-29.3 / -38.2
- Oil	520 / 498	-3.3 / -62.1	-10.7 / -63.0	-10.6 / -62.9	-11.1 / -64.0
- Natural gas	397 / 397	-13.2 / -36.9	-21.1 / -48.1	-27.4 / -54	-29.5 / -54.4
- Nuclear	201 / 216	-0.2 / 17.1	-7.5 / -2.7	-21.6 / -40.9	-59.0 / -57.6
- Renewables	320 / 398	3.5 / 43.6	-4.4 / 19.5	9.4 / 39.7	30.2 / 44.9
Primary Energy Consumption Share of :					
- Solid fuels	10.8 / 7.6	10.1 / 9.5	12.4 / 9.2	12 / 6.8	9.0 / 7.0
- Oil	32.3 / 30.5	32.8 / 13.5	32.1 / 15.6	32.5 / 16.4	33.9 / 16.3
- Natural gas	24.6 / 24.3	22.5 / 17.9	21.6 / 17.4	20.1 / 16.2	20.5 / 16.4
- Nuclear	12.5 / 13.2	13.1 / 18.1	12.8 / 17.8	11.0 / 11.4	6.0 / 8.3
- Renewables	19.9 / 24.4	21.6 / 41.0	21.2 / 40.2	24.5 / 49.4	30.6 / 52.3
Renewables Share[84] - Overall	24.4 / 28.7	26.5 / 51.4	26.4 / 50.8	30.3 / 59.2	35.4 / 61.7
- Share in electricity, heat. & cooling[85]	31 / 36.8	34.2 / 51.4	34.1 / 51.4	39.7 / 63.4	47.3 / 66.7
- Share in heating & cooling	23.8 / 26.6	25.9 / 49.0	25.8 / 46.0	30.6 / 53.9	35.2 / 54.1
- Share in electricity	42.7 / 50.1	47.3 / 53.2	46.1 / 55.2	53.1 / 70.3	65.7 / 75.8
- Share in transport	12 / 13.9	12.8 / 67.9	14.0 / 67.6	14.6 / 71.7	15.6 / 74.9
Net Energy Imports (2010=100)	96 / 101	89 / 56	83 / 50	81 / 47	78 / 46
Net Imports of Gas (2010=100)	105 / 122	91 / 74	82 / 61	74 / 55	72 / 53
Import Dependency (net imports to primary energy consumption)	55.1 / 56.6	53.6 / 36.8	52.8 / 38.2	51.8 / 38.0	52.3 / 38.2
Fossil Fuel Net Imports in bn €'10 *(average annual 2011-30 / 2031-50)*	461 / 548	452 / 375	441 / 343	439 / 334	434 / 326

81 Measured as energy consumption / private income

82 Measured as energy consumption / value added

83 Measured as energy consumption / GDP

84 Share of RES in gross final energy consumption according to 2009 RES Directive.

85 Contribution of RES in gross final energy consumption of electricity and heating & cooling, based on the individual calculations of the RES according to 2009 RES Directive.

Fossil Fuels Import Bill Savings in 2011-2030/2031-2050 compared to reference (bn € '10) *(cumulative 20 year savings from imports)*	n.a.	-190 / -3,404	-401 / -4,084	-450 / -4,271	-550 / -4,425

Scenarios with reference settings (not compatible with 2050 GHG objectives):

Indicator		**"Reference settings, carbon values or EE policies (GHG35)" 2030 / 2050**		
	Reference	GHG35®	GHG37®	GHG40®
Primary Energy Consumption (Mtoe)	1,611 / 1,630	1,542 / 1,441	1,576 / 1,553	1,548 / 1,542
Energy Savings (*evaluated against the 2007 Baseline projections for 2030)*	-21.0 / n.a.	-24.4 / n.a.	-22.9 / n.a.	-24.4 / n.a.
Energy Intensity (2010 = 100) *(primary energy to GDP)*	67 / 52	64 / 46	66 / 49	65 / 49
- Industry	81 / 68	78 / 61	81 / 68	81 / 68
- Residential	72 / 54	67 / 48	68 / 48	66 / 47
- Tertiary	65 / 49	61 / 45	60 / 41	57 / 39
- Transport	71 / 56	69 / 45	71 / 56	71 / 56
Primary Energy Consumption in Reference and % change compared to Reference	1611 / 1630	-4.3 / -11.6	-2.2 / -4.7	-3.9 / -5.4
- Solid fuels	174 / 124	7.6 / -15.8	-2.8 / -3.5	-15.7 / -7.5
- Oil	520 / 498	-4.6 / -25.4	-0.8 / -2.6	-1.6 / -3.7
- Natural gas	397 / 397	-13.1 / -13.9	-4.4 / -9.8	-6.1 / -14.2
- Nuclear	201 / 216	-2.8 / 0.8	-2.5 / -6.5	-2.5 / -4.0
- Renewables	320 / 398	-0.4 / 2.7	-1.1 / -1.5	0.4 / 1.2
Primary Energy Consumption Share of :				
- Solid fuels	10.8 / 7.6	12.1 / 7.2	10.7 / 7.7	9.5 / 7.4
- Oil	32.3 / 30.5	32.2 / 25.8	32.7 / 31.2	33.1 / 31.1
- Natural gas	24.6 / 24.3	22.4 / 23.7	24.1 / 23	24.1 / 22.1
- Nuclear	12.5 / 13.2	12.7 / 15.1	12.4 / 13	12.7 / 13.4
- Renewables	19.9 / 24.4	20.7 / 28.3	20.1 / 25.2	20.8 / 26.1
Renewables Share - Overall	24.4 / 28.7	25.5 / 33.7	24.7 / 29.9	25.5 / 31.0
- Share in electricity, heating & cooling	31.0 / 36.8	32.6 / 39.6	31.6 / 38.5	32.9 / 39.9
- Share in heating & cooling	23.8 / 26.6	24.6 / 28. 6	24.4 / 28.3	25.5 / 30.5
- Share in electricity	42.7 / 50.1	45.4 / 52.2	43.1 / 50.9	44.6 / 51.4
- Share in transport	12.0 / 13.9	12.9 / 34.4	12.0 / 15.8	12.0 / 16.8

Net Energy Imports (2010=100)	96 / 101	90 / 81	94 / 96	92 / 94
Net Imports of Gas (2010=100)	105 / 122	91 / 104	100 / 110	99 / 104
Import Dependency (net imports to primary energy consumption)	55.1 / 56.6	53.7 / 51.3	55.1 / 56.4	54.8 / 55.5
Fossil Fuel Net Imports in bn €'10 *(average annual 2011-30 / 2031-50)*	461 / 548	451 / 470	459 / 529	457 / 518
Fossil Fuels Import Bill Savings in 2011-2030/2031-2050 compared to reference (bn € '10) *(cumulative 20 year savings from imports)*	n.a	-198 / -1554	-46 / -382	-83 / -592

Source: PRIMES 2014.

Final energy demand declines in a similar manner as primary energy consumption with similar differences in magnitude of the decreases brought by the enabling setting, energy efficiency policies and RES targets. The residential and tertiary sectors experience the strongest reduction (in comparison to the Reference) as these can most easily switch fuels, and as they are targeted by a majority of energy efficiency policies improving significantly insulation. The relative share of electricity increases in final energy demand, especially for the scenarios with specific RES targets.

Gross electricity generation decreases by 2030 for all scenarios in comparison to the Reference. In 2030-2050 it continues to decrease for all scenarios except the one driven by sole 40% GHG reduction target. For scenarios that achieve 40% GHG reductions in 2030 and the long term GHG reductions goals by 2050, the scenarios with ambitious energy efficiency would see no reduction in generation from solids, but this reverses after 2030 with electricity generation from solids (with CCS), as well as nuclear, increasing only in the scenario driven by a sole 40% GHG reduction target. For all scenarios generation from renewables increases and increases are most significant for scenarios with RES targets.

The growing role of renewables is reflected in annual electricity grid cost (grid maintenance and investment), which is already significant in the Reference scenario. Differences with regard to the Reference are visible only for scenarios with RES targets. As renewable energies require more sophisticated infrastructure (electricity lines, smart grids, storage facilities, etc.), the grid costs are higher under the scenarios featuring RES targets by 4%-10 % in 2030 and by 6%-11% in 2050 in comparison to the Reference scenario.

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), which increase substantially already in 2030 under scenarios with RES targets (between 2 to 3 percentage points compared to Reference) whereas they stay almost constant for other scenarios. This is due to synergies between the increased penetration of renewable energies and co-generation which mainly uses biomass as a feedstock. In 2050, however, the CHP shares decline (in comparison to the Reference) for all scenarios as there is increasing competition for biofuels/biomass feedstocks in transport. The sharpest largest decrease happens under the scenario driven by a 40% GHG target for 2030

Concerning CCS development, the development (observed in terms of shares of electricity from CCS (presented in the Table) or CO2 emissions captured by CCS) is very slow up until after 2030 in all scenarios. For the scenarios with ambitious EE there is actually a decrease compared to Reference. Post 2030, almost all scenarios show the increase in emissions captured but the most significant deployment happens under the scenario driven by a 40% GHG target partly because, under carbon pricing as main driver, solids coupled with CCS

become a cost effective option to mitigate CO2 emissions, especially due to the higher ETS prices. This is also reflected in the higher share of coal in the fuel mix under that scenario. In 2050, CCS deployment increases quite significantly in all scenarios, except in the scenario driven by 45% GHG and 35% RES targets in 2030. In general, the CCS share in 2050 is significantly lower in scenarios with RES targets.

Energy related CO2 emissions decrease between 2 to 15 percentage points in 2030 and by between 4 to 49 percentage points in 2050 (in comparison to the Reference). Only very small decreases are achieved for the scenarios under the Reference setting, causing the EU to miss the 80% GHG reduction objective for 2050. The decreases in 2030 are highest for the most ambitious scenario in terms of GHG, RES and energy efficiency measures.

As regards carbon intensity of power generation[86], there are important improvements in all the scenarios, including in the Reference scenario. The strongest improvements occur already in 2030 under the most ambitious scenario in terms of GHG, RES and energy efficiency measures, while other scenarios achieve much greater improvements in a post-2030 perspective.

Table 13 Other energy system impacts

Scenarios with enabling settings (compatible with 2050 GHG objectives):

Indicator		**"Carbon val." 2030 / 2050**	**"Concrete EE measures" 2030 / 2050**		
	Reference	GHG40	GHG40EE	GHG40EE RES30	GHG45EE RES35
Final Energy Demand (Mtoe)	1,126 / 1,151	1,073 / 885	991 / 752	995 / 747	978 / 743
- Industry share	27.3 / 26.8	27.5 / 28.3	28.2 / 28.7	27.7 / 28.3	27.9 / 28.3
Residential share	26.4 / 26.4	25.9 / 25.5	25.3 / 21.9	25.6 / 22.0	25.3 / 22.2
-Tertiary share	14.9 / 15	14.2 / 13.4	13.4 / 12.2	13.7 / 12.2	13.3 / 12.7
-Transport share	31.4 / 31.8	32.4 / 32.9	33.1 / 37.2	33.0 / 37.5	33.5 / 36.8
Gross Electricity Generation (*TWh*)	3,664 / 4,339	3,532 / 5,040	3,431 / 4,210	3,428 / 4,196	3,279 / 4,271
- Solids Share	13 / 8.4	11.6 / 10.1	15.3 / 9.3	14.2 / 5.6	8.0 / 4.9
- Oil Share	0.6 / 0.5	0.5 / 0.1	0.5 / 0.1	0.4 / 0.2	0.7 / 0.2
- Natural Gas Share	19.5 / 17.3	15.3 / 12.5	14.2 / 11.6	11.9 / 9.8	13.3 / 9.1
- Nuclear share	21.8 / 21.3	22.6 / 21.6	21.4 / 21.3	18.0 / 12.8	9.8 / 8.9
- Renewables share	44.5 / 51.6	49.3 / 54.2	48.0 / 56.2	54.9 / 69.4	67.3 / 73.7
- of which hydro share	10.8 / 9.8	11.2 / 8.6	11.5 / 10.2	11.7 / 10.5	12.5 / 10.3
- of which wind share	21.0 / 24.8	23.9 / 26.5	22.6 / 26.4	26.0 / 33.4	31.4 / 36.4
- of which Solar, tidal, etc. share	5.8 / 8.4	6.4 / 9.5	6.1 / 9.5	6.9 / 12.1	8.9 / 12.6

86 The amount of CO2 emitted per unit of energy consumed or produced.

- of which Biomass & waste share	6.6 / 7.9	7.5 / 8.6	7.5 / 9.3	10.0 / 12.0	13.3 / 12.9
CCS indicator (% of electricity from CCS) (difference in p.p.)	0.45 / 6.9	0.77 / 14.72	0.29 / 10.82	0.23 / 7.47	0.25 / 3.01
CHP indicator (% of electricity from CHP) (difference in p.p.)	16.1 / 16.2	16.4 / 14.0	16.4 / 14.4	17.8 / 15.6	19.6 / 15.8
Energy related CO2 emissions reduction vs 2005	-30.5 / -42.9	-36.8 / -80.9	-38.1 / -81.7	-40.1 / -81.8	-45.7 / -79.9
Carbon intensity of power generation *(per MWhe+MWhth)*	17.8 / 7.9	15.1 / 0.7	18.0 / 1.3	16.1 / 1.5	12.1 / 3.0
Annual Electricity Grid Cost in Reference (€'10 per MWhe) and % change compared to Reference	39.97 / 44.83	2.7 / -0.4	0.7 / -3.0	3.9 / 5.8	10.3 / 10.9

Scenarios with reference settings (not compatible with 2050 GHG objectives):

Indicator		**"Reference settings, carbon values Or concrete EE measures (GHG35)"** **2030 / 2050**		
	Reference	GHG35®	GHG37®	GHG40®
Final Energy Demand (Mtoe)	1,126 / 1,151	1,074 / 995	1,099 / 1,091	1,082 / 1,075
- Industry share	27.3 / 26.8	27.4 / 27.6	27.9 / 28.4	28.2 / 28.7
Residential share	26.4 / 26.4	26.1 / 27.0	25.8 / 24.8	25.4 / 24.5
-Tertiary share	14.9 / 15.0	14.6 / 15.7	14.1 / 13.2	13.7 / 12.8
-Transport share	31.4 / 31.8	31.8 / 29.7	32.2 / 33.6	32.7 / 34.0
Gross Electricity Generation (*TWh*)	3,664 / 4,339	3,531 / 4,339	3,586 / 4,180	3,534 / 4,111
- Solids Share	13.0 / 8.4	15.5 / 6.9	12.9 / 8.5	10.6 / 8.4
- Oil Share	0.6 / 0.5	0.5 / 0.3	0.6 / 0.5	0.6 / 0.5
- Natural Gas Share	19.5 / 17.3	14.2 / 16.9	19.2 / 16.9	19.5 / 15.5
- Nuclear share	21.8 / 21.3	22.0 / 21.5	21.7 / 20.6	22 / 21.6
- Renewables share	44.5 / 51.6	47.2 / 53.5	45 / 52.5	46.5 / 53.0
- of which hydro share	10.8 / 9.8	11.2 / 9.9	11.0 / 10.2	11.2 / 10.4
- of which wind share	21.0 / 24.8	22.3 / 24.9	21.3 / 25	22.0 / 25.1
- of which Solar, tidal, etc. share	5.8 / 8.4	6.1 / 8.7	5.7 / 8.5	5.8 / 8.3
- of which Biomass & waste share	6.6 / 7.9	7.3 / 9.2	6.8 / 8.2	7.2 / 8.5
CCS indicator (% of electricity from CCS) (difference in p.p.)	0.45 / 6.9	0.27 / 4.82	0.5 / 6.96	0.73 / 9.44
CHP indicator (% of electricity from CHP) (difference in p.p.)	16.1 / 16.2	16.5 / 16.8	16.2 / 16.3	16.4 / 15.5
Energy related CO2 emissions reduction vs 2005	-30.5 / -42.9	-33.3 / -54.1	-32.3 / -46.4	-35.9 / -49.6

Carbon intensity of power generation *(per MWhe+MWhth)*	17.8 / 7.9	18 / 7.7	17.6 / 7.8	15.6 / 6.1
Annual Electricity Grid Cost in Reference (€'10 per MWhe) and % change compared to Reference	39.97 / 44.83	0.3 / 4.0	0.0 / -1.2	1.0 / -1.0

The main conclusions from this Section are that the policy scenarios demonstrate significant differences in terms of the consumption of various primary energy sources (notably in terms of coal, gas and RES) with impacts on power generation capacity and power generation investment. Nevertheless, primary energy consumption is reduced and significant energy savings are achieved in all scenarios analysed, especially in scenarios with ambitious EE policies and RES targets. Consequently, the energy intensity of the EU economy is reduced.

While some scenarios have a pre-set RES target, other scenarios also see RES shares increase – thanks to the pull effect of the GHG reduction, though to a lower level than the pre-set target. Net imports decrease significantly for all scenarios and in more pronounced manner under the scenarios with ambitious EE policies. While there are only small differences in terms of import dependence which is also altered by energy savings, the positive impacts of scenarios are well visible in the fossil fuels import bill savings. The savings are the highest for scenarios with ambitious EE policies and RES targets. Finally all scenarios have impact on development of CHP and CCS, which visibly increase their penetration, with the scenario focussing on GHG only having the highest shares of CCS. Because of all the above, carbon intensity of the power generation improves significantly.

5.1.4. Economic impacts

5.1.4.1. Economic impacts in the energy system

As explained in Section 2.3, the EU Reference scenario 2013 projecting the consequences of already adopted policies as well as developments largely unrelated to policy shows until 2020 an increasing ratio of total energy system cost to GDP, from 12.8 % in 2010 to 14.0 % in 2030, and then decreasing to 12.3 % in 2050. This development reflects rising energy import prices, the need to replace ageing energy infrastructure and the extension and enhancement of network infrastructures and other investment costs in the framework of already agreed policies; while the benefits of this investment in terms of fuel spending is more tangible in the longer term. The policy scenarios evaluated all show higher energy system costs up to 2030 and beyond. Compared to the EU Reference Scenario 2013, energy system costs in policy scenarios are in the year 2030 0.03 to 0.84 percentage points higher compared to GDP (see Table 14). These additional increases are smaller than those resulting under the Reference scenario itself. This said, differences between policy scenarios and the Reference scenario as regards the *average* annual system costs over the period 2011 to 2030 are small in relative terms, though differences exist between policy scenarios. In 2050, all policy scenarios show significantly higher total energy system costs compared to GDP than the Reference scenario, of 0.33 to 3.18 percentage points, the lower range representing scenarios that would not be compatible with 2050 climate objectives. The scenario driven by 35% GHG target combined with EE policies produces the lowest system cost increases compared to the Reference scenario in 2030 of 0.03%. Over the period 2011-2030, it even produces lower system costs compared to the Reference scenario as strengthening of moderate energy efficiency policies after 2020, as opposed to gradual phase out assumed in the EU Reference Scenario 2013, contributes to further removal of barriers, bringing financial benefits for consumers related to

stationary uses and offsetting a large part of the additional capital costs (even though including disutility costs, costs remain higher than in Reference) [87].

In assessing energy system costs, a series of important considerations should 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 discount rates for energy users according to the sector.

Moreover, energy policies addressing barriers to energy efficiency, such as lack of finance, of information or split incentives can lead to lower discount rates, notably if Energy Service Companies (ESCOs) come into play and take care of services and households' energy operations and investment. In simulating the economic decision-making such lower discount rates are applied where, for example, lack of information and finance is addressed by specialised companies that provide energy services in a professional way on the basis of highly energy efficient equipment installed at the consumer site. This action is thereby facilitating economically rational choices of energy consumers by, for example, providing professional support through such ESCOs in order to better exploit the existing substantial energy efficiency potential, with both energy consumers and ESCOs benefiting from the significant energy costs savings available. Also, the total energy economy benefits via, for example, lower energy import costs and lower energy supply investment requirements contribute to lowering the system costs.

Discount rates also play a role in determining annuities for investments in the context of calculating energy system costs. 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 the 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. 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.

With this in mind, the modelling results suggest that such system cost increases both for 2030 and 2050 are the highest in the scenario with a 45% GHG reduction, ambitious EE and 35% RES in 2030 (see Table 14). Clearly, the level of ambition as regards renewables and energy efficiency policies impact system costs[88] while at the same time reduce compliance costs related to the ETS itself (and have a positive impact on the fossil fuel trade balance). It has to be noted that costs are, in part, higher in the scenarios that achieve 40% and 45% GHG reductions with ambitious EE and RES because the achieved levels of EE and RES penetration are higher than those achieved in the scenarios focusing only on GHG reductions as well as considering the different modelling approaches implemented which reduce

[87] Due to changing behaviour that results in less consumption of energy services compared to Reference there are associated disutility costs.

[88] A discarded scenario (see Section4.1.2.3) resulting in 40% GHG reductions in 2030 based on very high ambition level of both RES and EE but no changes to the ETS reduction factor (not shown in Table 2) would result in even higher system costs, as many abatement and efficiency options in the ETS sectors with relatively low cost would not be taken advantage of.

comparability among scenarios (see Section 5.1). The costs should be thus measured against the benefits in terms of energy security and energy savings. The long term costs and cost-efficiencies of the various scenarios are challenging to assess with any precision. What is clear is that technology development is necessary for long-term cost efficiency and needs specific R&D support at a right scale. The impacts of these developments can have significant impacts on technology costs.

The modelling results also show synergies between ambitious RES and EE policies. Adding a specific renewables target (higher than what otherwise would have resulted) to a comparable scenario with ambitious EE policies but without such a RES target has a very low impact on cost increases and investment expenditures in generation and boilers in relative terms (see Table 14). In other words, the benefits from additional RES targets in terms of local employment as well as domestic investment expenditure rather than outflows of income for fossil fuel imports have a positive growth and further employment effects with only limited additional energy system costs . In addition, there are important interactions between the two areas, with higher energy efficiency resulting in lower energy consumption, which directly impacts the share of renewables (which is measured as a percentage of final energy consumption). Strong energy efficiency measures can therefore *themselves* contribute to increased shares of renewables because of reduced need for additional new renewables development.

The *components* of energy system costs differ substantially across policy scenarios. Energy Purchases (including fuel, steam and electricity costs) are significantly reduced in all scenarios, most notably in scenarios with explicit EE policies and RES targets; while investment costs increase, again more notably in scenarios with explicit EE policies and RES targets (see Table 14). This is due to the higher levels of EE and RES achieved in these scenarios, as well as to the approach to how policies are modelled. Furthermore, 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 lower fuel costs) by an amount that would correspond to some 40% of the cost of investments in energy efficiency in the residential sector[89].

These indications should be put in the context of the EU's deteriorating trade balance for fossil fuels. While the EU possesses significant reserves of certain fossil fuels, in particular coal, reduced fuel costs would positively impact the EU's trade balance and keep funds in the EU economy. Moreover, while higher investment expenditures add to system costs, investment costs for the "buyer" will be revenue for the "seller", i.e. for sectors and companies providing technologies and solutions for the reduction of emissions, the improvement of energy efficiency, the deployment of renewables, etc. In an increasingly open world economy, part of this revenue will go to companies outside the EU, but such investments have greater potential for driving jobs and growth in the EU than fuel imports, in particular due to the local nature of much energy efficiency investment, renewables installation, etc. and the industrial and technological leadership the EU companies still have in terms of energy efficient and low-carbon technology (see also social impacts Section 5.1.5).

[89] 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/20130619-energy_performance_certificates_in_buildings.pdf

Table 14: Energy system costs and sub-components[90]

Scenarios with enabling settings (compatible with 2050 GHG objectives):

Indicator		"Carbon values" 2030 / 2050	"Concrete EE measures" 2030 / 2050		
	Reference	GHG40	GHG40EE	GHG40EERES30	GHG45EERES35
Total System Costs in bn €'10 *(average annual 2011-30 / 2031-50)*	2,067 / 2,520	2,069 / 2,727	2,089 / 2,881	2,089 / 2,891	2,102 / 2,925
Total System Costs as % of GDP *(average annual 2011-30 / 2031-50)*	14.30 / 13.03	14.31 / 14.10	14.45 / 14.90	14.45 / 14.95	14.54 / 15.12
Total System Costs as % of GDP increase *(average annual 2011-30 / 2031-50)* compared to Reference in % points	n.a.	0.01 / 1.07	0.15 / 1.87	0.15 / 1.92	0.24 / 2.09
Total System Costs as % of GDP in 2030/2050 *(2010 value: 12.76 %)*	14.03/ 12.30	14.18 / 13.96	14.57 / 15.25	14.56 / 15.35	14.87 / 15.48
Total system Costs as % of GDP increase compared to Reference in % points, in 2030/2050	n.a.	0.15 / 1.65	0.54 / 2.95	0.54 / 3.05	0.84 / 3.18
Energy Purchases in bn €'10 in Reference and change compared to Reference *(average annual 2011-30 / 2031-50)*	1,454 / 1,586	-18 / -192	-34 / -339	-31 / -319	-23 / -308
Investment Expenditures in bn €'10 in Reference and change compared to Reference *(average annual 2011-30 / 2031-50)*	816 / 949	38 / 239	59 / 365	63 / 384	93 / 384
Industry	19 / 30	5 / 58	18 / 122	18 / 122	22 / 118
Residential and tertiary	50 / 38	25 / 79	40 / 175	34 / 183	47 / 176
Transport	660 / 782	2 / 61	2 / 59	2 / 59	2 / 71
Grid	37 / 41	4 / 15	1 / 1	3 / 6	5 / 11
Generation and boilers	50 / 59	3 / 26	-2 / 7	5 / 13	18 / 8

Scenarios with reference settings (not compatible with 2050 GHG objectives):

Indicator		"Reference settings, carbon values Or concrete EE measures (GHG35)" 2030 / 2050

[90] 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. 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. They do not include any disutility costs associated with changed behaviour, nor the cost related to auctioning.

	Reference	GHG35®	GHG37®	GHG40®
Total System Costs in bn €'10 *(average annual 2011-30 / 2031-50)*	2,067 / 2,520	2,064/2,584	2,073/2,569	2,074/2,590
Total System Costs as % of GDP *(average annual 2011-30 / 2031-50)*	14.30 / 13.03	14.28 / 13.36	14.34 / 13.28	14.35 / 13.39
Total System Costs as % of GDP increase *(average annual 2011-30 / 2031-50)* compared to Reference in % points	n.a.	-0.02[91] / 0.33	0.04 / 0.25	0.05 / 0.36
Total System Costs as % of GDP in 2030/2050 *(2010 value: 12.76 %)*	14.03 / 12.3	14.06 / 12.94	14.16 / 12.63	14.23 / 12.71
Total system Costs as % of GDP increase compared to Reference in % points, in 2030/2050	n.a.	0.03 / 0.64	0.13 / 0.33	0.20 / 0.41
Energy Purchases in bn €'10 *(average annual 2011-30 / 2031-50)*	1,454 / 1,586	-26 / -191	-8 / -58	-8 / -65
Investment Expenditures[92] in bn €'10 in Reference and change compared to Reference *(average annual 2011-30 / 2031-50)*	816 / 949	17 / 101	19 / 30	30 / 37
Industry	19 / 30	11 / 32	0 / 0	0 / 0
Residential and tert.	50 / 38	8 / 14	22 / 35	33 / 43
Transport	660 / 782	0 / 51	0 / 0	-1 / -1
Grid	37 / 41	-2 / 5	-1 / -3	-2 / -4
Generation and boilers	50 / 59	0 / 0	-1 / -2	0 / -1

Source: PRIMES 2014.

The total investment expenditure will obviously differ between various sectors of the economy, with the most pronounced additional (in comparison to the Reference scenario) needs especially in the residential sector (between € 8 billion to € 47 billion of average additional annual spending in 2011-30) but also in industry. The EU Reference scenario 2013 projects significant investment expenditures in both transport and the energy sector up to 2030 and beyond, but in a 2030 perspective there are no significant changes in relative terms. Post 2030, investment expenditures in the transport sector increase very significantly, in large part relating to electrification. Additional investment expenditure for industry (annual average) compared to the EU Reference Scenario 2013 range from almost zero to € 22 billion[93]. The lower ranges are representing the scenarios in reference setting with 37% target without ambitious EE and the upper ranges represent the more ambitious scenarios featuring EE and RES policies. Investment expenditures in industry are also more pronounced in scenarios with ambitious EE measures because they foresee the introduction of best available technologies

91 Including disutility costs, cost over the period 2010-2030 are higher than in Reference, due to changing behaviour that results in less consumption of energy services compared to Reference.

92 Investments expenditures include total purchases of transport equipment for households and businesses (including road and non-road transport), but not infrastructure costs.

93 In Constant €2010.

for all industries, in particular compared to scenarios solely based on carbon and efficiency values.

Other important economic impacts directly affecting all energy consumers are impacts on electricity prices[94], the ETS price and the abatement cost in the non-ETS sectors presented in Table 15 below. The significant increases in electricity prices already under the Reference scenario (31% increase in real terms until 2030, compared to 2010) are described in Annex 7.1, with important drivers being the impact of rising energy import prices of all fossil fuels by 40% and more up to 2020, the need for strong necessary infrastructure investment to replace obsolete capacity and extend the grids, as well as agreed policies to achieve the energy and climate objectives of the package. Electricity price changes compared to the EU Reference Scenario 2013 range from – 1% to +11% in the year 2030. Except for the scenario driven by the most ambitious GHG, RES and EE, the increases (or even decreases) are fairly moderate. The positive reducing impact on electricity prices from ambitious energy efficiency policies[95] – both in a 2030 and 2050 perspective is noticeable. In the scenario driven by 40%GHG target and ambitious EE policies price projections for 2030 are actually lower than in the EU Reference Scenario 2013.

Assuming cost-efficient deployment of RES across the EU, the analysis suggests that adding an explicit renewables target of 30% in 2030 to a scenario already including ambitious EE policies would lead to only slightly higher electricity prices reflecting impacts on investment expenditures for the deployment of new capacity and adaptation of the electricity system[96] that overcompensate for the low operational costs of most renewables. Without ambitious EE policies, the impact of higher RES penetration on electricity prices would be higher, reflecting the need for more RES deployment to ensure a specific share if energy consumption is higher.

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 the EU Reference Scenario 2013, 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 11 and 53 €/tCO2 in 2030, depending on the specific scenario (see Table 15). In a 2050 perspective, a continuation of the approach to 2030 would result in 85 to 264 €/tCO2, depending on the scenario. Scenarios based on more ambitious and explicit energy efficiency policies and higher ambition levels for renewables than those that would result from single GHG target and carbon pricing demonstrate a *significantly lower* ETS price compared to scenarios driven by a GHG target. This reflects the positive contribution of both renewables and energy efficiency to emission reductions in the ETS sectors, in particular in the power sector (both directly and indirectly through lower electricity consumption), as well as, (driven by ambitious efficiency policies) shifting emission reduction efforts from ETS to non-ETS sectors to attain the same overall GHG reduction. Higher levels of renewables and energy efficiency than those resulting from scenarios driven by a GHG target will therefore have a moderating impact on the ETS price and compliance cost, but will at the same time significantly reduce incentives from the ETS itself for a switch in power generation to less CO2 intensive fuels or the introduction of new technologies such as CCS.

Energy related costs (including operational and energy intensive capital costs) for energy intensive industries compared to their value added are projected to increase from 38 % in

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94 Fossil fuel prices do not depend on the policies quantitatively assessed by the modelling and are therefore exogenous in the modelling.

95 Reflecting both efficiency gains in power generation and the impacts from lower demand.

96 E.g. backup-capacity to variable generation, smarter grids accommodating decentralised generation, storage needs etc.

2010 to 44% in the Reference scenario and by between 44% to 46 % in 2030 in the policy scenarios, with relatively small differences between them and also in comparison to the EU Reference scenario 2013 in that time perspective. The highest increases occur for scenarios with ambitious energy efficiency. In a 2050 perspective, this ratio is projected to increase significantly under the policy scenarios, but significantly less in the scenarios based solely on carbon and efficiency values.

Table 15: Electricity and carbon prices, energy related costs for energy intensive industries

Scenarios with enabling settings (compatible with 2050 GHG objectives):

Indicator		**"Carbon val." 2030 / 2050**	**"Concrete EE measures" 2030 / 2050**		
	Reference	GHG40	GHG40EE	GHG40EERES 30	GHG45EERES 35
Average Price of Electricity[97] (€/MWh)	176 / 175	179 / 183	174 / 178	178 / 192	196 / 197
ETS carbon price (€/t of CO2-eq)	35 / 100	40 / 264	22 / 158	11 / 152	14 / 85
Implicit carbon price non-ETS (€/tCO2)	0 / 0	40 / 264	22 / 158	11 / 152	15 / 85
Average Renewables value (€/ MWh)	34 / 16	34 / 15	34 / 15	56 / 36	134 / 46
Average energy efficiency value (€/ toe)	181 / 95	184 / 604	693 / 2108	693 / 2108	793 / 2285
Share of energy costs in energy intensive industries[98]	41.8 / 41.0	42.1 / 54.2	44.5 / 72.4	44.0 / 71.8	45.3 / 71.8

Scenarios with reference settings (not compatible with 2050 GHG objectives):

Indicator		**"Reference settings, carbon values Or concrete EE measures (GHG35)" 2030 / 2050**		
	Reference	GHG35®	GHG37®	GHG40®
Average Price of Electricity (€/MWh)	176 / 175	174 / 176	176 / 175	181 / 180
ETS carbon price (€/tCO2)	35 / 100	27 / 99	35 / 100	53 / 152
Implicit carbon price non-ETS (€/tCO2)	0 / 0	1 / 1	35 / 100	53 / 152
Average Renewables value (€/ MWh)	34 / 16	34 / 15	34 / 15	34 / 16
Average energy efficiency				

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

98 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.

value (€/ toe)	181 / 95		321 / 405	181 / 137	209 / 111
Share of energy costs in energy intensive industries	41.8 / 41.0		43.5 / 48.4	41.9 / 40.9	42.2 / 41.1

Source: PRIMES 2014.

It should be noted that long term projections of electricity prices and ETS prices but also other indicators are associated with a significant degree of uncertainty, and are sensitive to assumed GDP and world energy prices as well as projected production levels and the resulting impacts on energy consumption. Electricity price projections, as other energy modelling output, are based on the assumption of a perfectly functioning internal energy market and prices reflect all actual costs plus a required rate of return (not more and not less) for generation, transmission and distribution and other electricity system costs such as electricity storage.

The main conclusions of this Section are that system costs increase in all policy scenarios by 2030. These increases are, however, very small for the scenario resulting in 35% GHG reductions and are for other scenarios small in comparison to changes in the Reference scenario itself. In the Reference scenario, the ratio of total energy system cost to GDP increases until 2030 and later decreases. For the scenarios achieving 40% GHG reductions, costs are lowest for the scenario only focusing on GHG reductions. Higher levels of ambition as regards RES targets and EE policies increase costs while reducing ETS carbon prices.

There are also synergies between ambitious RES and EE policies. Adding a specific RES target to a scenario already benefiting from ambitious EE policies, results in low cost impacts. The components of energy system costs differ substantially across policy scenarios. Energy Purchases are significantly reduced in all scenarios, most notably in scenarios with explicit EE policies and RES targets. But investment costs increase, again more notably in scenarios with explicit EE policies and RES targets. Importantly, these investments have great potential for driving jobs and growth in the EU.

The electricity prices increase considerably in the Reference scenario until especially 2020 and stabilise later. The electricity prices further increase in majority of policy scenarios, while they actually decrease in the scenario with 40% GHG target coupled with ambitious EE policies and in the scenario with 35% GHG target coupled with moderate EE policies. Prices remain stable in the scenario driven by the 37% GHG target. These changes are fairly moderate except for a more pronounced increase in the scenario driven by the most ambitious GHG, RES and EE policies. Assuming cost-efficient deployment of RES across the EU, adding a pre-set renewables target of 30% to a scenario already including ambitious EE policies would lead to only slightly higher electricity prices.

Contrary to electricity prices, differences between policy scenarios are very pronounced with regard to the ETS price. Scenarios based on more ambitious EE policies and RES targets demonstrate a significantly lower ETS price.

5.1.4.2. Overall GDP impacts

Based on the modelling approach presented in Section 5.1.1, the impact on GDP in 2030 from various scenarios has been assessed. The analysis focuses on the GHG40 reduction scenario[99]. The modelling is based on carbon values in the non-ETS sector with GEM E3 and E3MG macro-economic modelling tools. These tools did not allow for a similar examination of the impact of additional EE policies and RES targets. Another macroeconomic model, E3ME,

[99] Section 5.3 gives additional information on GDP impacts of a GHG reduction up to 50%, but this in the context of international action.

was adapted[100] to analyse the impacts on employment of both the GHG target and combinations of EE and RES policies[101].

In all scenarios presented in this Section, it is assumed that third countries do not take measures beyond the pledges they made at present in the context of the UNFCCC.

Some further considerations on impacts related to action by third parties, or the impact of conditional targets in case of a global agreement in line with limiting global climate change below 2°C, are assessed in Section 5.3.

In assessing macroeconomic impacts, as well as sector specific impacts and employment impacts in subsequent sub-sections, the assumptions made about carbon pricing throughout the economy are important. In the modelling-setup used, potential negative impacts on GDP from the ambition levels assessed in this impact assessment are significantly contained and at times even reverted, if carbon pricing is achieving the same cost of GHG emissions throughout the economy, and if the revenues from this carbon pricing would be used to lower labour costs. Such carbon pricing could in principle only be achieved by extending the ETS to cover the entire EU economy or by applying a tax at a level of the current ETS price level to all sectors outside the ETS. The Commission has proposed[102] to amend energy taxation in a manner to incorporate carbon pricing. Annex 7.8 also discusses the impacts of extending the scope of the ETS to other sectors. Moreover, it is clear that due to low price elasticity of energy demand in many sectors that would be subject to such a CO2 tax – together with other market failures and imperfections, such a CO2 tax would need to be accommodated with policies directed at remedying these issues, as discussed in Section 5.8.

Table 16 gives an overview of the projected GDP impacts based on the GEM E3 model. As regards the GHG-lead scenario resulting in 40% GHG reductions, it projects a loss of between 0.1% and 0.45% of GDP depending on the approach to carbon pricing in the non-ETS sectors and the use of auctioning in the ETS. Negative impacts are more limited if carbon pricing is applied throughout the economy (i.e. via ETS or carbon tax) and if revenues are used to lower labour costs. This confirms previous assessments[103] that carbon pricing can achieve more positive macroeconomic outcomes if revenues from these carbon pricing tools are used in a manner beneficial for the entire economy, for example if tax revenues are used to reduce labour taxation costs, and thus improve competitiveness across the economy.

100 In order to be able to reflect impacts of targets other than only GHG reductions, but without losing the benefits of macro-economic modelling across sectors, the E3ME model was adapted. Firstly the power generation mix was treated as exogenous in E3ME and adapted to the results of the PRIMES Reference scenario, two 40% GHG reduction scenarios (with moderate energy efficiency and renewables policies as well with ambitious energy efficiency and renewables policies achieving 30% RES) as well as the 45% GHG with ambitious EE and renewables policies achieving 45% RES. Secondly also the increased energy efficiency investments generated by the PRIMES model for the different projections are introduced in E3ME, and matched by a resulting reduction in energy savings in those sectors. Thirdly, the model still optimises GHG reductions across sectors, taking into account that with higher EE and RES penetration, carbon prices can change, impacting revenue recycling.

101 GEM E3, E3MG and E3ME are macro-economic modelling tools. GEM E3 is a general equilibrium model, E3MG and E3ME are econometric models. GEME3 and E3MG scope is global, whereas E3ME is focussed on the EU only.

102 COM(2011) 169/3, Proposal for a Council Directive amending Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity

103 See for instance the Impact Assessment accompanying A Roadmap for moving to a competitive low carbon economy in 2050, SEC(2011) 288 final.

Table 16: GEM E-3 projections of GDP impact of a 40% GHG reduction compared to the Reference scenario

Auctioning in ETS	Only Power sector	Only Power sector	Only Power sector	All sectors ETS
Tax in the Non ETS sectors	No	No	Yes	Yes
Recycling method for revenues from carbon pricing	Subsidy for consumers	Labour cost reduction	Labour cost reduction	Labour cost reduction
GDP % change compared to Reference				
	-0,45%	-0,40%	-0,21%	-0,10%

Source: GEM E3, JRC, IPTS

The E3MG and E3ME modelling tools were also used to simulate impacts of the scenarios with "enabling setting", compared to the Reference scenario (where GHG emissions are only reduced by 32% in 2030). With recycling of auctioning used towards lowering labour costs (which is not assumed in the Reference scenario), impacts on GDP in the scenario led by a 40% GHG target based on carbon values of a higher emission reduction would be limited. Extended auctioning to all sectors in the ETS and introducing taxation in the Non ETS could actually result in a limited positive impact increasing GDP compared with the Reference case.

Table 17: E3MG projections of GDP impact of a GHG led scenario resulting in 40% GHG reductions in 2030 compared to the Reference scenario

Auctioning in ETS	Only Power sector	All sectors ETS
Tax in the Non ETS sectors	No	Yes
Recycling method for revenues from carbon pricing	Labour cost reduction all sectors	
GDP % change compared to Reference		
Gross Domestic Product	0,0%	0,2%

Additional modelling using E3ME model was carried out in order to assess the impact on the GDP and employment of the introduction of ambitious energy efficiency policies and renewables targets. It assumes carbon pricing in the form or auctioning in the ETS for the power sector and carbon taxation in the non ETS which is used to lower labour taxation. The differences between scenarios in terms of GDP are small but positive (see Table 18).

Table 18: E3ME projections of GDP impact for 2030 compared to Reference of scenarios based on concrete and more ambitious EE policies

	GDP (€2005m)	2030 change compared to Reference
Reference	15631346	
GHG40EE	15716872	0.55%
GHG40EERES30	15702597	0.46%
GHG45EE RES35	15714010	0.53%

The main conclusions of this Section are that overall the impact on economic growth of achieving a 40% GHG reduction target, with or without ambitious EE or additional RES targets is limited, with impacts by 2030 to be less than 1% of GDP. Impacts depend notably on the approach to carbon pricing (auctioning and/or taxation) and the extent to which revenues from carbon pricing are used to lower labour taxation. Also higher levels of energy

efficiency and renewables, requiring higher level of investments could result in positive GDP impacts.

Scenarios resulting in lower GHG reductions are expected to have relatively lower impacts on GDP compared to the reference scenario.

5.1.4.3. Sectoral impacts

The GEM E3 model was also used to assess impacts of a step up to 40% GHG reductions on the production of industrial sectors with relative high energy needs and exposed to international competition and what the role is of free allocation or auctioning.

Normally, the GEM E3 model assumes that the ETS companies optimise profits by fully taking into account the opportunity cost of freely allocated allowances when setting the prices of the goods they sell. In microeconomic theory, such an assumption would constitute a profit optimising strategy. The product price thus includes the carbon price even for those allowances that companies received for free. This modelling set-up is the base case in GEM E3, including in the Reference scenario where auctioning is assumed only in the power sector. This modelling set-up is also reflecting allocation systems where the free allocation is fixed for an indefinite period, determined by a one-off historic grandfathering.

But not all industries agree that this behaviour correctly describes what takes place. Some, certainly the energy intensive sectors exposed to outside competition, claim that they do not engage in such type of price-setting, when they receive allowances for free. They claim that they see free allocation rather as a compensation for the costs of the introduction of a carbon price on emissions which they do not include in the pricing of their goods. This type of behaviour focuses on keeping production volumes and market share high. This behaviour could also reflect a situation where future allocation depends on production decisions made today. Examples can be closure rules that reduce or stop free allocation when production decreases or closes down and rules for capacity expansions and new entrants. Furthermore, if periodic updating of free allocation (on the basis of benchmarks and updated production figures) also takes place, production decisions today will impact future allocation. In such systems, companies may have an incentive to maintain or even increase production, on the basis of the expectation that this will be reflected in the future in terms of the amount of free allocated allowances in the next period.

For a discussion on the extent to which free allocation is at present fixed or flexible based on production in the ETS, see Annex 7.6.

To assess the impact of auctioning or free allocation in the scenario driven by a 40% GHG reduction target and carbon values, both modelling set-ups reflecting different company behaviours are modelled in GEM E3. On the one hand, it is assumed that companies include opportunity costs of freely allocated allowances in their price setting, and on the other hand it is assumed that companies do not include the opportunity cost of freely allocated allowances.

Table 19 gives the results of the set of modelling runs that assume company behaviour towards free allocation is not to include opportunity costs in their prices whereas Table 20 gives the results that assume that companies do include opportunity costs. These assumptions are also implemented each time in the Reference case. Furthermore, for the assessed policy scenarios it is assumed that labour costs are reduced if carbon pricing is generated.

In Table 19 three scenarios are compared to the Reference scenario:

- Full auctioning in the ETS, no taxation in the Non ETS.
- Only auctioning for the Power sector, free allocation for other sectors in the ETS, no taxation in the Non ETS

- Only auctioning for the power sector, free allocation for other sector in the ETS, taxation in the Non ETS

Table 19: Impact of a 40% GHG reduction in 2030 on energy-intensive sectors production assuming companies that receive free allocation, do not incorporate the opportunity cost in their prices.

	Reference	Scenario 1	Scenario 2	Scenario 3
Auctioning in ETS	Only Power	All sectors	Only Power	Only Power
Free allocation	Sectors other than Power	No	Sectors other than Power	Sectors other than Power
Tax in the Non ETS sectors	No	No	No	Yes
Change in 2030 production compared to Reference				
Ferrous metals	na	-6,1%	-1,6%	-0,1%
Non-ferrous metals	na	0,2%	-0,5%	1,4%
Chemical Products	na	-1,1%	-0,4%	0,8%
Non-metallic minerals	na	-4,5%	-0,8%	-0,2%

The sector experiencing the largest relative increase in production compared to the Reference scenario if allowances are allocated free of charge is the ferrous metals sector with 4.5% higher production with free allowances (comparing scenario 2 to scenario 1), followed by the non-metallic minerals with an improvement of 3.7% compared to a scenario with no free allowances.

Two effects are at play: first companies receiving free allocation are inclined to increase production compared to auctioning because they do not need to include the cost of the allowance in their price setting and they want to maximise volume, whereas with auctioning this incentive does not exist and they actually will include the cost for allowances in their price. Furthermore, due to the volume increases in production, also emissions increase in those sectors if no additional action would be taken. In order to meet the target, additional emission reductions in the power sector need to be realised[104] or increased abatement efforts in the industrial sector need to be undertaken which actually results in an overall higher carbon price in case of free allocation compared to auctioning (where this incentive to increase production does not exist). Furthermore, this increased price generates increased carbon revenues which results in higher revenue recycling and subsequent lower labour costs. But this effect is less important. A sensitivity analysis performed on scenario 2, recycling auctioning revenue to subsidise consumer spending rather than lowering labour costs, only lowers the beneficial impact of free allocation on average for these sectors by 0.045%. Only the Non-ferrous metals sector seems negatively affected in scenario 2 with free allocation compared to the situation with auctioning, with higher carbon prices having a higher impact on this sector, potentially also due to increased electricity price impacts.

Overall, all sectors benefit in scenario 3 from the increased revenues from taxation in the Non ETS sectors, as the modelling set-up assumes that this would result in higher reductions in labour costs and the resulting positive impact on overall cost structure of these sectors.

Table 20 instead gives results of the set of modelling runs that assume companies include the opportunity costs of free allowances in their prices to ensure profit maximisation. 3 scenarios are compared to the Reference scenario:

104 In the policy scenarios, the energy mix in the power sector is fixed and based on the power sector energy mix of the PRIMES scenario for a 40% GHG reduction. Additional emission reductions in the power sector need to come from reductions in demand for electricity.

- Only auctioning for the Power sector, free allocation for other sector in the ETS, no taxation in the Non ETS
- Full auctioning in the ETS, no taxation in the Non ETS.
- Full auctioning in the ETS, taxation in the Non ETS

Table 20: Impact of a 40% GHG reduction in 2030 on energy-intensive sectors production assuming companies that receive free allocation, incorporate the opportunity cost in their prices.

	Reference	Scenario 1	Scenario 2	Scenario 3
Auctioning in ETS	Only Power	Only Power	All sectors	All sectors
Free allocation	Sectors other than Power	Sectors other than Power	No	No
Tax in the Non ETS sectors	No	No	No	Yes
Change in 2030 production compared to Reference				
Ferrous metals	na	-3,3%	-2,8%	-1,9%
Non-ferrous metals	na	-0,1%	0,6%	1,8%
Chemical Products	na	-0,6%	-0,1%	0,7%
Non-metallic minerals	na	-2,8%	-2,6%	-2,3%

Here the impact of free allocation compared to auctioning (scenario 1 compared to scenario 2) is the opposite of those seen in Table 19, with production actually decreasing in case of free allocation. The reason for this is that in both scenarios, companies incorporate the value of an allowance in their price, and thus price setting is identical, be it with auctioning or free allocation. The difference in impacts is explicable in macroeconomic terms, with auctioning and subsequent revenue recycling leading to higher economic output (see also Section 5.1.4.3), improving output also in the energy intensive industrial sectors. Also in this run, all sectors benefit from increased taxation in the non ETS, lowering all sector labour costs and improving competitiveness of the energy intensive industrial sectors.

It seems from the above results that if the market situation does not allow sectors to incorporate opportunity costs of free allocation, but rather use the free allocation to maintain and maximise production volumes, then the impact of 40% GHG reductions combined with auctioning on their total production is notably negative, compared to a situation with free allocation. On the other hand if many sectors would behave in this manner, then carbon prices will be somewhat higher in the case of free allocation compared to auctioning (which is negative for sectors sensitive to indirect impacts on electricity prices due to increased carbon prices).

If companies instead incorporate the cost of free allocation in their price setting, then there is little direct impact on their production from the choice between free allocation and auctioning, and indirectly, through an improved macroeconomic outlook, auctioning might even increase their production volume. Of course, this depends to what extent auctioning revenue is recycled in a manner that improves overall economic efficiency.

The main conclusions of these Sections are that many of those industries that cannot include the opportunity costs of free allocation in its prices because of competitive pressures would be adversely impacted unless counteracting measures are in place. In particular free allocation of allowances would be an effective means of reducing the risk on carbon leakage and preserve the output of those industries. But it is expected that for different industrial sectors and products, different levels of cost pass-through exist. A thorough understanding of cost pass-through based on empirical evidence while at the same time considering changing circumstances in a 2030 perspective would therefore be needed to elaborate carbon leakage

measures that provide adequate safeguards but avoid over-compensation of industry for costs recovered in the market in case of a 40% GHG reduction target.

For a more in-depth assessment of policy design issues regarding free allocation and auctioning and the impact on carbon leakage in a 2030 framework, see Section 5.5.

5.1.5. Social impacts

Social impacts analysed in this Section focus on employment and distributional effects (including notably affordability of energy for vulnerable customers) Section 5.1.5.1 starts with the macroeconomic analysis of employment impacts. Section 5.1.5.2 then looks at more sectoral level detail, focussed on the power sector and impacts of increased energy efficiency measures. Finally, Section 5.1.5.3 addresses the findings on affordability of energy, with a focus on vulnerable customers.

5.1.5.1. Macroeconomic assessment of employment impacts.

The assessment is based on a number of macroeconomic modelling tools.

One modelling tool, E3ME, was adapted to look at the impact of a 40% GHG reduction target as well as ambitious energy efficiency and renewables policies. Also, the GEM-E3 model tool was used to look at the impact of options achieving a 40% GHG reduction only, but was not used to assess impacts of additional EE and RES policies and targets.

E3ME

The **E3ME model** in adapted form (for a more detailed explanation, see introduction of Section 5.1.4.2) was applied to analyse the impacts on employment of both the GHG target and combinations of EE and RES policies.

First it was assumed that auctioning revenues are transferred to private citizens. In the Reference scenario it is assumed that there is only auctioning for the power sector. In the policy scenarios, it is assumed that taxation in the non ETS sectors is also introduced, and that this pays for additional investments in EE and RES. Any remaining revenues are transferred to private citizens. In case of a 40% GHG reduction and ambitious EE and 30 % renewables, revenues from auctioning and taxation are not sufficient to cover all the additional investments, and are therefore assumed to be financed by capital coming from private citizens.

This model projects that compared to the Reference case, the scenario led by a 40% GHG reduction in 2030 would create on the aggregate level of around 0.7 million additional jobs (645,000) and the scenario based on 40% GHG reduction, ambitious explicit EE policies and a 30% RES target would generate 1.25 million additional jobs in a 2030 perspective, compared to the Reference scenario (see Table 21).

Aggregate employment effects mask greater patterns of structural change at sectoral level because of the restructuring processes taking place. At sectoral level, investments in renewable energy power generation capacity and energy-efficient equipment and technologies create jobs in basic manufacturing, engineering and transport equipment, utilities, construction, and their supply chains. On the other hand, extraction industries are negatively affected in the GHG 40% scenarios. This impact is more moderate in the scenario with ambitious energy efficiency and 30% RES due to higher reductions in oil and gas and less so in coal than in the scenario with moderate EE and RES policies.

This will also matter for distributional impacts. A study by the OECD indicates that concentration of employment in the most polluting industries in relatively low GDP per capita countries within the EU area presents a risk that the adjustment costs associated with the

transition towards a low carbon economy could be greater where living standards are below the EU average[105].

Table 21: E3ME projections of employment impacts for 2030 compared to Reference of GHG reduction scenario with additional policies for EE and RES, assuming revenue recycling to consumers and energy efficiency and renewable energy investments

2030 employment	'000s of persons			% change compared to Reference	
	Reference	GHG 40%	GHG 40% + EE + 30% RES	GHG 40%	GHG 40% + EE + 30% RES
Agriculture	9391	9402	9407	0,1%	0,2%
Extraction Industries	500	479	498	-4,2%	-0,4%
Basic manufacturing	14839	14913	14944	0,5%	0,7%
Engineering and transport equipment	15277	15367	15429	0,6%	1,0%
Utilities	2280	2301	2308	0,9%	1,2%
Construction	16599	16708	16890	0,7%	1,8%
Distribution and retail	35314	35348	35452	0,1%	0,4%
Transport	9411	9455	9471	0,5%	0,6%
Communications, publishing and television	20307	20384	20440	0,4%	0,7%
Business services	41048	41225	41293	0,4%	0,6%
Public services	66735	66797	66814	0,1%	0,1%
Total employment	**231701**	**232379**	**232947**	**0,3%**	**0,5%**

Additional modelling using the E3ME model for the scenarios with ambitious EE and RES policies was carried out assuming that carbon pricing in the form or auctioning in the ETS for the power sector and taxation in the non ETS is used to lower labour costs, and not simply recycled to consumers. The differences between scenarios in terms of GDP and employment compared to Reference are small but positive (more employment with 31% and even 34% primary energy savings than under Reference) and are mainly due to lower carbon prices from EE and RES, which under the modelling assumptions would lead to lower CO2 tax revenue and the corresponding lower reduction of labour costs explaining the difference of impacts on employment than presented in Table 21.

Table 22: E3ME projections of employment impacts for 2030 compared to Reference of GHG reduction scenario with additional policies for EE and RES, assuming revenue recycling to lower labour costs and energy efficiency and renewable energy investments

	Employment (thousands of persons)	2030 change compared to Reference
Reference	231861	
GHG40EE	232132	0.12%
GHG40EERES30	232081	0.09%
GHG45EE RES35	232075	0.09%

GEM E3

105 OECD, 2012, The Jobs Potential of a Shift Towards a Low-carbon Economy, http://www.oecd.org/els/emp/50503551.pdf

Looking at employment impacts also by applying the GEM E3 model primarily to assess the economic impacts of reducing GHG emissions by 40% (see Sections 5.1.4.2 and 5.1.4.3 above) provides a complement to the E3ME as it also reflects the impact from various implementation approaches to carbon pricing and the ETS (see Table 23), but does not assess the impact of more ambitious EE and RES policies[106].

Negative employment impacts in some sectors are smaller for scenarios with more carbon pricing through taxation in sectors outside the current ETS. With the assumption that the associated revenue is used to lower labour costs (e.g. through lower employer's social charges), overall employment effects can be positive compared to Reference in case of full auctioning and carbon taxation in the Non ETS, adding in total 430,000 jobs in a 2030 perspective.

Sectors typically gaining are those that manufacture equipment. Sectors typically being affected negatively are the metals sectors, whereas employment impacts in other energy intensive industrial sectors are smaller or even positive (primarily due to decreases in labour costs, provided this is what carbon tax revenue would be used for).

The modelling with GEM E3 confirms what other economic literature typically indicate, i.e. that increasing the tax level on resource use and reducing it on, for example, labour could have a beneficial impact on growth and employment, with even a net positive outcome on employment in case of both full auctioning in the ETS and carbon taxation in the Non ETS, making labour relatively cheaper than capital and thus increasing total employment, even if the overall impact on GDP remains negative. Therefore, a tax shift from labour towards CO_2 tax (in the non-ETS sectors) may reduce the cost of the climate policy compared to cases where this shift is not applied. This underlines the importance for Member States to use revenues from such potential CO2 taxation in a targeted and efficient manner.

Table 23: GEM E-3 projections of employment impacts of a 40% GHG reduction compared to Reference

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Auctioning in ETS	Only Power sector	Only Power sector	Only Power sector	All sectors ETS
Tax in the Non ETS sectors	No	No	Yes	Yes
Recycling method for revenues from carbon pricing	Subsidy for consumers	Labour cost reduction	Labour cost reduction	Labour cost reduction
2030 Employment change compared to Reference				
% change employment	-0,61%	-0,44%	-0,02%	0,20%
Millions of jobs				
Millions of jobs	-1.33 mio	-0,96	-0,04	0,43
Ferrous metals	-4%	-4%	-3%	-2%
Non-ferrous metals	0%	0%	2%	2%
Chemical Products	-1%	-1%	0%	1%
Non-metallic minerals	-3%	-3%	-3%	-2%

Source: GEM E3, JRC, IPTS

For a summary of this Section, see end of Section 5.1.5.2

106 The results in Table 23 for employment are from the same scenarios projections as presented in Table 16 (which shows GDP impacts). Similarly the results in scenario 2 and 4 are from the same projections as scenarios 1 and 3 presented in Table 20.

5.1.5.2. Sectoral analysis related to employment

In addition to the macroeconomic modelling in the previous Section, a dedicated employment study was conducted of selected sectors. It focused on employment impacts of additional investments in the power sector (covering coal, oil, gas, nuclear, wind, solar, biomass)[107] and retrofitting of energy efficiency equipment in buildings (e.g. houses, flats) and non-industrial buildings (e.g. public buildings, offices). This analysis focuses on key sectors involved in the transformation towards lower GHG emissions. It attempts to estimate how many jobs would be created directly by these investments[108].

Table 25 provides estimates of the employment effects in terms of number of jobs generated with capital investments made that year according to PRIMES data. On this basis, the Reference scenario projects investments that are the equivalent of 750,000 jobs per annum. Additional employment in the two policy scenarios analysed over this period represents some 219,000 to 304,000 jobs, illustrating the positive impact of both ambitious EE policies and a RES developments at the aggregate level.

The biggest increases in employment result from changes in energy efficiency requirements in the residential and tertiary sector. Employment generated by these investments is 49% and 67% higher than in the Reference case. The employment changes due to increased investments in the power generation sector are smaller but positive on the aggregate level, with losses in oil, gas and coal power plants and nuclear power (the latter only in the scenario with ambitious EE measures and a 30% RES target).

It is to be noted that no job estimates are given for operational expenditure, and thus the employment impact is not assessed due for instance to increased demand for biomass, decreased demand for fossil fuels or maintenance of power plants (be it fossil fuels or renewables).

Table 24: Jobs associated with investments in the power sector and energy efficiency, 2011-2030

Average annual employment 2011-2030 related to investments	Reference	GHG 40%	GHG 40% + EE + 30% RES	Change compared to Reference			
				GHG 40%		GHG 40% + EE + 30% RES	
	('000)	('000)	('000)	('000)	% change	('000)	% change
Nuclear	46	47	28	1	2%	-18	-40%
Wind	152	170	183	18	12%	31	21%
Solar	69	72	74	3	4%	5	7%
Coal	26	26	24	1	2%	-2	-7%
Oil	2	2	2	-0	-13%	-1	-26%

107 It does not include impact on operational expenditure in the power sector and the resulting job changes.

108 The methodology applied includes the following steps: 1) A breakdown is made along the value chain of capital investments according to supply sector. For instance, when investing 1 million € in a wind plant, x% goes to engineering, y% to turbine manufacturers, z% to grid connection, etc. 2) For each part of this value chain the resulting labour impact in the supply sector is identified. For instance, a million spend on engineering services generates x man years of work for the engineering firm. 3) Based on (2) and (3) direct jobs generated per million € of capital investment in wind, coal, etc. are estimated. 4) Using the capital investment data from PRIMES, total jobs due to capital investment in the power sector and for energy efficiency are estimated. This is done for the Reference and two policy options, i.e. the -40% GHG target with moderate energy efficiency and renewables policies and the one with ambitious energy efficiency and renewables policies achieving 30% RES.

Gas	31	26	21	-5	-17%	-10	-31%
Biomass	18	21	44	3	16%	26	139%
Total Power Generation Investments	345	365	376	20	6%	32	9%
Residential	295	408	428	113	38%	133	45%
Tertiary	110	196	250	86	78%	140	127%
Total Energy Efficiency Investments	405	604	678	199	49%	273	67%
Total	750	968	1.054	219	29%	304	41%

Under both scenarios employment impacts in the last 5 years up to 2030 are more pronounced with up to 823,000 additional jobs compared to Reference, mainly due to high investments in energy efficiency.

Table 25: Difference in Jobs compared to Reference of investments in the power sector and energy efficiency, 2026-2030

Difference from Reference Average annual employment 2026-2030 related to investments	GHG 40%		GHG 40% + EE + 30% RES	
	('000)	% change	('000)	% change
Nuclear	4	4%	-61	-63%
Wind	51	42%	60	50%
Solar	15	55%	11	40%
Coal	3	29%	-7	-58%
Oil	-0	-50%	-0	-58%
Gas	-12	-44%	-19	-67%
Biomass	8	47%	72	443%
Total Power Generation Investments	69	23%	56	19%
Residential	245	109%	361	160%
Tertiary	182	272%	406	609%
Total Energy Efficiency Investments	427	146%	767	263%
Total	496	83%	823	138%

Other studies also underline the job creation potential of certain RES development and EE policies. A study on the economic assessment of low-carbon vehicles[109] concludes that depending on the model used, net jobs created from the manufacturing of fuel-efficient automotive components and from a general boost to the wider economy as a result of decreased spending on imported oil, could represent between 356,000 and 443,000 new jobs.

In conclusion, these different analytical tools suggest that on the aggregate level there may be a positive net contribution from policies reflecting the various scenarios analysed, especially in scenarios with explicit EE measures and renewables targets. Impacts on the sectoral level is

[109] "An economic assessment of low-carbon vehicles" by Cambridge Econometrics and Ricardo-AEA, March 2013, http://www.ricardo-aea.com/cms/assets/MediaRelease/Economic-Assessment-Vehicles-FINAL2.pdf

expected to differ and the analysis suggest that the negative impact will be most pronounced in extraction industries and most positive in sectors providing solutions to more efficient energy use and renewables development. Negative employment effects can be contained or even reverted in other sectors depending on the approach to carbon pricing, most notably carbon taxation in non-ETS sectors and use of taxation revenue to lower employers' fees.

The main conclusions of both Section 5.1.5.1 and Section 5.1.5.2 are that overall net employment impacts are limited can be positive compared to the reference scenario on the aggregate level. Reduction of labour taxation, compensated by increasing revenues from carbon pricing would be beneficial for employment. Also the focus on ambitious energy efficiency and RES targets are expected to increase employment compared to scenarios without them. Between sectors, differences can be larger, with typically sectors meeting the need for increased investments seeing employment growth compared to the reference scenario, such as equipment and the building sectors, whereas employment in e.g. extracting industries for fossil fuels are expected to decrease.

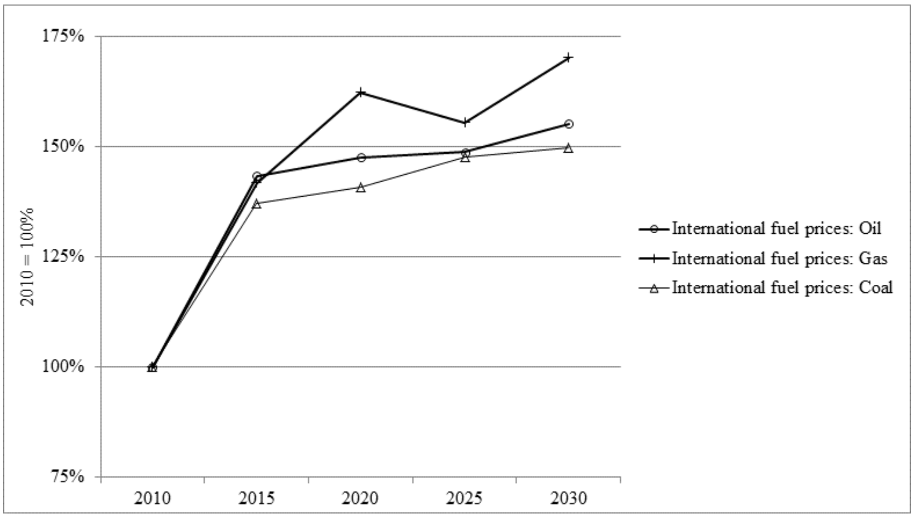
The above analysis does not fully capture issues related to skills, job mobility and restructuring across and within sectors. For a discussion on skills and training, see Annex 7.7.

5.1.5.3. Affordability of energy

What matters for affordability of energy is both operational and capital expenditure related to energy use, operational expenditure (cost) being dependent on both energy prices and consumption volumes, which are impacted by the efficiency of energy use. These expenditures need to be seen in relation 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. At the same time, such investments often raise energy related capital costs.

As shown and explained in Annex 7.1, both prices for fossil fuels and electricity are projected to increase in the Reference scenario. For fossil fuel prices, this takes place during the period up to 2030 and beyond due to projected rising fuel import prices. As regards electricity, there are relatively small changes resulting from most of the policy scenarios analysed. With respect to fossil fuels, the EU is a net importer. Fuel import prices are an exogenous variable in the assessment with the PRIMES model and thus end-user prices for coal and gas are therefore not affected by the design of the scenarios and main options for headline targets in 2030. For this reason, the other price related part of this Section focuses on electricity prices, while it will be equally important to ensure affordable gas supplies to households in a 2030 perspective.

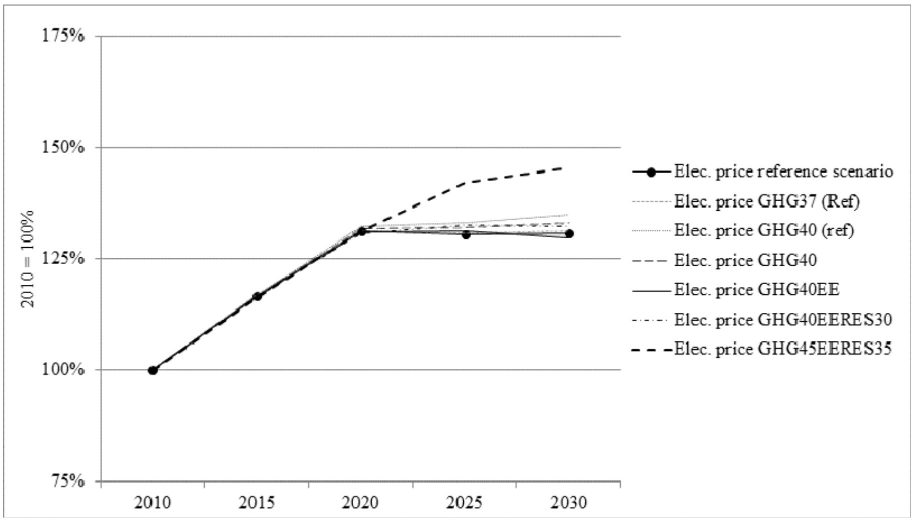
Figure 2: International fuel prices developments



For electricity, price increases already happen in the Reference scenario, mainly until 2020. This is caused by a complex interaction of a series of factors, including rising import prices for gas and coal, the need for infrastructure investment to replace, for example, obsolete generation capacity and extend energy networks, as well as agreed policies to achieve the EU's 2020 energy and climate objectives. (see Section 2.3 for a detailed analysis of developments under the reference scenario)After 2020, prices are rather stable in the Reference scenario. Overall import prices for fossil fuels are increasing significantly over the period 2010-2030.

As shown in Figure 3 and explained in Section 5.1.4.1, electricity price increases in a 2030 perspective are projected to be similar to those under the reference scenario, but somewhat lower in the scenario combining ambitious energy efficiency measures with a 40% GHG target. Projected price increases in 2030 are the most pronounced in the scenario combining a 45% GHG target, a 35% renewables target and ambitious energy efficiency policies. Among the scenarios resulting in 40% GHG reductions in 2030, the one based on a sole GHG target with moderate renewables and energy efficiency policies is projected to result in a small price increase of less than 2% compared to the Reference scenario in a 2030 perspective. Implementing ambitious efficiency policies is expected to reduce electricity prices in 2030, but by very little in relative terms. The scenario including a RES target of 40% sees an increase of around 1% compared to the Reference scenario, if met in the context of ambitious energy efficiency policies. As further described in Section 5.1, these projections are based on a cost-efficient approach to meeting targets on the EU level.

Figure 3: Average price of electricity in final demand sectors



Source: PRIMES 2013

Though limited compared to the Reference scenario, these price increases in most of the policy scenarios can put some additional pressure on the affordability of electricity supply in particular for consumers who cannot afford or otherwise are prevented from taking energy efficiency measures, unless adequate policies or measures are in place to address the issue. The drivers behind price increases in the policy scenarios are largely the same as in the reference scenario (see Section 2.3).

For assessing affordability for households in general what matters is ultimately the energy *cost compared to the available income*, and not the price itself. This is – in addition to the energy price – impacted by the amount of energy consumption and by the investment costs incurred to save energy. The share of energy related costs in household expenditures increases in the Reference scenario in the period to 2030, and decreases afterwards back to today's level. In the policy scenarios, additional increases in 2030 are small, ranging from 0.2 to 0.5 percentage points in the scenarios with a 40% target, with the lowest increase in the case of the single GHG target combined with moderate efficiency and renewables policies. The highest increase occurs in the 45% GHG target combined with 35% RES target and very ambitious efficiency policies. This reflects the fact that in 2030 the additional investment expenditures across scenarios are still higher than the energy savings generated by these investments. When assessing costs, see also Section 5.1 on the modelling set-up of the various scenarios.

Table 26: share of energy costs in household expenditure

Indicator		**"Carbon val." 2030 / 2050**	**"Concrete EE measures" 2030 / 2050**		
	Reference	GHG40	GHG40EE	GHG40EERES 30	GHG45EERES 35
Share of energy related cost (including transport) in household expenditure (in %, 2010: 12.4%)	14.6 / 12.6	14.8 / 14.1	15.1 / 15.0	15.0 / 15.1	15.3 / 15.3
Share of energy related cost (excluding transport) in household expenditure (in %,	9.3 / 8.0	9.4 / 8.7	9.5 / 9.7	9.4 / 9.8	9.7 / 9.9

2010: 7.5%)					
Avg. electricity price incr. compared to 2010 price (%)	30.8 / 30.1	33.3 / 36.2	29.9 / 33.9	32.3 / 43.2	45.7 / 46.6
Average electricity price change compared to ref. (percentage points)	n.a.	1.9 / 4.7	-0.7 / 2.2	1.1 / 10.1	11.3 / 12.7

Scenarios with Reference settings (not compatible with 2050 GHG objectives):

Indicator		**"Reference settings, carbon values or concrete EE measures (GHG35)"** **2030 / 2050**		
	Reference	GHG35®	GHG37®	GHG40®
Share of energy related cost (including transport) in household expenditure (in %, 2010: 12.4%)	14.6 / 12.6	14.6 / 13.2	14.8 / 13	14.9 / 13.1
Share of energy related cost (excluding transport) in household expenditure (in %, 2010: 7.5%)	9.3 / 8.0	9.3 / 8.0	9.5 / 8.4	9.6 / 8.5
Avg. electricity price incr. compared to 2010 price (%)	30.8 / 30.1	29.6 / 30.8	31.3 / 30.6	35.0 / 33.7
Average electricity price change compared to ref. (percentage points)	n.a.	-1.0 / 0.6	0.3 / 0.4	3.2 / 2.8

Source: PRIMES.

The results for 2030 do not point to a general affordability problem caused specifically by the 2030 targets and policies evaluated in this IA, but could rather arise due to developments projected already under the Reference case, (see also Section 5.1.4.1 on the uncertainties involved in projecting electricity prices; similar uncertainties exist also with fossil fuel price projections). Energy efficiency measures have a triple role to play in addressing affordability of energy: First, they have a lowering impact on the price itself (as illustrated by Figure 3). Second, they reduce consumption and therefore mitigate the effect of price increases. Third, the investments needed to achieve higher levels of energy efficiency often come with additional capital cost, which may be substantial in the medium term and may be prohibitive where consumers are required to pay up front. The cost-efficiency of the energy efficiency improvements must be ensured. Moreover, some households may suffer from liquidity constraints or not have correct or complete information with regard to the options at their disposal. The current Energy Efficiency Directive and other EU legislation include elements addressing these issues, but such elements may have to be strengthened in a 2030 perspective.

On this basis, it appears that targeted assistance for energy efficiency investment or schemes ensuring adequate availability of service choices or addressing level and quality / comprehension of information available to consumers should be prioritized as key tools to address affordability of energy in the context of the EU's transition to an integrated and market-based energy system. Assistance through social systems for vulnerable consumers, particularly when these are complementary to the measures above, may have a positive effect. On the other hand, direct intervention in the market to regulate prices indiscriminately or in a general manner would undermine the long-term sustainability of the electricity system. The Commission is currently working with stakeholders (consumer representatives, regulators, Ministries, NGOs, industry, ombudsmen etc.) to prepare guidance to Member States on how to best assist vulnerable energy consumers. A report, foreseen for the end of 2013, will address these issues in more detail.

In addition, the projections for household costs and energy price increases also illustrate the fundamental importance of designing policy at the EU and national level in a way that contains cost impacts to a minimum. A cost-efficient approach to implementation to meet 2030 objectives is one important element, while at the same time keeping in mind the long term cost implications of the policy choices for 2030. For natural gas as much as for electricity, enhanced competition, supply diversification and an adequate approach to tariffs and taxation[110] are all important aspects in contributing to affordably energy supplies in the EU, and will at the same time contribute towards more secure energy provision. These same issues are equally relevant for ensuring competitive energy prices for industry in an international comparison.

These aspects are already addressed by EU and national policy and will have to continue and be strengthened over the period up to 2030 (see also Section 5.2 addressing related indicators / aspirational objectives) through social policies for vulnerable consumers.

For a summary of this Section, see end of Section 5.1.5.4.

5.1.5.4. Citizen involvement in energy markets

Several barriers exist to the involvement of citizens in the energy markets (as explained in the problem definition), and they are often common across the European Union. Economic barriers to the involvement of citizens as investors in the energy markets depend largely on the risk profiles of investments. Specific policies aiming at EE and RES deployment has proven to be suited to reduce the barriers to the involvement of citizens (88% of renewable energy capacity in Germany is owned by entities other than conventional energy companies, among them 35% by individuals). Policies aiming at addressing non-economic barriers to citizens' involvement are not necessarily linked to specific targets (for EE and RES). However, policy options with specific targets or strong EU measures could be expected to increase the likelihood for successful Europeanization of measures targeting such non-economic barriers through harmonised framework for planning, information and best practice exchange, citizen involvement and reduction of administrative barriers.

The main conclusions of both Sections 5.1.5.3 and 5.1.5.4 are that both fossil fuel prices (up to 2030) and electricity prices (up to 2020) are expected to increase already in the Reference scenario, putting pressure on the affordability of energy. Ambitious EE policies can reduce the electricity prices in 2030 perspective whereas RES policies lead to small increases in prices if accompanied by ambitious energy efficiency policies. All scenarios implying GHG reductions at 40 percent or less demonstrate small differences compared to the Reference scenario.

The share of energy-related costs (operational and capital costs) in households' expenditure increases in the Reference scenario up to 2030 and the additional increases in policy scenario are relatively small. The balance is expected to shift from operational costs to capital costs. EE investment can have a sizeable, containing impact on operational energy expenditure and thereby contribute to affordability but may require targeted assistance to facilitate investments for vulnerable consumers.

[110] In the scenarios analysed, energy excise tax rates (EU minimal rates or higher national ones) are kept constant in real term. For the scenarios under Reference settings, the minimum rates relate to the Energy Taxation Directive of 2003, whereas for the scenarios with ambitious and very ambitious energy efficiency policies minimum excise rates according to the Commission's proposal for a revised Energy Taxation Directive have been assumed. Again existing higher national rates are used where applicable; all rates rise with inflation, i.e. are kept constant in real terms.

Policy options with concrete EE policies and RES targets can facilitate the involvement of citizens in the energy markets.

5.2. Indicators / aspirational objectives relating to competitiveness of the energy system and security of supply

On the basis of the introduction to this aspect in Section 4, the following advantages and disadvantages of the various options for other targets than those relating to GHG, RES and EE should be considered (for options around what such indicators could be, see end of this Section):

Option 1: No such targets or indicators are set.

The main advantage of this option is that it would not add complexity to the 2030 framework.

The main disadvantage of this option is that if would significantly remove visibility of and importance given to other aspects of security of supply and competitiveness than those addressed by RES and EE targets and policies, and that it would not be compatible with the strong emphasis by Parliament and Member States in the European Council on the importance and complexity of these other objectives.

Option 2: Other 2030 targets for other aspects of competitiveness and security of supply are set, and treated in an equal manner as potential targets for GHG, RES and EE.

The main advantage of this approach is that it would fully recognise the complexity of the competitiveness and security of supply objectives, and the fact that progress in this regard cannot be ensured solely through potential targets and measures for GHG, renewables and energy savings. Moreover, it would provide a clear mandate for strong policies in these areas at EU and national level to ensure that the targets are met.

A major disadvantage of this option is that it would add complexity to the framework as such and would significantly complicate interactions and coherence between various energy and climate areas. It would be particularly difficult to ensure that progress towards a broader set of targets is made at the same time due to complex interactions, and difficult policy decisions would arise if progress towards meeting one target works against another. Such trade-offs between competitiveness targets and environmental sustainability targets would be particularly sensitive. Moreover, targets should only be set for areas where concrete policies to achieve them are conceivable, and if it is feasible to capture complex objectives in one or a limited set of targets. Due to the international dimension of both competitiveness and security of supply (e.g. price differentials, import diversification), and the heterogeneous approaches and concerns of Member States in relation to these objectives, simple but comprehensive targets at the EU level, progress on which could be ensured through concrete EU policies, are not easily conceivable.

Option 3: No other such targets are set, but relevant indicators are defined to keep track of progress over time and to provide a knowledge basis for policy action; potentially associated with aspirational objectives in a 2030 perspective.

The main advantage of this approach is that it would recognise the importance of other aspects of competitiveness and security of supply than those addressed by RES and EE targets and policies without setting binding targets that could be difficult to implement and fully integrate with other binding measures. Moreover, by following the development of such indicators over time, policy makers would get a good basis for development and / or adaption of policy direction if need be. In order to ensure that such policy action is taken on the basis of real developments, aspirational objectives in a given time perspective could be defined with respect to these indicators

The general disadvantage of this option can be deducted from an e contrario assessment of the above-mentioned advantages of options 1) and 2).

Indicators / aspirational objectives that could be considered, in part based on the outcome of the public consultation, are:

- End-price differentials for gas and electricity between the EU and other major economies.
- Level of market integration, through for example numbers of energy market coupling and the level of interconnections between Member States.
- Reliance on indigenous energy resources / degree of energy self-sufficiency in the EU.
- Diversification of energy imports (routes, fuels, countries).
- Grid stability / continuous and uninterrupted energy supply.
- CCS

The main conclusions of this Section is that hard targets for other aspects of security of energy supply might add unwarranted complexity to the framework and be difficult to enforce; while a key set of indicators, some of which with aspirational objectives, could be a useful to acknowledge that all energy objectives in a 2030 perspective cannot be met solely by GHG, RES and EE.

5.3. EU action in the context of increased international climate action

The EU's current GHG target for 2020 is set at 20% below 1990 levels, but with a 30% reduction conditional on a global and comprehensive agreement, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

This approach was agreed in order to limit impacts on the EU economy in case our efforts would not be reciprocated by the international community and to provide an incentive to other economies to commit to GHG reductions. At the same time, the conditional target adds an element of uncertainty to the ultimate ambition level for 2020. In this sense, dual targets (the higher of which is conditional to international climate action), or a single conditional target, work against the long term predictability of the framework, amidst persisting uncertainties whether and when a sufficiently comprehensive international climate agreement will be agreed. At the same time, a dual approach contains the impacts on those sectors of the economy especially hard hit by unilateral climate targets, by not committing to the higher level unless competitors in third countries also face comparable carbon constraints. These considerations are equally valid in a 2030 perspective.

This impact assessment provides information for a political decision on potential targets and policies for GHG, energy efficiency and renewable energy. This includes information on the impacts of unconditional targets or conditional targets to international climate action. If a unilateral as well as conditional GHG target for 2030 were to be the preferred approach, the fundamental question is at what level these targets should be set. The impact assessment in Section 5.1 assesses a range of 35% to 45% of domestic reductions, without assessing what the impact would be of additional action in third countries.

This Section assesses what the impact would be of a higher conditional target for the EU, with at the same time sufficient global action to limit global warming to below 2°C.

The precise level of such a conditional target for the EU in the context of an international agreement would depend on many elements of the international agreement, most notably the extent to which mitigation commitments in the new agreement would collectively be sufficient to stay on track towards the -2°C objective, as well as individually ambitious, fair and in accordance with responsibilities and capabilities. This will clearly require action by all parties, comparable reduction targets by countries with similar responsibilities and capabilities as the EU, and considerable emission reduction efforts by emerging economies to enable their emissions to peak before 2030.

To inform negotiations, modelling comparison exercises have typically explored various distributions of global mitigation efforts, how they differ from distributing efforts according to the cost-effective potential, their economic impacts for different regions often expressed as % of GDP, and their relation with past, current and future emission levels or other indicators. Targets differ between approaches, with the highest targets most often attributed to higher income countries.

The modelling for the Low Carbon Roadmap focussed on what the EU contribution domestically could be for global reductions to be achieved cost efficiently, but does not pre-judge if the resulting reductions would represent a fair contribution to global action together with other regions' reductions[111].

In order to simulate potential costs of a conditional target, and without prejudice to any eventual position on what a potential unilateral and a potential conditional target may be, two examples are assessed based on 35% unilateral and 45% conditional, and 40% unilateral and 50% conditional GHG targets below 1990 levels by 2030[112]. For the unconditional target, it is assumed that international offsets are not permitted (see Section 5.4.2 for a discussion in this regard).

The GEM E3 model was used to assess the impact of the unilateral and conditional GHG reductions by 2030 compared to 1990. Table 27 gives an overview of the impact on GDP and the production for energy intensive sectors typically deemed to be exposed to international competition.

- First the impact of the unilateral GHG reduction in the EU is assessed without additional action in third countries and with no access to international credits both for the 35% GHG reduction and the 40% GHG reduction in the EU[113].
- Second, the impact of a the conditional GHG reduction in the EU is assessed, with other countries also taking action in line with what is needed to achieve the 2ºC objective, both for a 45% and a 50% GHG reduction in the EU compared to 1990[114].

[111] For example also in the EU climate and energy package, it was recognised that attributing the 2020 targets according to cost efficiency, would not result in a fair treatment amongst EU Member States.

[112] This is a simplified target that is based around a simple linear trajectory, starting in 2020 at a -30% target (the conditional target that the EU put forward in 2009 as its proposal for 2020 in the context of a global agreement) gradually decreasing to reach by 2050 90%, at the higher end of the range from 80% to 95% of reduction targets for developed countries in line with the below 2°C objective in the IPCC's 4th Assessment Report for 2050.

[113] The modelling assumes for there is only auctioning for the power sector in the EU, that any revenues from auctioning is distributed in a lump sum to consumers and that companies fully include opportunity costs of free allowances in their price setting (this latter is also assumed for third countries). As such the results of a scenario with 40% GHG reductions in the EU and no additional action in third countries are very similar to those presented in scenario 1 of Table 20.

- Third, the impact of allowing emission trading between countries under the conditional target is assessed. In this case the EU would achieve 35/40% reductions domestically and acquire a number of international credits to comply with the 45/50% GHG reduction target.

Compared to the unilateral, lower targets, scenario, the GDP impacts of the conditional, higher, scenarios (including international climate action) are worse with no access to international credits, as the differences in marginal abatement cost is not taken advantage of. With the possibility to acquire international credits and use them for compliance purposes in the ETS, the negative GDP impact from a higher conditional target would be smaller but still larger than if the EU would have reduced emissions to -35% or -40% without the others taking action. In the scenarios with global action, the additional negative impacts on aggregated EU GDP is in large part driven by the fact that also global GDP would be negatively impacted by the necessary global climate mitigation.

Impacts on specific industrial sectors vary, but the benefits from global climate change efforts for sectors subject to global competition are large and with access to international offsets most of the EU sectors analysed would experience significantly higher levels of production in 2030 under the conditional 45/50% target than under the unconditional 35/45% targets. The only exception is the non-metallic minerals sector that would see production decrease in the case of a 50% target with 40% achieved domestically.

This analysis confirms that for the EU's energy intensive industries subject to international competition, production output and relative global market share would be positively impacted by similar emission constraints being imposed also in third countries if international offsets would be permitted, with of course positive impacts largest, in case the EU target is the smallest.

Table 27: Impact conditional target on GDP and production of energy-intensive sectors, GEM-E3 model

	Reference	**35% GHG reduction domestically**	**45% GHG reduction domestically**	**45% GHG reduction target of which 35% is achieved domestically**	
Other countries	As in Reference	As in Reference	Achieve reduction target in line with global action domestically	Achieve reduction target in line with global action. but allowing part of the effort though international carbon markets	
	EU	EU	EU	EU	Global
Total GHG vs 1990	-32%	-35%	-45%	-35%	/
ETS GHG vs 2005	-36%	-37%	-49%	-34%	na
Non-ETS GHG vs 2005	-20%	-25%	-35%	-28%	na
GDP (% vs Reference)	na	-0,21%	-2,20%	-0,53%	-1,86%
	Impact on production energy intensive industries compared to Reference				
Ferrous metals	na	-2,3%	7,3%	18,7%	-5,2%
Non-ferrous metals	na	-0,1%	2,6%	5,8%	-3,1%
Chemical Products	na	-0,5%	10,1%	9,5%	-2,9%
Non-metallic minerals	na	-2,2%	-6,3%	2,1%	-3,8%

114 Global emission targets in GEM E3 modelled for 2030 equal to around 10% below 2010 levels. OECD members (those individually represented in the model) have on average a target of around -45% below 2010 levels. Other countries aggregate target requires peaking of emissions before 2030.

	Reference	40% GHG reduction domestically	50% GHG reduction domestically	50% GHG reduction target of which 40% is achieved domestically	
Other countries	As in Reference	As in Reference	Achieve reduction target in line with global action domestically	Achieve reduction target in line with global action. but allowing part of the effort though international carbon markets	
	EU	EU	EU	EU	Global
Total GHG vs 1990	-32%	-40%	-49%	-42%	/
ETS GHG vs 2005	-36%	-43%	-54%	-45%	na
Non-ETS GHG vs 2005	-20%	-30%	-38%	-32%	na
GDP (% vs Reference)	na	-0,45%	-3,40%	-1,22%	-1,97%
Impact on production energy intensive industries compared to Reference					
Ferrous metals	na	-3.5%	-2,6%	8,7%	-5,2%
Non-ferrous metals	na	-0.3%	-0,6%	3,5%	-3,4%
Chemical Products	na	-0.7%	5,9%	6,1%	-2,9%
Non-metallic minerals	na	-2.8%	-12,5%	-2,9%	-4,0%

In addition the PACE model was used to perform an analysis comparing the impact of international action in-line with the 2°C objective.

PACE is a general equilibrium model that has a higher degree of sectoral differentiation between industrial sectors than the GEM E3 model. However, it only models CO2 emissions from fuel combustion. In the Reference scenario, the model assumes full auctioning of ETS allowances in the power sector, a decreasing share of free allocation for sectors not on the carbon leakage list, reaching 0% in 2027, and fully free allocation (100%) for sectors on the carbon leakage list. The sectors listed in Table 28 below are such industrial sectors. They produce goods other than energy. Emission reductions in the Reference scenario are below those calculated for the Reference scenario for PRIMES or GEM-E3: CO_2 emission reductions in 2030 are only 25% below 1990 level.

For the policy scenarios it is assumed that:

- Either continued free allocation is applied for the sectors on the carbon leakage list
- or that auctioning is introduced for these sectors.

Furthermore the modelling assumes for all scenarios a nominal GHG reduction target of 40% by 2030. However, in most scenarios the existing surplus of carbon credits on the ETS market is gradually consumed. This leads to a reduced GHG reduction from the nominal 40% to 36%. With the exception of a "global action" scenario, assumed to be consistent with the globally agreed 2°C objective, non-EU countries climate action assumes a freeze of their commitments in 2020 at the level of their Copenhagen pledges[115].

All scenarios assume that sectors included in the carbon leakage list do not include the opportunity costs of free allowances in their product prices and that a carbon tax is introduced in the non-ETS. All revenues from carbon pricing are returned as a lump sum to consumers.

The resulting losses of production do not appear to be very large. However, this is in part due to a significant effort already being included in the Reference scenario[116]. Free allocation of

[115] Global emission targets in PACE modelled for 2030 equal to around 12.5% below 2010 levels.

[116] The impact assessment accompanying A Roadmap for moving to a competitive low carbon economy (SEC(2011) 288 final) assessed the impact on production for energy intensive industries of a 40% GHG

ETS-allowances reduces the production losses compared to a scenario where ETS allowances would be auctioned. Global action impacts EU competitive sectors positively (although less outspoken than in the GEM E3 modelling). EU GDP impacts of global action are positive, driven by the improved competitiveness impact. Gradual consumption of the ETS allowances surplus reduce impacts in a number of sectors compared to a situation whereby the surplus is not consumed, and GHG reduction efforts are larger.

Table 28: Impact international action on GDP and production of energy-intensive sectors, PACE model

	Refe-rence	No consumption of ETS-surplus	Consumption of ETS surplus	Consumption of ETS surplus,	Consumption of ETS-surplus and global action in-line with 2C
Free allocation for energy intensive industrial sectors	Yes	Yes	Yes	No	No
Total GHG vs 1990	-25%	-40%	-36%	-36%	-36%
ETS GHG vs 2005	-37%	-49%	-41%	-41%	-41%
Non-ETS GHG vs 2005	-10%	-27%	-27%	-27%	-27%
GDP (vs Reference)		-0,7%	-0,6%	-0,6%	-0,4%
	Impact on production of energy intensive industries compared to Reference				
Cement	na	-1,1%	-1,3%	-2,4%	-2,1%
Bricks, tiles and construction products	na	-0,5%	-1,1%	-3,1%	-2,8%
Iron and steel - production	na	-0,6%	0,5%	-1,6%	-0,3%
Aluminium	na	-1,8%	-1,0%	-2,4%	-1,0%
Fertilizers	na	-1,4%	0,2%	-1,5%	2,3%
Organic chemicals	na	-0,9%	0,3%	-1,5%	1,5%
Inorganic chemicals	na	-1,5%	0,0%	-1,7%	1,1%

The main conclusion of this Section are that benefits from global efforts to meet the 2°C objective for most EU sectors subject to global competition are clearly positive compared to a situation that the EU would take unilateral action. Impacts on EU sectors of any step-up to such conditional target can be reduced through access to international offsets.

5.4. Structural measures in the EU ETS

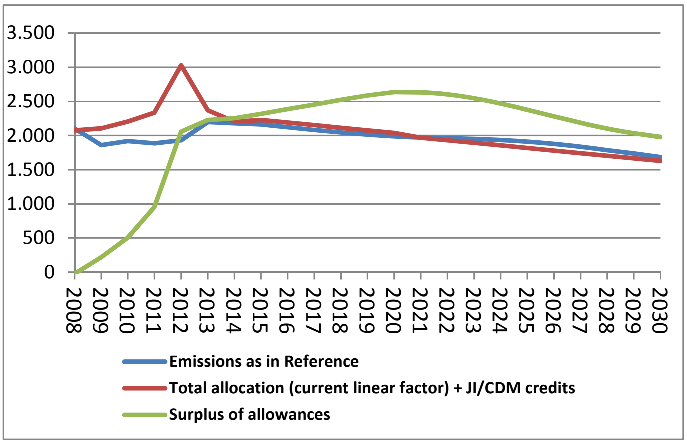
A surplus has built up rapidly in the EU ETS by the end of phase 2 (2008-2012). This was primarily due to the economic crisis resulting in emissions well below the total cap and the inflow of a large amount of international credits, allowed under the ETS directive to enter over the period 2008-2020. Figure 4 gives an overview of the build-up of the surplus up to 2030 under the Reference scenario[117]. At the end of phase 2, the surplus was already over 2

reduction with a Reference scenario where the EU achieves its 20% GHG reduction target by 2020 internally, and keeps this level of emissions constant up to 2030.

117 Up to 2012, historic data is used. From 2013 GHG emissions are extrapolated based on the Reference projections (see Annex 7.1) and adapted to include only intra EU flights in 2012 and international flights from 2013 onwards. Allocation for EU 28 during Phase 3 (2013-2020) and Phase 4 (2021-2028) is based on data used for the Commission Decision concerning national implementation measures for the transitional free allocation of greenhouse gas emission allowances. Total amount of JI and CDM

billion allowances and this is projected to continue to grow to over 2.5 billion by 2020, to only gradually reduce afterwards. The recent proposal of the Commission to change the coverage of aviation under the ETS, limiting it to European regional airspace and exempting certain flights from lower income countries with small shares of global aviation[118], is expected to further increase this overall surplus[119].

Figure 4: Example of build-up surplus in ETS based on Reference emissions profile and existing cap



Based on the outcome of the public consultation launched by the Commission's Carbon Market Report[120], options for structural measures preferred by many stakeholders include:

(1) Early revision of the linear reduction factor to maintain the long term credibility of the ETS…

(2) …combined with the retirement of allowances to maintain credibility in the short-term

(3) A reserve mechanism that would allow for a more dynamic supply of allowances which would not focus on prices but rather on supply / demand imbalances of allowances.

Of these 3 options, options 2 and 3 are clearly linked to addressing the surplus in order to bring the supply/demand balance back in equilibrium, rather than determining the ambition level for 2030. These are therefore discussed and assessed in a separate impact assessment regarding a structural measure to strengthen the EU ETS.

Of the six initially proposed structural measures, three are inherently linked to the 2030 framework, notably the revision of the linear reduction factor, the extension of the scope of

credits up to 2020 is assumed to be 1600 million credits, while still excluding any inflow of JI and CDM credits through aviation in the ETS.

118 COM(2013) 722 final

119 The change in coverage would apply from the beginning of 2014 with a view on the implementation from 2020 onwards of a global market based mechanism, currently discussed in ICAO. The change of coverage is expected to lower net demand for allowances from the aviation sector in the ETS, thus resulting in an increase in the surplus. This potential increase is not assessed in this impact assessment. It will depend on the final agreement in Council and Parliament on how to implement this and on the impact of any final agreement regarding market based mechanisms for aviation under ICAO. But assuming continued application up to 2030 of the coverage in the proposed revision by the Commission, first estimates put the maximum impact at a reduction by up to 50% for the net demand from this sector. Assuming the emission profile of aviation as modelled by the PRIMES model, this would increase the surplus by around 300 million by 2030.

120 COM(2012) 652 final

the EU ETS post 2020 and the use of international credits post 2020. The revision of the linear reduction factor will be part of the decisions to be taken on the overall 2030 framework. International credits need to be considered in the light of the link with international efforts and climate finance. Instead, the decision to extent the scope will still require further analysis, while a qualitative assessment is taken up in Annex 7.8.

5.4.1. *Revision of the annual linear reduction factor*

According the ETS Directive, the ETS cap for stationary sources decreases linearly, with an annual amount equal to 1.74% of the average annual allocation during phase 2 (excluding aviation), referred to as the linear reduction factor[121]. This is equivalent to an annual reduction of around 38 million allowances.

The scenario with 40% GHG reductions and moderate EE and RES policies up to 2030 achieves emission reductions in the ETS of 43% by 2030 compared to 2005. Setting a cap at this 2030 emission level would require a change of the linear reduction factor. A revised linear reduction factor applied from 2021 onwards to all sectors included in the ETS would require a linear reduction factor of 2.2% to be coherent with a 2030 cap equal to 43% reductions[122]. The resulting surplus in 2030 is equivalent to around 2.3 billion allowances.

The interaction of different targets and policies impact the emissions in the ETS over the full time period 2013-2030. In the 40% GHG + ambitious EE policies, total emissions in the ETS are higher than in the 40% GHG scenario, whereas in the GHG + ambitious EE and 30% RES they are actually lower. A linear reduction factor for the other 40% scenarios leading to the same surplus is given in the Table below.

Table 29: Linear reduction factors from 2021 onwards to 2030 depending on different 40% GHG scenarios

	Linear reduction factor if changed from 2021 onwards up to 2030 to achieve a surplus of 2.3 billion allowances in 2030, all sectors included
GHG40	-2.2%
GHG40/EE	-2.1%
GHG40/ EE/RES30	-2.3%

Scenarios resulting in less than 40% GHG reductions compared to 1990 would require a smaller or no increase of the factor.

Figure 5 applies the same linear reduction factor of 2.2% starting from 2021 onwards and shows the impact on the surplus using the three 40% GHG scenarios, confirming that if the linear reduction factor is kept constant across scenarios, the surplus in 2030 would be lowest in case of ambitious EE policies and highest in case of ambitious RES targets.

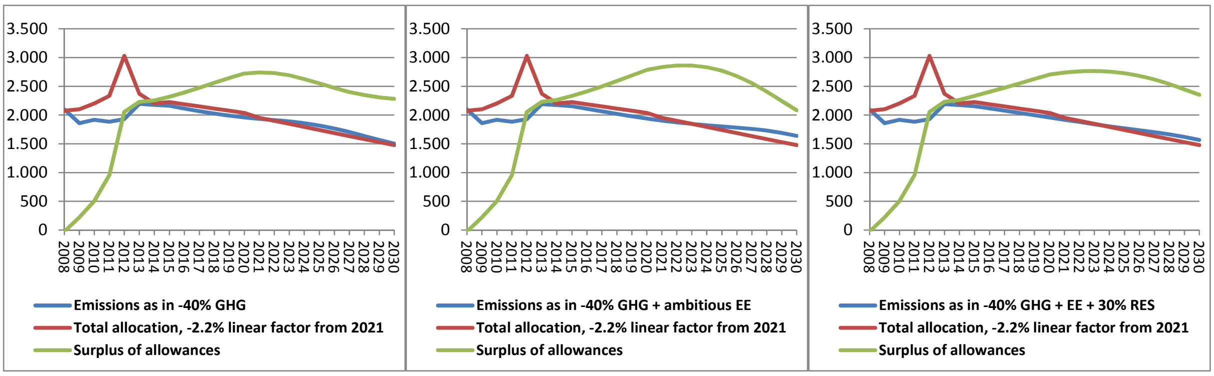
All these scenarios resulting in a 40% GHG emission reductions result in a decline of the surplus after 2020. However this only happens gradually, such that a surplus of around 2 billion allowances or more remains by 2030. This is a level similar to the Reference scenario, but under these scenarios with lower emissions and a more ambitious cap in 2030. In a 2030 perspective, the lowest remaining surplus results from the scenario with a strong focus on

[121] To determine 2013 allocation, the linear factor is applied starting from 2010 onwards.

[122] This linear reduction factor would not decrease the ETS cap by 2050 to -90% compared to 2005 but rather to -84%. A 90% reduction was the average reduction projected for the Roadmap for moving towards a competitive low carbon economy in 2050. In order to set the cap equal to this level in 2050 the linear reduction factor in the ETS would need to further increase to -2.4% until 2050.

ambitious EE policies and the highest surplus results from the scenario with a 30% RES target.

Figure 5: Example of possible supply demand pattern ETS based on 40% GHG reduction emissions profiles, ETS cap of 43% by 2030



It should be noted that in the 40% GHG only scenario, emission reductions are required to reach 40% GHG reductions in 2030 and 80% GHG reductions in 2050, and carbon values are set accordingly to achieve these emission reductions cost efficiently (see also Section 5.1.1). However, in this specific scenario, the model does not assess the potential impact in the short to mid-term of high surplus levels on the risk of potential short sightedness by companies when making investment decisions. As outlined in the carbon market report, today's market surplus clearly risks affecting price formation, in a way that short term prices may not reflect longer term scarcity, which can affect incentives to reduce emissions in the short to medium term despite the longer term scarcity.

Therefore, the modelling represents a situation where the market after 2020 would have to continue to operate for more than a decade with rather high surpluses, be it shrinking ones, strongly driven by longer term considerations with respect to scarcity and costs. If long term considerations are not sufficient to create market certainty, ETS prices may actually be lower, emissions higher and the surplus lower than projected in the scenarios with 40% GHG reductions. This would mean that despite the fact that the cap is in line with an overall 40% GHG target, the emissions in 2030 would be considerably higher.

40% GHG reductions in 2030 could be achieved also without changing the linear reduction factor (through strong renewables and energy efficiency policies), but such an approach would only increase the surplus significantly, thus not addressing the current surplus in the ETS and undermining the relevance of the ETS in providing incentives for low-carbon investment in the medium to long term.

The main conclusion of this Section is that setting a 2030 cap at the level of the projected 2030 emissions levels in the ETS and consistent with a GHG reduction target of 40%, would require a linear reduction factor from 2021 onwards of around 2.2%. This would gradually improve the market balance but by itself be insufficient to fully address the surplus. It thereby may result in insufficient incentives to actually reduce emissions in line with the cap and thus result in less emission reductions than needed to achieve a 40% GHG reduction overall by 2030.

5.4.2. Use of international credits

The amount of international credits that can be used in the ETS for compliance in phase 2 and 3 (2008-2020) is fixed[123]. The total entitlement is now estimated to be around 1.6 billion credits[124]. The default situation is that no additional entitlements are created after 2020.

Domestically, the use of international credits was intended to contain compliance costs and as such also address concerns about carbon leakage. They were also seen as a buffer against short term fluctuations in demand that could not be met through the supply in allowances. These credit entitlements allowed under the ETS legislation have been generous. The present inflow of ERU/CERs into the EU ETS for compliance purposes[125] correspond to half of the existing 2 billion surplus.

Table 30: CER/ERU submissions in phase 2 of the ETS for compliance purposes (MtCO2e)

Mt $CO_{2\text{-eq.}}$	**2008**	**2009**	**2010**	**2011**	**2012**	**Phase 2**
CER/ERUs	83.5	80.6	137.2	253.7	503.7	1,058.7

Source: Bloomberg New Energy Finance (2013): "2012 compliance: shades of grey revealed".

The use of international credits is intended to deliver reduced compliance costs, transfer sustainable technologies to third countries while engaging them in stronger climate action. For these reasons, the EU decided that the conditional offer of 30% GHG emission reductions by 2020 would allow for an increase in the use of credits by up to 50% of the increased effort.

The Clean Development Mechanisms (CDM) and Joint Implementation (JI) are the instruments through which credits have been generated. There are several difficulties associated with them. Additionality and baselines are notoriously difficult to establish with serious concerns about transparency of methods used often related to JI. Many projects are therefore contested by many stakeholders. There is a potential for excessive rents and perverse incentives. There are concerns about unequal geographical distribution of projects and human rights. With CDM, there is a lack of an own contribution to mitigation by the seller. It remains to be seen to what extent the UN review of both Kyoto mechanisms can alleviate these concerns which resulted in restrictions by buying countries. The EU banned credits from afforestation and reforestation projects and later restricted credits from certain industrial gases[126].

Any further use of international credits in a 2030 framework needs to address how many could be used (quantity?) and what type could be used (quality?).

Under business as usual (Reference scenario) there is no demand for international credits in the EU ETS (see Figure 4) after 2020, given that it would only add to the already potentially very large surplus of allowances (and credits as allowed up to 2020 in the ETS). This remains true even where a 2030 target is set to deliver a 40% GHG reduction. If overall emissions are to be reduced by 40% by 2030 compared to 1990, then even with a 43% reduction target in

123 http://ec.europa.eu/clima/policies/ets/linking/docs/rice_regulation_20131107_en.pdf

124 Bloomberg New Energy Finance (2013): "Phase III imports set to a minimum", Carbon markets global analyst reaction.

125 Other factors behind the increased use notably in 2012 was the uncertainty surrounding the future eligibility of certain ERUs and the phase-out of certain industrial gas credits as eligible credits for compliance after 2012.

126 For more information, see also Commission Staff Working Document Accompanying the Commission decision on applying use restrictions on international credits (from HFC-23 and N2O projects) pursuant to Article 11a(9) of Directive 2009/29/EC

the EU ETS compared to 2005, there could still be a surplus in the EU ETS amounting to around 2 billion allowances by 2030. This is reflected in the default situation, whereby no further credits are used for compliance after 2020. Hence, limiting the access to international credits is a necessary but in itself, i.e. without other options, suboptimal option to address the ETS surplus.

An unconditional domestic target with no additional access to international credits would create investor certainty towards the level of reduction that will need to be achieved within the EU. Demand shocks in the EU ETS could be contained through the remaining large surplus of allowances, potentially complemented by a mechanism to stabilise the market (see separate impact assessment regarding a structural measure to strengthen the EU ETS.) and the Article 29a mechanism of the ETS Directive avoiding risks of large sustained price increases.

Nevertheless, to facilitate a high level of ambition by 2030 in the rest of the world, the EU could also set a conditional target for 2030. This would be implemented if international conditions are right. A 2030 framework with an unconditional target not allowing for additional large inflows of international credits and a conditional one allowing a large share of additional efforts being met through international credits, could create more certainty on what is really necessary domestically than the current 2020 targets, which did not give industry such certainty.

A conditional target with demand for international credits offer third countries the potential to benefit from demand from the EU's carbon market, creating substantial climate finance flows if matched by similar demand from high income parties within an international agreement.

Post 2020, in light of an ambitious international agreement, it is essential that the EU can guarantee that only high quality credits enter the EU ETS. Both the generation and use of international credits need to contain an element of net mitigation action. An important step will be to move away from project-based mechanisms towards sectoral approaches, certainly in more advanced economies. First steps in this direction have been taken. In the Durban Climate Conference in 2011, the EU secured the establishment of a New Market Mechanism (NMM) and in parallel, the EU continues to work towards a substantially reformed CDM. More economically advanced countries should move away from the CDM towards the implementation of the NMM, while over time, the CDM would increasingly be focussed on Least Developed Countries (LDCs). This is already reflected in EU legislation. From 2013, CDM credits from new projects are only accepted for compliance in the EU ETS if they are from LDCs.

Through EU legislation, it could be ensured that credits entering the EU ETS come from systems which include an element of own contribution or from Parties taking appropriate action in the fight against climate change. EU ETS legislation will ultimately determine what can be used for compliance. If the rules for the implementation of the NMM cannot be agreed through the UNFCCC, the EU has the option to pursue the establishment of such a mechanism bilaterally or in cooperation with other major buyers.

The main conclusions of this Section are that investor certainty in the EU may benefit from an unconditional GHG reduction target with no additional access to international credits, while allowing that a large share of the additional effort to meet a conditional target comes from international credits. This may incentivise further development of a genuine international carbon market that captures own appropriate action by all parties.

But to create a genuine level playing field, the EU interest lies in promoting the development and implementation of compatible emissions trading systems throughout the world. Linking

of systems enables participants in one system to use units from a linked system for compliance purposes. New systems have been established or are being planned in many countries[127] and most systems are open to enter into linking agreements. If systems are compatible in design and similar in ambition, linking can be done without harming investor certainty with respect to the required domestic reductions. Examples how this can be done include linking with Switzerland, where negotiations are well underway.

5.4.3. Improve the functioning of the EU ETS through addressing the market imbalance

As outlined in the Carbon Market Report and in Section 5.4.1, improving the functioning of the ETS will require addressing the growing structural supply-demand imbalance. The Commission has proposed to backload some auctioning of allowances to later into phase 3 to address this on the short term. When backloading would be implemented, this will first decrease the existing surplus, to increase again towards the end of phase 3, and will therefore not address the surplus in the mid to long term.

In Section 5.4.1 it was also shown that a change of the linear factor in line with the assessed emission reductions for 2030 would only gradually impact the supply demand imbalances and not address the surplus sufficiently in the short to mid-term.

Theoretically, it would be possible to adopt a more ambitious linear reduction factor in a way it is set not only to achieve a certain reduction, but also to consume the surplus at the same time. For instance to get to a surplus in 2030 at around half the annual cap, while achieving the 40% GHG, would require a linear reduction factor of around 3.4%, which by 2045 would have reduced the ETS cap to zero[128]. This is clearly no practical manner to improve the functioning of the market and create longer term investor certainty.

Addressing the surplus will therefore require a structural measure with a more direct approach, such as for instance the creation of a market stability reserve or the permanent retirement of some allowances.

This latter option would impact the total cap even though it can be implemented without changing the linear reduction factor. It would result in a reduction of the total allowances available to operators in the ETS.

The creation of a market stability reserve would not change the cap or the amount of allowances available for operators in the ETS as well as potentially prevent the creation of future structural supply-demand imbalances, depending on its design. This can improve the functioning of the market and ensure the market takes into account better long term fundamentals. If decided well before the end of phase 3 and implemented as of around 2020, it could dampen the effects of a resurgence of the surplus in 2020 when backloading would increase the supply again.

For more information regarding the assessment of these options, see the Impact Assessment as regards the establishment of a Structural measure to strengthen the EU Emissions Trading System. This not only looks into the establishment of these mechanisms in the context of the existing legislation (as represented in the Reference scenario), but also has a sensitivity analysis included on how it would function in case of a change of the linear reduction factor as discussed in Section 5.4.1 above.

[127] E.g. New Zealand, Canada (Quebec), Korea, Australia, Switzerland, Turkey, Mexico and Chile, China, Ukraine, Kazakhstan and Costa Rica.

[128] The LRF would have to be changed more in this example, if the potential increasing impact on the surplus of the proposed change of the coverage of aviation under the ETS is taken into account.

5.5. Carbon leakage measures in a 2030 framework

Carbon leakage is defined in the ETS directive as an increase in greenhouse gas emissions in third countries where industry would not be subject to comparable carbon constraints, due to the impact of the ETS[129]. An empirical study[130] was recently finalised that explored whether there was evidence of such carbon leakage among the energy intensive industries in the period 2005-2012, i.e. phases 1 and 2 of the EU ETS. A main conclusion of the study was that this was not the case and that carbon leakage was successfully prevented, notably through the provision of free allocation of emission allowances.

There was actually in aggregate considerable surplus of allowances accrued by industry up to 2012[131] translating into considerable potential resources for the involved sectors. The empirical study for instance estimated that the cement, clinker and lime producers participating in the EU ETS have received in the period 2008-2011 160 million allowances beyond their verified emissions. For the pulp, paper and paperboard producers this was estimated to be equivalent to over 57 million allowances for the period 2008-2012.

The use of international credits was initially intended to contain upwards price risks, and as such also address concerns about carbon leakage. But in retrospect, it appears that these credit entitlements may have been too generous, in particular in the light of unexpected developments impacting the ETS, notably the economic crisis. It is expected that the inflow of these international credits has added a number of allowances corresponding to more than half of the expected surplus in the ETS market by 2020. For an analysis of the potential use of international credits in a 2030 framework, see Section 5.4.2.

Industry, commenting on the study, pointed out that whereas free allocation indeed has protected the existing production facilities in the EU, it does not protect against what some argue can be called "investment leakage". They claim that investments in the EU are halted because of perceived higher future costs related to climate policy in the EU than in other regions, resulting in those investments taking place in those other regions instead, i.e. carbon investment leakage.

This investment leakage affects, according to industrial stakeholders, both the recurrent investments needed to keep installations highly efficient (leading thus to relative reductions in efficiency), as well as negatively impacting investment decisions regarding major new plants, resulting in increased production outside of the EU.

It was not possible in the study to empirically assert whether investment leakage has occurred. Trends of the type described could be due to a number of factors not related to the ETS, and often associated with the effects of globalisation in general, such as:

- A maturing European economy, slow population growth and slower GDP growth compared to emerging economies which create economically more beneficial

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129 See recital 24 of the ETS Directive: *[…] an increase in greenhouse gas emissions in third countries where industry would not be subject to comparable carbon constraints (carbon leakage).*

130 Carbon Leakage Evidence Project: Factsheets for selected sectors, Ecorys, 23 September 2013. The study produced set of factsheets for a selection of sectors. The factsheets present historical data and assess the degree to which carbon leakage may have occurred in the sector. They were assembled using publicly available data, draft versions were commented by European industry representatives. http://ec.europa.eu/clima/policies/ets/cap/leakage/docs/cl_evidence_factsheets_en.pdf

131 See for instance Table 7, Proportionate Impact Assessment Accompanying the proposed Commission Regulation amending Regulation (EU) No 1031/2010 in particular to determine the volumes of greenhouse gas emission allowances to be auctioned in 2013-2020.

circumstances for investment in industries outside Europe (Europe experienced a similar period of rapid industrialisation after WWII).

- Lower factor prices including labour, land and energy.
- Lower regulatory burden related to, for instance, safety, labour and environmental regulation (whereas often political instability, regulatory risk and currency risk are perceived as higher burdens in those economies).

The empirical study noted that the carbon costs as a share of total costs during the period studied tended to be too small to be the main driver of relocation or investment decisions when compared to, for instance, labour, energy or raw material costs. One conclusion was that energy costs in total, and especially the recent development of unconventional fuels in the US, is starting to play a role in the investment decisions for some sectors.

Regarding the future, Section 5.1.4 assesses the situation where indeed carbon constraints are further increased in the EU to achieve a 40% GHG reduction by 2030, whereas in other countries they remain as in the Reference case. Table 19 gives the resulting impact on EU industries, assessed with the GEM E3 model. This analysis seems to indicate that impacts on industrial sectors can be alleviated to some extent if free allocation is continued, while some factors like benchmarks and production data are reviewed periodically. However, it would potentially increase carbon prices in the ETS because industrial sectors with free allocation distributed on the basis of future production levels might be incentivised to increase production in order to obtain more free allocation in following periods, and as such results in additional, more costly GHG reductions elsewhere in the ETS. With the introduction of increased levels of auctioning for all those sectors in the EU ETS after 2020 and up to 2030, impacts of a unilateral increase of the target to 40% are projected to be negative for them.

Section 5.3 assessed what the impacts on these sectors would be in case of a conditional target beyond the 40% that could only be implemented if other regions also undertake strong climate action. For all four energy intensive industrial sectors[132], it was projected that there would be a strong relative improvement of the competitive position of EU industries, actually resulting in significant production increase in three of the sectors, if accompanied with access to the international carbon market for the additional target beyond 40%. For two of the sectors this was actually even the case if the unconditional target would be fully met domestically, even without access to the international carbon market (see Table 27).

Overall the results seem to indicate that carbon leakage measures are not necessary in case sufficient global action is undertaken, but that some level of free allocation, through periodic review of factors determining free allocation, can be beneficial in a situation whereby the EU would step up its reduction effort to 40% GHG reductions by 2030 with third countries not undertaking comparable action. If it would be decided to preserve the approach of free allocation through benchmarking up to 2030 to address the risk of carbon leakage, a number of important design features will need to be revisited:

- **A periodic revision of the benchmark values** may be needed to reflect the technological developments which have happened since the benchmark values were first determined in 2011, based on 2006-2008 data. Such a revision could be envisaged to take into account technological developments, which most likely are not taking place at the same pace in all sectors. A reflection would also be needed for which products there should be benchmarks, whether the current system of fall-back

132 Ferrous metals, Non-ferrous metals, Chemical Products and Non-metallic minerals.

approaches can be refined, and whether the determination of the benchmark values should continue to be based on the average of the 10% best in the EU, or on any other basis.

- **Baseline years to be taken into account.** The current free allocation system multiplies benchmark values with production data for certain Reference years. There would need to be a reflection whether and when the Reference years used for phase 3 free allocations should be reviewed, such that phase 4 free allocation would be based on production data from more recent years. Such a system would provide a closer link between allocation and production levels, but it may also be more complex and lead to less certainty for the installations in the long term. It may be useful to consider reviewing both benchmarks and production data in combination to provide more clarity at the time decisions are taken and reduce uncertainty as a result of too frequent reviews.
- **Maximum amount of free allocation.** In the current system, the amount of free allocation is calculated bottom-up based on benchmarks and production data, but there is also a top-down maximum amount of allowances allowed. The maximum amount is currently a fixed share of the total cap. Such a cap is crucial as a backstop to ensure also long term environmental integrity of the system and to correct possible misconceptions and/or misapplications of the free allocation system ensuring transparency and equitable burden-sharing among sectors. But it needs to be assessed if the present share of the total decreasing cap should be amended, taking into account different opportunities to reduce emissions for those sectors receiving free allocation and those not. Lessons learnt from the first years of phase 3 should be taken into account.
- **Carbon leakage.** Free allocation after 2020 should in principle only be provided to those sectors that are really affected by the risk of carbon leakage. This requires further reflection based on the growing experience with free allocation based on carbon leakage status in phase 3 as well as a review of climate policy efforts undertaken by other major countries. The purpose of free allocation should be to address competitiveness concerns in an accurate manner, while avoiding over-allocation and maintaining appropriate incentives for low carbon growth and emission reductions. It needs to be recognised that the real carbon leakage situation of sectors on the present carbon leakage list may differ considerably – some may face much stronger competitive pressure than others. Some might operate in truly global markets, while others might merely be sectors where import and export constitute an important share of production and consumption, but where goods are still subject to significant diversification. Therefore, some reflection may be needed if some form of progressiveness would be useful, recognising that for some sectors within the larger group that can be deemed exposed to a risk of carbon leakage it would make sense to provide for relatively more free allocation than for others. Such a division groups can lead to a more accurate picture of the competitiveness situation of sectors, but could increase the complexity of any analysis. Another element which may merit reflection is the relation between the length of validity of the carbon leakage list and the length of the trading period, taking into account both regulatory predictability and developments affecting the competitiveness situation of industrial sectors.

5.5.1. *Indirect emissions compensation*

Currently, indirect ETS costs in electricity prices, passed on to industrial electricity consumers, can be compensated for the most electro-intensive industries via national subsidies subject to state aid scrutiny. Stakeholders have expressed concern that this will result in different treatment across Member States for the same sectors, depending on the willingness and ability of Member States to provide state aid. It merits reflection if this approach should be continued and to what extent such support is warranted, which is linked to the quite complex impact of climate policies on electricity prices. If yes, it needs to be considered if it could be improved to avoid as much as possible the distortion of intra-EU competition and to ensure a level playing field. Furthermore, in case of sufficient global action, the continuation of these measures may no longer be necessary.

5.5.2. *The use of auction revenues for proactive low-carbon innovation measures*

Higher levels of free allocation to industry will result in fewer allowances for auctioning. It could as such reduce the capacity to use auctioning as a distributional tool across Member States even though carbon prices may also actually increase (see Section 5.1.4). Auction revenue or other forms of ETS related revenues (such as what is currently done with the so called NER 300) could also be used in a more targeted manner, for example towards demonstration and deployment of promising new technologies for the energy intensive industries subject to ETS. Such funding would in principle not directly alleviate carbon leakage, but could in the longer term be crucial to ensure that industrial sectors can make a successful transition to low carbon production. A dedicated programme at the EU level could be more efficient in creating break-through technologies due to scope and size than if spread out over 28 Member States. To ensure efficient use of such funding, earmarking revenues for technology subsidies should be specific rather than general, targeting technologies that suffer from pervasive market and coordination failures in development and / or take-up by individual firms.

Stakeholders' opinions on the risk on carbon leakage typically agree that some measures may be needed. The energy intensive industry and general business organizations note that European industry needs enhanced protection mechanisms, including the use of allowance revenues within industry with some suggesting also the development of an EU-wide instrument to replace the national state aid mechanisms regarding indirect ETS costs related to electricity prices. Trade unions typically agree that energy intensive industries should be preserved in the EU but note that the carbon leakage list needs to be reviewed. Instead NGOs, RES organizations, non-energy intensive companies and part of academia say there is little evidence for carbon leakage, that there needs to be more focus in carbon leakage instruments, with specifically NGOs stressing that free allowances are discouraging investments in low carbon technologies.

The main conclusions from this Section are that at present there is no evidence that carbon leakage has occurred already. But for the future, as long as other regions do not take comparable action on climate change, continued free allocation on the basis of periodically updated benchmarks can be a suitable tool to address the risk on carbon leakage with free allocation focussing more on these industries that cannot easily differentiate prices from those of outside competitors.

Indirect impacts from carbon prices on electricity prices can be compensated through state aid, but it needs to be considered if improvements are needed to avoid distortion of intra-EU competition. In case of strong global action, the continuation of these measures should be reviewed. Continued funding of innovation through schemes like the NER300 do not address directly carbon leakage but if well implemented can focus on much needed break-through

technologies also within industry, it could reduce costs to meet long term objectives and create a technological advantage.

5.6. Sectors not included in the ETS or Non ETS: Policy options for the Land Sector

The question on the extension of the scope of the ETS to include sectors at present covered in the non ETS, in particular fuels for transport and heating, is addressed in Annex 7.8 on structural measures. The question on distributional aspects of target setting in the non ETS is addressed in Section 5.9.

This Section addresses policy design options for (non-energy related) emissions from agriculture, and emissions and removals from Land Use, Land Use Change and Forestry (LULUCF), in short AFOLU (agriculture, forestry and land use).

5.6.1. The problem

While the land sector presents modest mitigation potential in the EU, it does incorporate two important carbon pools: forest biomass and soil organic carbon. The correct handling of these – through land use management approaches for forest and agriculture – is essential in order to a) optimise further removals and b) avoid emissions, wherever cost-effectively possible.

In Section 5.1.2, it is shown that these carbon stocks are overall expected to decline over time under current policies. This is due in part to increased use of biomass for energy purposes. It also gives estimates of further land use changes under policy scenarios with higher greenhouse gas and renewables targets, which have knock-on effects on land use practices within the EU, and can also lead to increased bio-energy import, potentially causing carbon leakage and indirect land use changes. However, these scenarios do not include actions to increase removals and reduce emissions through specific measures.

Moreover, global demand for food and feed is expected to continue to rise under current trends, thereby affecting the agricultural sector in the EU, and associated greenhouse gas emissions.

The protection, therefore, of these AFOLU carbon pools will be of growing importance in a post-2020 framework.

In contrast with the non-CO_2 emissions in the Agriculture sector (which is currently within the scope of the Effort Sharing Decision), the LULUCF sector is not included in the reduction commitment in the current 2020 Climate and Energy package. In the context of the Climate and Energy Package, The Council and the European Parliament have indeed expressed the request that all sectors should contribute to cost-effective emissions reductions.

The current LULUCF legislative framework provides for a step-wise progression to improve data and introduce best practice, as preparation for the inclusion of the sector within the overall 2030 policy framework.

5.6.2. The policy options for 2030

An approach for the integration of the land sector into an EU framework could in principle be based on one of three options:

- Option 1 ("Status Quo"): Maintain non-CO_2 Agriculture sector emissions in a potential future Effort Sharing Decision, and further develop a LULUCF sector policy approach separately.
- Option 2 ("Effort Sharing"): Include the LULUCF sector into a potential future Effort Sharing Decision;

- Option 3 ("Land Sector Pillar"): Merging the LULUCF and Agriculture non-CO2 sector emissions into one new and independent pillar of the EU's climate policy

For the pros and cons of a new Effort Sharing Decision in a 2030 perspective, see Section 5.9

5.6.3. Comparison of options

Option 1 (Status quo) continues the separate treatment of LULUCF, outside the Effort Sharing Decision (ESD)[133]. However, this status quo does not imply a no-action scenario, as targets and appropriate measures could be developed separately. Flexibilities with other sectors could be considered. However, the major disadvantage of this option would be that agricultural and LULUCF emissions would be addressed with different policy tools, while they concern the same agricultural activities.

Option 2 (Effort sharing) would increase the number of sectors in the ESD and thus increase flexibility for Member States to achieve a given target. It would also have the advantage, compared to option 1, that Member States could develop an integrated approach for agriculture and forestry. Certain synergies and trade-offs could potentially be better addressed[134].

However, it needs to be borne in mind that, although specific flexibilities are allowed, the ESD is developed around a linear trajectory with an annual compliance cycle. It will need to be further assessed whether the inclusion in the ESD of LULUCF emissions/removals, which are characterised by potentially large annual fluctuations, long time horizons and uncertainties related to data reliability (unless sophisticated monitoring techniques are used) is compatible with the Effort Sharing Decision[135]. In addition, the cost-effective potential for removals is certainly geographically variable which may make the sharing of effort in the ESD more complicated.

In summary, option 2 would add flexibility and enable an integrated approach, but would increase complexity and raise methodological issues, including consequences in terms of target setting.

Option 3 (land sector Pillar) would have similar advantages to option 2. It would enable a more dedicated policy approach that takes into account the specificities of the sector, and can build on and use the Common Agriculture Policy to deliver. In this context, it would need to be considered which instruments (e.g. national targets, dedicated EU measures, or national measures financed through rural development policy measures) are most suitable. Assuming that this option would also comprise fixed national targets, it would lack the advantage of flexibility between sectors within the overall ESD, but give an opportunity for a policy approach that would reflect the sector's particularities (permanence, long time cycles, natural variability etc.).

5.6.4. Policy monitoring and evaluation

The application of today's accounting rules together with the development of more accurate monitoring and reporting methods – under Decision 529/2013 – should further improve the data and information availability.

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133 The Effort Sharing Decision defines the national GHG reduction targets for the so called Non ETS sector, i.e. those sectors not included in the EU ETS

134 For instance a decision to move from livestock production on grassland to energy crop production could imply a reduction of methane emissions from livestock and increase renewable energy production, but would also increase emissions from the soil.

135 DK, FR and HU chose annual compliance for LULUCF sector in CP1.

The effect that different accounting rules (e.g. flexibilities between different activities; caps on credits and debits; reference levels etc.) could have on the absolute number of credits/debits generated by these two sectors in a post-2020 international framework, will need to be further assessed.

The main conclusions of this Section are that there are benefits of integrating land use and agricultural mitigation policies. Both options 2 and 3 would deliver this. Option 2 may make the sharing of effort in the ESD more complicated. Instead option 3 could reduce national flexibility across sectors, but would allow to reflect the sector's particularities better, including through further improved incentives for climate friendly and smart agriculture within a post-2020 Common Agricultural Policy.

5.7. Implementing a potential RES target

As explained already in Section 4.2, the purpose of this impact assessment is not to evaluate in detail the various possible means of meeting a potential renewables target for 2030. Such a detailed evaluation would be carried out in preparation of any future legislative proposals in this regard if there is political agreement on a 2030 renewables target as such.

At this stage some more general considerations concerning practical design suffice, building on the assessment of lessons learnt from the 2020 framework and the responses to the public consultation. Three main aspects of implementation would have to be considered:

- The level at which the target should be applied / who should be the obligated entity, where three main options are conceivable: EU level, Member State level through differentiated national targets, or at the level of energy suppliers.
- If the target should be applicable to energy consumption as such, or rather to specific sectors and / or energy carriers such as electricity, heating and cooling or transport.
- If the implementing approach should be based on technical neutrality between various renewables options, or if differentiated approaches for each type of renewable technology should be applied.

On this basis, three main options for implementation of a potential legally binding renewables target for 2030 can be identified:

(1) Continuation of Member State specific targets and support schemes.

(2) As option i) but with a non-discriminatory opening of national support schemes or strong coordination between Member States, possibly under the condition that there is sufficient transmission capacity between the Member States involved, and

(3) A gradual Europeanization of the approach to ensuring progress towards a 2030 objective.

For all these main options, sub-options can be defined, including

(a) Target applicable to all energy consumption, or only subsets of energy consumption (in specific sectors such as transport, or for specific energy carriers such as electricity or heat)

(b) Target met in a technology neutral approach, or through specific approaches to specific renewables technologies.

Without pre-empting the outcome of a future more detailed assessment were a legislative proposal to be made, and also considering that some of these aspects would not be decided on the EU level depending on the main option chosen, there are several important trade-offs in

choosing between these options and sub-options that policy makers at any level should consider.

First, an EU-level target would avoid setting national targets which potentially could lead to development of renewables where the resources are the most abundant, and thereby in theory improving cost-efficiency at the aggregate EU level in meeting a set objective. At the same time, if Member States do not have specific targets, they would have less incentive to mitigate administrative barriers and facilitate uptake through grid developments and necessary licensing. Moreover, Member State targets could better ensure a balanced development of renewables across the EU economy and society. An EU level target would also require giving the EU the means to deliver on such a target through concrete policies on the ground, going beyond current levels of harmonisation.

Second, meeting an EU target without national support schemes (which would result from national targets unless Member States decide to combine support schemes across national borders) but with schemes at the EU level would be less distortive to competition and market integration, but would at the same time reduce Member State flexibility to adapt to specific circumstances and decide themselves how to finance / support RES developments.

Third, technology neutrality and equal treatment of all renewable options without sector specific targets or support schemes would improve short to medium term cost-efficiency, at least in theory. On the other hand, truly technology neutral approaches would typically lead to excess profits for producers of more cost-competitive renewables; and would not ensure development, deployment and cost-reductions that could be necessary for cost-efficiency in the longer term, in particular if the EU were to agree on more ambitious renewables objectives post 2030 (as suggested by the Roadmap 2050, however not the subject matter of this Impact Assessment). Moreover, the development of innovative, currently more costly RES technologies might be hampered, impacting thereby on longer term industrial leadership of EU companies.

The quantitative assessment of scenarios and options in Section 5.1 above and the specific information on system cost and price impacts from various renewable levels is based on the assumption of cost-efficient deployment of renewables in the EU post 2020, on the basis of implementation of the legally binding national RES targets for 2020. Potential future decisions at the EU or national level would have to be based on detailed analysis (including modelling) of the various options. Such analysis focusing less on optimising cost-efficiency at the EU level throughout the period up to 2050 could result in higher system cost and price impacts.

Other measures to support renewables development

As the text of the current Renewable Energy Directive makes clear, a renewable energy target is only partly about the structuring of possible support. As shown under the current framework, a target can drive several other policy measures which can be implemented at European or national level, which are necessary to remove the barriers to the growth of renewable energy and reduce the cost of renewable energy. Such measures which are already required include increased development of energy infrastructure, improved and fairer grid access for renewable energy, smoother and faster regimes for product and project planning authorisation, greater consistency of certification procedures across Member States, for products and for equipment installers, consistent training and qualification regimes for the EU labour force, and so on. The "soft" measures contained in the current Renewable Energy Directive will also need to be reviewed in the 2030 framework independently of the target discussion, with a view to removing redundant ones and strengthening cost effective ones.

Were a EU renewable energy target, or national targets, for 2030 not to be adopted, then the importance of such soft measures for removing barriers to renewable energy would increase in order to ensure progress also in absence of a target. However, such measures would not necessarily be developed by Member States on their own initiative. For any cost effective renewable energy growth, such soft measures would need to be regulated for separately, and where appropriate at the EU level to ensure a level playing field and the integrity of the internal energy market. (In the same way infrastructure planning and energy efficiency measures have been adopted at the European level instead of leaving Member States to develop their own different measures under a legally binding target framework).

Renewable energy in transport

The work on indirect land-use change has demonstrated how the transport sector is in need of incentives for deployment (at this stage small amounts) of advanced alternative fuels. Thus, innovation in advanced renewable fuels will be important to reduce costs of such renewable fuels, which will be needed to increase competitiveness, security of supply and GHG reduction in the transport sector. This will be in addition to continued push for electric vehicles and modal shift as set out in the White paper for Transport."

Sustainability of solid and gaseous biomass

The Commission is currently analysing the sustainability issues associated with increased use of solid and gaseous biomass for electricity, heating and cooling in the EU, with the view to decide whether additional EU action is needed and appropriate. While imports of wood pellets will increase up to 2030, according to projections the major part of biomass for heating and power production is expected to be sourced domestically. According to existing scientific understanding, most of the biomass supply chains currently used in the EU provide significant carbon emission reductions compared to fossil fuels. Only a limited number of biomass feedstocks may have uncertain or potentially negative climate benefits. However, the comparisons depend partly on the methodological assumptions made in the relevant studies. The Commission is currently reviewing the scientific basis and possible safeguards and will take this into account in the above mentioned analysis.

Irrespective of potential future sustainability criteria for these aspects currently under discussion and not subject of this impact assessment, it will remain important in this regard to improve the greenhouse gas mitigation benefits of biomass through: (i) sustainable forest management practices that enhance forest productivity; (ii) minimization of process chain emissions; and (iii) efficient use of biomass to displace greenhouse gas–intensive fuels. However it should be considered that not all biomass types per se deliver GHG benefits, and the overall GHG mitigation benefits should be assessed in this light.

The main conclusion of this Section is that there are several options for implementation of a potential legally binding renewables target for 2030. Detailed evaluation of possible approaches would be carried out in preparation of any future legislative proposals in this regard if there is political agreement on a 2030 renewables target as such.

If the 2030 framework were not to include an explicit RES target, other supporting measures relating to e.g. infrastructure, planning and permitting, grid access, targeted funding etc. would remain important.

5.8. Implementing a potential energy savings / efficiency target

None of the scenarios / policy options presented and analysed in previous Sections will materialise unless there is significant improvement of energy efficiency, driven *inter alia* by

public policy across the EU economy up to 2030 and beyond. Energy efficiency is therefore fundamental for the transition.

All scenarios quantitatively analysed in Section 5.1 include explicit or implicit assumptions about such public policies to varying degrees, but the purpose of this impact assessment is not to evaluate in detail the various means of meeting a potential energy efficiency target/objective for 2030. Such assessment should not and cannot be made except as part of the 2014 review of the approach to energy savings in a 2020 perspective. This 2014 review should also consider if energy intensity rather than absolute energy savings could be a more suitable basis for post 2020 objectives in sectors of the economy where energy consumption is strongly correlated with economic activity; provided that implicit or explicit sectoral targets would be considered appropriate and cost-effective.

Irrespective of any potential 2030 targets in this regard, and without prejudice to the 2014 review, it will be important also in a 2030 perspective to continue policies at the EU level which ensure a high level of energy efficiency, especially in areas such as buildings, energy consuming appliances, vehicles etc. to ensure a level playing field and safeguard the internal market for related products. There will be a need to foster governance and the capacity of market actors and policymakers to introduce energy efficiency measures and to improve the finance-ability and risk profile of energy efficiency investments.

Price elasticity of energy demand is low in many sectors of the economy, in particular in the residential and transport sectors. In industry too, energy-saving measures with short payback times are often not taken up. Energy prices (including the indirect impact from the ETS) will in many situations not be enough to drive the necessary developments in a 2030 perspective, underlining the need for specific policies. A mix of EU level and more flexible Member State approaches in defining and implementing energy efficiency policies (as under the current framework) would safeguard the internal market and undistorted competition on the one hand, and facilitate taking into account national and regional circumstances in a non-distortive manner on the other.

The main conclusion from this Section is that energy efficiency is fundamental for the decarbonisation, and that all policy scenarios analysed therefore include explicit or implicit assumptions about such public policies to varying degrees.

This IA does not evaluate in detail the various means of meeting a potential energy efficiency target/objective for 2030. Such assessment will be part of the 2014 review of the approach to energy savings in a 2020 perspective.

5.9. Differential impacts across member states

The adoption of GHG and RES targets as well as and EE policies would have different impacts on different Member States, depending on how such targets and ambition levels are met. The modelling setup is based on the assumption that EU-wide targets are met in a cost-optimal way, while reflecting existing policies of the Member States already included in the Reference Scenario. This Impact Assessment does not quantitatively address impacts of various implementation approaches with respect to distribution of efforts between Member States and between the Member State and the EU level, on, for example, non-ETS emissions and RES, and future assessments will determine if priority should be given to cost-efficiency at the EU level or other considerations such as ensuring an equitable effort sharing, and to what extent flexibility mechanisms can contribute to both.

With this in mind, this Section provides an indication of the impacts on Member States of different levels of policies and targets which would result in a cost-efficient approach on the EU level in a 2030 perspective, and compares those impacts to the Reference, where at the

same time it should be remembered that the Reference scenario in itself implies significant investments. Then, the distribution of additional system costs and investments is analysed, as well as benefits to health, the environment and fuel savings. Finally, an overview is given of possible means to address issues of equity and capacity. All results shown are indicative and associated with a significant degree of uncertainty as a detailed verification of Member State results has not been carried out.

5.9.1. Impacts on Member State level

5.9.1.1. GHG emission reductions and Renewables shares

Total GHG as well as non-ETS emission reductions per Member State in 2030 are shown in

Table 31 and

Table 32 for:

- the option with 35% GHG reductions and EE policies
- the range associated with options achieving 40% GHG reductions
- the option with 45% GHG reduction, ambitious EE policies and a 35% RES target

The Reference year is 2005 as this is the base year for current legislation regulating GHG emissions in both the ETS and non-ETS sectors.

Table 31: Projected Member State total GHG reductions vs 2005

% total GHG reductions	Reference 2020	Reference 2030	2030 policy scenarios deviation from the Reference Scenario level, in percentage points			
			GHG35/EE	Minimum for GHG -40% scenarios	Maximum for GHG- 40% scenarios	GHG45/EE/ RES35
EU	-19%	-28%	-3%	-8%	-9%	-14%
BE	-18%	-19%	-5%	-8%	-12%	-14%
BG	-17%	-22%	-4%	-8%	-16%	-22%
CZ	-23%	-32%	-2%	-1%	-8%	-8%
DK	-27%	-35%	-6%	-9%	-12%	-15%
DE	-22%	-35%	-1%	-6%	-8%	-14%
EE	-14%	-31%	3%	-1%	-11%	-15%
IE	-15%	-23%	-6%	-10%	-13%	-14%
EL	-29%	-47%	-3%	-4%	-8%	-14%
ES	-21%	-19%	-6%	-8%	-11%	-15%
FR	-21%	-28%	-5%	-9%	-12%	-15%
HR	-17%	-22%	-4%	-9%	-9%	-16%
IT	-25%	-30%	-4%	-6%	-10%	-15%
CY	-22%	-24%	-4%	-5%	-8%	-11%
LV	-1%	5%	-14%	-14%	-27%	-31%
LT	-6%	-15%	-6%	-12%	-16%	-22%
LU	-16%	-18%	-4%	-4%	-10%	-11%
HU	-27%	-33%	-3%	-7%	-9%	-11%
MT	-43%	-49%	-3%	-5%	-6%	-8%
NL	-12%	-20%	-3%	-9%	-14%	-17%
AT	-12%	-23%	-2%	-8%	-10%	-11%
PL	9%	-5%	-6%	-7%	-14%	-9%
PT	-29%	-41%	-2%	-6%	-7%	-10%
RO	-15%	-20%	0%	-4%	-9%	-10%
SI	-15%	-18%	-6%	-9%	-14%	-18%

SK	-14%	-17%	-3%	-6%	-8%	-14%
FI	-9%	-14%	-3%	-7%	-11%	-22%
SE	-10%	-16%	-4%	-7%	-13%	-18%
UK	-28%	-38%	-2%	-7%	-10%	-12%

Table 32: Projected Member State GHG reductions in non-ETS sectors vs 2005

% GHG reductions in non- ETS	Reference 2030	2030 policy scenarios deviation from the Reference Scenario level, in percentage points			
		GHG35/EE	Minimum for GHG -40% scenarios	Maximum for GHG- 40% scenarios	GHG45/EE/ RES35
EU	-20%	-6%	-10%	-14%	-14%
BE	-15%	-6%	-9%	-17%	-17%
BG	-13%	-6%	-12%	-13%	-12%
CZ	-10%	-5%	-13%	-17%	-17%
DK	-20%	-6%	-11%	-13%	-13%
DE	-33%	-5%	-8%	-14%	-13%
EE	-9%	-8%	-14%	-19%	-17%
IE	-7%	-7%	-14%	-18%	-17%
EL	-32%	-4%	-7%	-9%	-9%
ES	-13%	-7%	-10%	-14%	-14%
FR	-23%	-6%	-11%	-15%	-15%
HR	-12%	-7%	-13%	-15%	-16%
IT	-23%	-5%	-8%	-12%	-11%
CY	-11%	-7%	-9%	-14%	-13%
LV	-3%	-8%	-14%	-18%	-15%
LT	-9%	-9%	-14%	-19%	-17%
LU	-16%	-4%	-4%	-11%	-11%
HU	-19%	-4%	-10%	-14%	-14%
MT	-17%	-6%	-10%	-12%	-11%
NL	-20%	-5%	-8%	-12%	-13%
AT	-19%	-5%	-8%	-13%	-13%
PL	7%	-10%	-19%	-24%	-21%
PT	-24%	-5%	-10%	-11%	-11%
RO	-6%	-6%	-12%	-13%	-14%
SI	-5%	-6%	-9%	-15%	-15%
SK	-6%	-5%	-11%	-16%	-16%
FI	-21%	-4%	-9%	-12%	-10%
SE	-21%	-4%	-8%	-12%	-11%
UK	-25%	-5%	-10%	-14%	-14%

Without prejudice to a future assessment of means of meeting a potential 2030 target for RES,

Table 33 provides, for the same scenarios the range of percentage of RES in final energy demand that would follow from a cost-efficient deployment on the EU level[136], compared to the 2020 targets and the 2030 projections under the Reference Scenario.

Table 33: Projected Member State renewable energy share in final energy consumption

% RES	RES	Reference	2030 policy scenarios deviation from the Reference

136 Reflecting existing policies and assumed future policies of the Member States already reflected in the Reference Scenario.

Share in final energy	target 2020	2030	Scenario level, in percentage points			
			GHG35/EE	Minimum for GHG -40% scenarios	Maximum for GHG- 40% scenarios	GHG45/EE/ RES35
EU	20%	24%	1%	1%	6%	11%
BE	13%	16%	1%	1%	7%	9%
BG	16%	20%	2%	0%	8%	14%
CZ	13%	15%	0%	0%	2%	6%
DK	30%	37%	3%	1%	7%	11%
DE	18%	25%	1%	2%	5%	10%
EE	25%	32%	-1%	-3%	8%	15%
IE	16%	24%	3%	1%	5%	10%
EL	18%	21%	4%	4%	8%	15%
ES	20%	24%	1%	0%	4%	12%
FR	23%	28%	1%	1%	9%	18%
HR	20%	24%	0%	1%	5%	12%
IT	17%	20%	1%	0%	6%	7%
CY	13%	22%	1%	0%	2%	6%
LV	40%	37%	6%	1%	14%	17%
LT	23%	22%	1%	1%	17%	28%
LU	11%	11%	1%	0%	1%	2%
HU	13%	15%	0%	1%	4%	13%
MT	10%	25%	1%	1%	3%	5%
NL	14%	18%	0%	1%	6%	8%
AT	34%	39%	1%	2%	5%	7%
PL	15%	18%	0%	0%	3%	4%
PT	31%	42%	0%	0%	3%	6%
RO	24%	29%	0%	-1%	2%	7%
SI	25%	28%	2%	2%	5%	14%
SK	14%	17%	1%	0%	6%	12%
FI	38%	38%	1%	0%	10%	26%
SE	49%	54%	2%	1%	7%	16%
UK	15%	18%	2%	1%	8%	10%

5.9.1.2. Energy system costs, investments and electricity prices

As discussed above, the model runs are based on the assumption that EU-wide targets are met in a cost-optimal way, given existing policies and assumed future policies of the Member States already reflected in the Reference Scenario. The scenario results show that such cost-optimal pathways would tend to lead to higher relative investment expenditures and system costs (as a percentage of GDP) in lower-income Member States, reflecting e.g. sometimes higher potential for cost-efficient GHG abatement, energy savings and RES deployment in those Member States. Moreover, the "denominator effect" implies that the ratio between costs and GDP is higher if GDP is lower. For the scenarios modelled, in the short term, these costs are only partially compensated by energy savings (see Section 5.1). On the other hand, benefits to air quality and human health are expected to be higher in lower income Member States (see below).

The tendency of lower income Member States to have higher additional system costs as percentage of GDP is illustrated below in Figure 6 for the -40% GHG only scenario. Spreads in other scenarios are of similar shape but with a size proportional to the average cost of the scenario. Note that the numbers for system costs do not take into account the existing redistribution between Member States of allowances within the EU-ETS.

Figure 6: Rise in average system costs, 2030, compared to Reference, as a % of GDP for the GHG40 scenario, compared to the GDP/capita in 2010. The EU average rise is 0.15%.

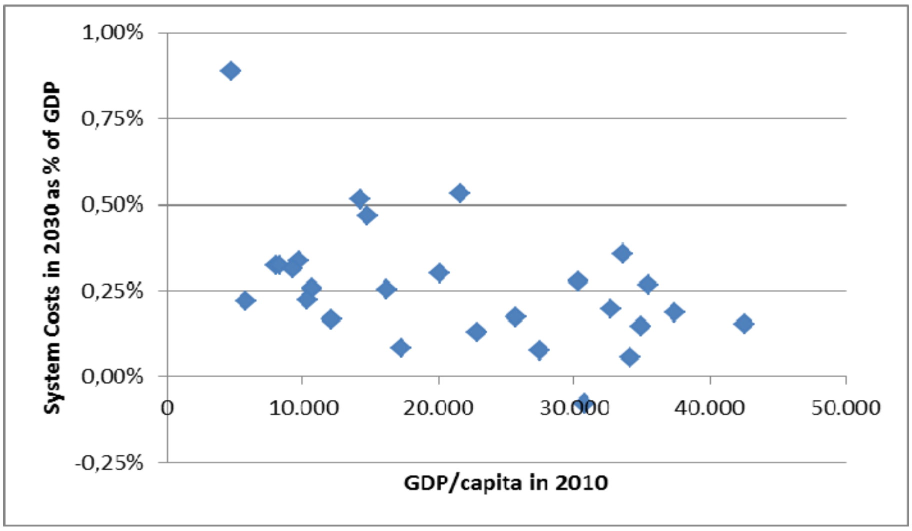


Table 34 and Table 35 give an overview in the form of ranges of impacts compared to Reference for the option with 35% GHG reduction and EE policies, scenarios achieving a 40% GHG reduction and the option with 45% GHG reduction, ambitious EE policies and a 35% RES target, for system costs ranges, investment expenditures and electricity price impacts.

Higher system costs are associated with increased investment expenditures, which compared to GDP, are typically higher in lower income Member States. Similarly increased investment expenditures impact electricity prices with electricity price increase smaller or even negative for the option with least emissions reductions mainly achieved through more energy efficiency (the option with 35% GHG reduction and EE policies), and on the opposite side the option with highest investments in EE and RES (option with 45% GHG reduction, ambitious EE policies and a 35% RES target) seeing strong electricity price increase.

But it should be noted that for the scenarios that invest in ambitious energy efficiency measures without ambitious RES, cost decreases for electricity prices are actually highest for lower income countries. This underlines that ambitious EE reduces the pressure for additional investments in the power sector, thus lowering electricity prices.

Table 34: Projected system costs and investments increases for the policy scenarios compared to the Reference

	System Costs as a % of GDP in 2030, 2030 policy scenarios deviation from the Reference Scenario level, in percentage points				Average Annual Investment Expenditures as a % of Average Yearly GDP for 2011-2030, 2030 policy scenarios deviation from the Reference Scenario level, in percentage points			
	GHG35/ EE	Minimum for GHG - 40% scenarios	Maximum for GHG-40% scenarios	GHG45/E E/ RES35	GHG35/ EE	Minimum for GHG - 40% scenarios	Maximum for GHG-40% scenarios	GHG45/E E/ RES35
EU	0.03%	0.15%	0.54%	0.84%	0.12%	0.21%	0,44%	0.73%
BE	0.16%	0.20%	1.05%	1.24%	0.22%	0.27%	0,68%	0.90%
BG	0.47%	0.41%	2.21%	3.07%	0.29%	0.43%	1,02%	1.60%
CZ	0.01%	0.30%	0.62%	0.79%	0.19%	0.32%	0,65%	0.83%
DK	0.14%	0.15%	0.52%	0.40%	0.07%	0.16%	0,30%	0.40%
DE	0.05%	0.28%	0.78%	0.90%	0.11%	0.22%	0,44%	0.61%
EE	-0.04%	0.26%	1.02%	1.35%	0.11%	0.43%	0,94%	1.19%

IE	0.06%	0.10%	0.36%	0.37%	0.10%	0.13%	0,34%	0.40%
EL	0.33%	0.20%	1.08%	1.38%	0.29%	0.23%	0,60%	0.83%
ES	0.10%	0.12%	0.46%	0.91%	0.11%	0.15%	0,33%	0.61%
FR	-0.10%	-0.08%	0.34%	0.86%	0.06%	0.14%	0,30%	0.62%
HR	0.05%	0.22%	0.87%	0.99%	0.09%	0.32%	0,62%	0.81%
IT	0.02%	0.17%	0.67%	0.84%	0.11%	0.20%	0,43%	0.60%
CY	0.25%	0.07%	0.56%	0.84%	0.10%	0.17%	0,35%	0.63%
LV	0.11%	0.32%	1.20%	1.41%	0.20%	0.43%	0,86%	1.05%
LT	0.25%	0.32%	1.92%	2.23%	0.23%	0.39%	0,91%	1.51%
LU	-0.07%	0.07%	0.31%	0.37%	0.11%	0.14%	0,27%	0.32%
HU	0.25%	0.18%	1.00%	1.33%	0.35%	0.43%	1,03%	1.36%
MT	0.26%	0.16%	0.67%	0.85%	0.00%	0.17%	0,25%	0.43%
NL	0.28%	0.19%	1.13%	1.31%	0.21%	0.25%	0,64%	0.83%
AT	-0.03%	0.06%	0.24%	0.34%	0.09%	0.14%	0,31%	0.38%
PL	0.14%	0.32%	0.99%	1.35%	0.20%	0.40%	0,72%	0.97%
PT	0.19%	0.20%	1.11%	1.25%	0.09%	0.17%	0,34%	0.45%
RO	-0.11%	0.22%	0.65%	1.22%	0.11%	0.34%	0,62%	0.96%
SI	-0.09%	0.08%	0.85%	1.57%	0.04%	0.23%	0,47%	0.80%
SK	0.06%	0.17%	0.64%	0.84%	0.19%	0.31%	0,66%	0.96%
FI	-0.03%	0.27%	0.43%	0.60%	0.18%	0.20%	0,52%	0.80%
SE	0.02%	0.18%	0.25%	0.74%	0.10%	0.18%	0,33%	0.51%
UK	-0.05%	0.07%	0.28%	0.38%	0.10%	0.21%	0,44%	0.57%

Table 35: Projected average price of electricity in final demand sectors increases for the policy scenarios compared to the Reference

Average Price of Electricity (€/MWh),	Reference 2030	2030 policy scenarios percentage deviation from the Reference Scenario level, in percentage points			
		GHG35/EE	Minimum for GHG - 40% scenarios	Maximum for GHG- 40% scenarios	GHG45/EE/ RES35
EU	176	0%	-1%	3%	11%
BE	207	-1%	-2%	3%	7%
BG	115	-1%	-6%	7%	8%
CZ	154	-1%	-14%	7%	-5%
DK	284	3%	0%	2%	0%
DE	240	0%	-1%	4%	5%
EE	119	-6%	-9%	12%	1%
IE	173	2%	0%	3%	4%
EL	148	-1%	-1%	4%	8%
ES	162	1%	-1%	3%	16%
FR	124	-2%	-2%	10%	43%
HR	141	-1%	-7%	1%	-2%
IT	186	0%	-1%	3%	6%
CY	131	2%	2%	5%	14%
LV	169	-2%	-4%	3%	1%
LT	153	-7%	-10%	12%	31%
LU	138	6%	1%	8%	7%
HU	137	-3%	-5%	3%	3%
MT	150	1%	1%	6%	12%
NL	205	0%	0%	6%	12%
AT	161	-3%	-4%	-1%	-2%
PL	157	-4%	-8%	9%	1%
PT	137	4%	1%	5%	6%
RO	116	-6%	-6%	4%	5%
SI	155	-8%	-4%	6%	15%
SK	136	0%	-3%	3%	3%

FI	162	0%	-5%	3%	-1%
SE	137	2%	2%	3%	18%
UK	204	1%	2%	4%	9%

The higher effort compared to GDP by lower income Member States suggests that compensatory measures and / or target differentiation to ensure an equitable 2030 framework will remain necessary. However, energy systems costs are to some extent compensated by positive impacts on energy security and health, and this should also be taken into account. Possible equity mechanisms will be discussed later in this Section.

The size and scope of the equity challenge depends on the combination of targets and policies finally chosen and the manner how they will be implemented, but also on the way to define what would be an equitable distribution of efforts. There is no single, objective metric to measure the equity challenge and way of addressing imbalances.

As an illustration, one could calculate the increases in energy system costs compared to Reference for achieving an EU-wide 40% GHG reduction, in so far as they are *above the EU average cost increases,* for those Member States with a 2010 GDP/capita lower than 90% of the EU average, for different combinations of EE policies and RES targets. This gives an indication of the level of transfers that would be needed to bring costs per GDP to equal levels with the EU average for the lower income Member States. The average annual transfer needed would be some € 1.7 to 4.6 billion per year on average 2021 to 2030 in scenarios resulting in 40% GHG reductions in 2030. The figures are €1.4 billion for the GHG35 scenario with moderate energy efficiency policies and €4.8 billion for the scenario which reduces 45% GHG with ambitious energy efficiency and 35% RES.

5.9.1.3. Environmental and health impacts

The environmental and health benefits received by the Member States should also be taken into account when considering costs and benefits. Reduced fossil fuel consumption improves health conditions through lower emissions of pollutants and lowers costs for air pollution control with benefits being disproportionately larger in lower income Member States expressed as a % of GPD and much larger in scenarios with ambitious energy efficiency policies and a renewables target. See also Table 36 and Table 37.

Table 36: Monetised health benefits in 2030 as a percentage of GDP

Health benefits in 2030 as % of GDP	2030 policy scenarios deviation from the Reference Scenario level, in percentage points							
	GHG35/EE		Range scenarios with -40% GHG reduction				GHG45/EE/ RES35	
	Low valuation	High valuation	Low valuation		High valuation		Low valuation	High valuation
			Min.	Max.	Min.	Max.		
EU28	0,02%	0,04%	0,03%	0,08%	0,07%	0,18%	0,09%	0,21%
BE	0,01%	0,02%	0,02%	0,04%	0,04%	0,10%	0,04%	0,10%
BG	0,14%	0,31%	0,18%	0,37%	0,42%	0,86%	0,55%	1,26%
CZ	0,05%	0,13%	0,06%	0,20%	0,14%	0,46%	0,21%	0,48%
DK	0,01%	0,02%	0,01%	0,02%	0,02%	0,05%	0,02%	0,05%
DE	0,00%	0,01%	0,02%	0,05%	0,04%	0,11%	0,08%	0,17%
EE	0,02%	0,06%	0,00%	0,11%	0,01%	0,25%	0,11%	0,26%
IE	0,00%	-0,01%	0,00%	0,01%	0,01%	0,02%	0,01%	0,03%
EL	0,06%	0,13%	0,06%	0,12%	0,13%	0,28%	0,17%	0,40%
ES	0,02%	0,04%	0,02%	0,05%	0,04%	0,12%	0,05%	0,11%
FR	0,01%	0,03%	0,01%	0,05%	0,03%	0,11%	0,04%	0,10%
HR	0,04%	0,08%	0,04%	0,11%	0,10%	0,25%	0,12%	0,27%
IT	0,05%	0,11%	0,04%	0,12%	0,09%	0,27%	0,14%	0,32%

CY	0,00%	0,00%	0,00%	0,00%	0,01%	0,01%	0,01%	0,03%
LV	0,04%	0,09%	0,03%	0,16%	0,06%	0,36%	0,15%	0,35%
LT	0,04%	0,09%	0,04%	0,15%	0,10%	0,34%	0,14%	0,33%
LU	0,00%	0,01%	0,01%	0,02%	0,01%	0,04%	0,02%	0,04%
HU	0,06%	0,14%	0,08%	0,20%	0,17%	0,47%	0,21%	0,50%
MT	0,01%	0,03%	0,01%	0,03%	0,03%	0,06%	0,03%	0,06%
NL	0,00%	0,00%	0,02%	0,04%	0,04%	0,09%	0,05%	0,11%
AT	0,02%	0,04%	0,02%	0,05%	0,04%	0,12%	0,06%	0,13%
PL	0,14%	0,32%	0,15%	0,69%	0,36%	1,59%	0,66%	1,53%
PT	0,02%	0,04%	0,02%	0,09%	0,05%	0,20%	0,08%	0,18%
RO	0,09%	0,20%	0,15%	0,40%	0,35%	0,92%	0,47%	1,09%
SI	0,04%	0,10%	0,05%	0,12%	0,10%	0,27%	0,12%	0,28%
SK	0,04%	0,08%	0,05%	0,14%	0,11%	0,33%	0,14%	0,31%
FI	0,01%	0,02%	0,01%	0,03%	0,02%	0,07%	0,04%	0,08%
SE	0,00%	0,01%	0,00%	0,01%	0,01%	0,03%	0,01%	0,02%
UK	-0,02%	-0,04%	0,01%	0,03%	0,03%	0,06%	0,01%	0,03%

Source: Mortality impacts based on IIASA (2013), Health benefit valuation uses valuation of mortality (value of life year lost) used for the Thematic Strategy on Air Pollution of €57700 (low estimate) and €133000 (High estimate)

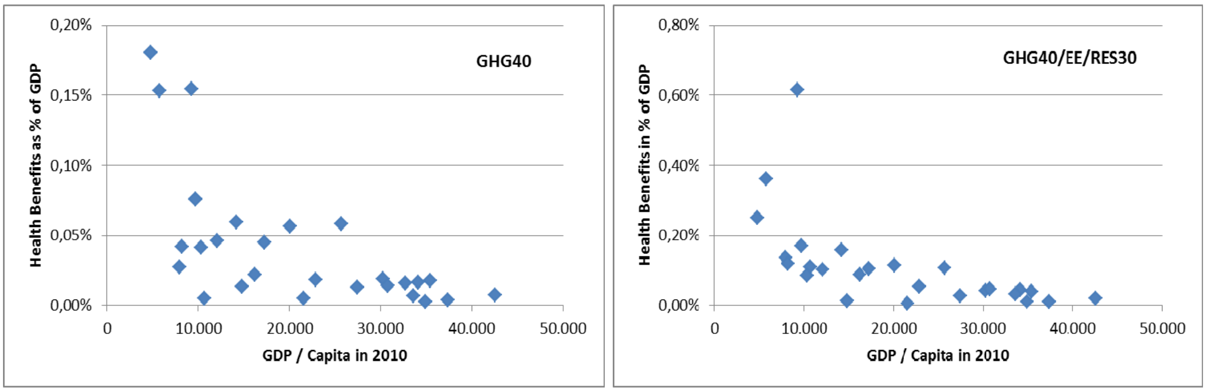
Table 37: reduced air pollution control costs by 2030 as a percentage of GDP

2030 reduced air pollution control costs as % of GDP	2030 policy scenarios deviation from the Reference Scenario level, in percentage points			
	GHG35/EE	Minimum for GHG -40% scenarios	Maximum for GHG- 40% scenarios	GHG45/EE/ RES35
EU28	0,01%	0,01%	0,02%	0,04%
BE	0,01%	0,01%	0,03%	0,03%
BG	0,05%	0,08%	0,18%	0,42%
CZ	0,01%	-0,01%	0,03%	0,04%
DK	0,01%	0,01%	0,02%	0,03%
DE	-0,01%	0,00%	0,02%	0,04%
EE	-0,05%	-0,01%	0,08%	0,13%
IE	0,01%	0,01%	0,02%	0,02%
EL	0,01%	0,03%	0,05%	0,09%
ES	0,01%	0,01%	0,04%	0,05%
FR	0,01%	0,01%	0,03%	0,03%
HR	0,01%	0,00%	0,03%	0,05%
IT	0,01%	0,01%	0,03%	0,05%
CY	0,01%	0,00%	0,03%	0,03%
LV	0,03%	0,01%	0,08%	0,08%
LT	0,02%	0,01%	0,05%	0,05%
LU	0,01%	0,00%	0,04%	0,04%
HU	0,01%	0,01%	0,03%	0,05%
MT	0,00%	0,00%	0,01%	0,01%
NL	0,00%	0,02%	0,04%	0,05%
AT	0,01%	0,00%	0,03%	0,03%
PL	0,04%	0,05%	0,07%	0,08%
PT	0,01%	0,00%	0,03%	0,03%
RO	-0,01%	0,04%	0,07%	0,13%
SI	0,03%	0,05%	0,10%	0,12%
SK	0,01%	0,00%	0,02%	0,05%
FI	0,01%	0,02%	0,05%	0,08%
SE	0,01%	0,01%	0,03%	0,03%
UK	-0,01%	0,00%	0,01%	0,01%

Source: IIASA (2013)

Figure 7: Health benefits per Member State as % of 2030 GDP compared to Reference (using low value of life year lost estimates), relative to GDP per capita

(Note scale differences of Y-axes)



Source: IIASA (2013), Benefit valuation uses valuation of mortality (value of life year lost) used for the Thematic Strategy on Air Pollution of €57000 (Low estimate)

Overall health benefits for scenarios that reduce emissions by 40% for Member States with a 2010 GDP/capita lower than 90% of the EU average, and that have system costs higher than the EU average, are in the range of € 1.8 to 6.4 billion assuming a low value of life year lost estimate and in the range of € 4.1 to 14.8 billion assuming a high value of life year lost estimate. Air pollution control costs decrease between € 0.67 and 0.95 billion compared to Reference for this group of countries for scenarios reducing 40% GHG emissions.

5.9.1.4. Energy Purchases

As a percentage of GDP, it is countries with a 2010 GDP/capita lower than 90% of the EU average which see the greatest benefits. Energy purchases decline especially strongly in the scenarios with ambitious energy efficiency policies.

Table 38 Reductions in energy purchases in 2030 as a percentage of GDP, compared to the Reference Scenario

2030 Energy Purchases compared to Reference as a % of GDP	2030 policy scenarios deviation from the Reference Scenario level, in percentage points			
	GHG35/EE	Minimum for GHG -40% scenarios	Maximum for GHG- 40% scenarios	GHG45/EE/ RES35
EU	-0.47%	-0.20%	-0.78%	-0.59%
BE	-0.61%	-0.26%	-0.82%	-0.77%
BG	-1.34%	0.00%	-2.23%	-1.54%
CZ	-0.77%	0.15%	-1.70%	-1.47%
DK	-0.26%	-0.24%	-0.53%	-0.64%
DE	-0.54%	-0.18%	-0.87%	-0.85%
EE	-0.87%	-0.18%	-1.96%	-1.71%
IE	-0.27%	-0.18%	-0.46%	-0.48%
EL	-0.53%	-0.21%	-0.70%	-0.57%
ES	-0.41%	-0.14%	-0.63%	-0.28%
FR	-0.43%	-0.25%	-0.68%	-0.05%
HR	-0.52%	-0.36%	-1.28%	-1.19%
IT	-0.44%	-0.21%	-0.63%	-0.52%
CY	-0.45%	-0.17%	-0.96%	-0.73%
LV	-0.93%	-0.47%	-1.70%	-1.74%
LT	-0.89%	-0.21%	-1.38%	-0.58%

LU	-0.23%	-0.15%	-0.26%	-0.23%
HU	-0.83%	-0.46%	-1.69%	-1.70%
MT	-0.27%	-0.11%	-0.49%	-0.26%
NL	-0.42%	-0.22%	-0.62%	-0.58%
AT	-0.53%	-0.23%	-0.88%	-0.90%
PL	-0.93%	-0.09%	-1.85%	-1.74%
PT	-0.41%	-0.21%	-0.33%	-0.30%
RO	-0.91%	-0.28%	-1.73%	-1.48%
SI	-0.75%	-0.13%	-1.00%	-0.35%
SK	-0.51%	-0.29%	-1.19%	-1.03%
FI	-0.64%	-0.18%	-1.34%	-1.27%
SE	-0.39%	-0.19%	-0.79%	-0.33%
UK	-0.33%	-0.18%	-0.66%	-0.56%

5.9.2. Meeting the equity challenge

If the distribution of efforts based on cost-effective optimisation were to be regarded as insufficiently fair, this could be addressed through various equity mechanisms. These could in principle include the measures in place up to 2020, e.g. differentiation of targets for non-ETS GHG reductions and RES, distribution of EU-ETS auctioning revenues and leveraging private investment flows through smart financial instruments. Any detailed assessment of impacts from various approaches to target setting will be subject to separate Impact Assessments if the Commission comes forward with dedicated proposals in this regard. Some general considerations are found below.

5.9.2.1. Leveraging private investment flows through smart financial instruments

As discussed in Section 2.3, even the Reference Scenario projections would require significant investment in a 2030 perspective both on the supply and demand sides, e.g. for electricity supply and for more efficient energy using equipment as well as building insulation. The current economic crisis poses additional challenges in the short term, as the cost and ability to finance the necessary investments varies across Member States and sectors of the EU economy. A long term issue of differing abilities is involved insofar as conditions for access to finance remain different for governments, consumers and business across different Member States.

The scenarios evaluated in this Impact Assessment all result in additional investment expenditures, with different impacts in different Member States.

For illustrative purposes, the analysed scenarios resulting in 40% GHG emission reductions imply additional investment needs compared to the Reference scenario of some 11 to 21 € billion annually on average between 2021 to 2030 in Member States with 2010 GDP/capita below 90% of the EU average. The additional investment needs above EU average would be some 3.1 to 7.6 € billion annually on average between 2021 to 2030.

To fund these long-term investments, governments, households and businesses of all sizes need access to long-term financing. As pointed out by the Commission's Green Paper on Long Term Financing[137], getting the long-term financing process right is central to supporting structural economic reform and returning to the long-run trend of sustainable economic growth.

A variety of financial instruments could *in principle* be used to address the capacity challenge, including EIB Bonds, the Project Bonds Initiative, Refinancing Guarantees, Public-Private Risk Sharing Arrangements, etc. Importantly, these instruments leverage private investment

[137] COM(2013) 150 final

flows: a large investment flow could be stimulated at relatively smaller fiscal cost. The sources and targets of these flows could be chosen to alleviate the different capabilities of Member States to finance long term investments in the energy system. Investors in the source state would profit from relatively stable, low-risk revenues. The investment flows to the target state would generate growth and jobs.

In this regard, it should be remembered that the EU already provides investment support for sustainable growth across Member States, including by developing and deploying financial engineering mechanisms. The five European Structural and Investment Funds and Horizon2020 are of particular importance in this regard. Investments in energy efficiency and the transformation of the energy system are among the targets of these programmes. At least 20% of the 2014-2020 Multiannual Financial Framework will be spent on climate action. For the year 2014 alone, the draft budget indicates that this represents approximately €28billion.

5.9.2.2. Differentiation of ambition level for GHG reductions for non-ETS

Without prejudice to a future decision in this regard, the ambition level for GHG reductions in the non-ETS sectors could *in principle* be differentiated by assigning a proportionally higher effort to higher-income Member States, such that the overall EU target is still reached. This approach was applied in the current package[138].

The relative size of emissions is such that, were differentiated targets to be applied, there is scope to increase the ambition level in the Non ETS in higher income Member States, in order to enable a lower ambition level in lower income Member States. Member States with a GDP/capita above 110% of the EU average will represent around 58% of total emissions in 2020, whereas this is only 20% for Member States with a GDP/capita of less than 75% of the EU average.

A disadvantage of continuing with differentiated targets in the non-ETS sectors is that overall costs would increase, if no cost efficient transfers would materialise and targets are met predominantly domestically. The cost-effective potential in lower-income Member States would then not be fully exploited. Examples include refurbishment of housing and renewables development, both of which have more potential in some relatively lower income Member States than in some relatively higher income ones, but which would require higher relative investment rates compared to GDP in those countries.

Furthermore, given the higher ambition levels foreseen for 2030, such a differentiation could pose greater challenges than in the 2020 Package. The scenarios achieving 40% GHG reductions compared to 1990 show that an EU-wide reduction of 30% to 35% will be required in non-ETS sectors compared to 2005. Keeping a similarly large spread in targets as in the current package for 2020 (the spread was 40 percentage points from -20% to + 20% depending on the Member State) would lead to very high ambition levels for some higher-income Member States whose domestic potential for making such reductions is relatively limited. The scenario that would result in 35% GHG reductions in 2030 would imply lower reductions in the non-ETS sectors, resulting in lesser efforts needed in all Member States.

It is however not necessary that such targets are met domestically. Flexibility mechanisms already exist in the Effort Sharing Decision which allow for allowance transfers between Member States. The current Impact Assessment does not estimate at what ambition level

[138] By 2020, the national targets under the Effort Sharing Decision will collectively deliver a reduction of around 10% in total EU emissions from the sectors covered compared with 2005 levels. But individual Member State targets range from a 20% emissions reduction by 2020 (from 2005 levels) for the richest Member States to a 20% increase for the least wealthy one.

differentiated targets could be set, taking into account the flexibility to trade in the Non ETS. It does not assess how the framework for allowance transfers in the Non ETS can be improved to ensure that indeed cost efficiency through transfers is reached and that tangible benefits arise for those Member States overshooting targets. The use of such transfers, together with financial instruments, could help as a catalyst for energy-efficiency investments, that may be cost-effective in lower income Member States, but whose citizens have a lower ability to finance upfront investments.

5.9.2.3. Distribution of EU-ETS Auctioning Revenues

Under the current EU-ETS, 88% of allowances to be auctioned are distributed to the Member States on the basis of their share of verified emissions from EU-ETS installations in 2005. 10% are allocated to the least wealthy EU Member States as an additional source of revenue to help them invest in reducing the carbon intensity of their economies and adapting to climate change. The remaining 2% is given as a 'Kyoto bonus' to nine EU Member States which by 2005 had reduced their greenhouse gas emissions by at least 20% of levels in their Kyoto Protocol base year or period.

Such redistributive mechanisms could be continued up to 2030, with the value of such transfers depending on the (rising) CO2 prices and the number of auctioned allowances, which would decline under current policies. The below table gives an indication of the size of auctioning revenues expected for different scenarios, for auctioning to the power sector only and full ETS auctioning.

The extent to which revenue from auctioning would be used in a targeted manner towards e.g. demonstration and deployment of promising new technologies (such as what is currently done with the so called NER 300) would lower the amounts available purely for distribution between Member States.

Table 39: Auctioning revenue projections in options achieving 40% GHG reductions and assuming different coverage of scope of sectors covered by auctioning

Billions of Euros	Auctioning only in the power sector		Auctioning in all ETS sectors	
	2030	Average 2021-2030	2030	Average 2021-2030
Reference	27	17	56	34
35% GHG + EE	20	13	43	27
40%GHG Reference settings	34	23	77	48
40% GHG Enabling settings	25	18	57	37
40% GHG + EE	17	14	35	28
40% GHG 30% RES + EE	7	8	16	17
45% GHG 35% RES + EE	7	9	18	20

Under the assumption that free allocation would continue outside the power sector also post 2020, 12% of the auctioning revenue (the share currently used to address distributional aspects) would amount to 0.8 to 2.8 billion € on an annual basis over the period 2021-2030. (These figures can be compared with the above average system costs in countries with GDP/capita below 90% of the EU average, as discussed in the previous Section).

Depending on the scenario, and the desired results for equity, a higher share of auctioning revenue would have to be used to address distributional issues if this were to be the only means of addressing it. The potential could increase by expanding auctioning to other sectors or the scope of EU-ETS as a whole (impacts and challenges of these options are discussed in Annex 7.8), or expanding the share of auctioning revenue used for distributional purposes. In this context, it should also be kept in mind that projections of the ETS price are associated with significant uncertainty (see Section 5.1.4.1), which may impact the perceived value of future redistribution.

The main conclusions of this Section are that if 2030 climate and energy targets are met in a cost-efficient manner on the aggregate EU level, costs relative to GDP are typically highest in lower income Member States and in scenarios that require highest investment expenditures due to ambitious EE and RES. At the same time, environmental and health benefits as well as fuel savings are also highest in these countries. Several options, all needing further assessment, have been identified that could help to address these distributional issues so as to allow an equitable outcome.

6. COMPARING OPTIONS / CONCLUSIONS

As explained in Section 4, the main policy options assessed by this Impact Assessment relate to the combination and ambition level of potential headline climate and energy targets for 2030, including information on possible policy options to implement these. On the basis of the extensive analysis of the seven representative scenarios in Section 5. Section 6.1 provides a detailed comparison of the scenarios used to evaluate and compare the policy options whereas Section 6.2 compares the trade-offs between the main policy options.

6.1. Comparing the scenarios

Table 40 give an overview of the main impacts of the different scenarios assessed. 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, as further explained in Section 5.1 and illustrated by the Low carbon Economy Roadmap and the Energy Roadmap 2050.

6.1.1. Environmental impacts

All scenarios demonstrate reduced GHG emissions compared to the Reference scenario. With respect to 1990 levels, the reduction levels are inherent in the scenario definition and for this reason lower in GHG35/EE® and GHG37® and higher in GHG45/EE/RES35. Scenarios differ however with regard to the balance of GHG reductions in the various sectors of the economy: scenarios with ambitious energy efficiency policies typically reducing GHG emissions more in the sectors outside of the ETS. In most scenarios, the power sector reduces emissions most compared to 2005 levels and the transport and agriculture sector reducing least. In scenarios with strong energy efficiency policies but without an explicit renewables target, reductions in the residential sector are substantial at levels similar of that of the power sector.

Emissions and absorptions from Land Use, Land Use Change and Forestry (LULUCF) are somewhat increased by increased production and consumption of renewable energy (and thus increased bio-energy demand) if increased demand for bio-energy is met largely through increased use of perennial energy crops. The eventual impact on GHG emissions would also depend in part on type of crops used and farming practices, as well as land use changes outside Europe to the extent imports are impacted.

With respect to pollutant emissions, all scenarios evaluated in this regard show clear benefits with respect to the Reference scenario, with more pronounced benefits in scenarios with ambitious energy efficiency policies and RES targets, due to the resulting reduction of fossil fuel consumption.

6.1.2. *Energy system impacts*

All scenarios show reduced energy consumption (both primary and final) compared to the Reference scenario, with more pronounced energy savings and improved energy intensity in scenarios with strong energy efficiency policies, with highest improvements in those scenarios that next to ambitious energy efficiency policies also include a renewables target.

The share of renewables increase modestly compared to the Reference scenario in the scenarios led by GHG emission reductions, but are more pronounced in scenarios with explicit renewables targets (at levels inherent with the design of such scenarios). Without a dedicated RES target for 2030, the pull effect of GHG reduction is projected to lead to RES shares ranging from 25% to 27% in 2030, depending on the level of the GHG target being 35% or 40%. The joint renewables share for electricity and heating & cooling is 34%, whereas this increases to 40% for the scenario that also achieves an overall renewables target of 30%.

The consumption of fossil fuels is projected to decrease in all scenarios compared to the Reference scenario, with higher reduction levels for gas and oil in particular in scenarios with ambitious energy efficiency policies. The use of oil and natural gas in particular is further reduced in scenarios with ambitious energy efficiency policies. As regards nuclear energy, the scenario driven by a GHG target projects no change in 2030, whereas scenarios with explicit renewables targets demonstrate significant decreases. Explicit energy efficiency policies also reduce the share of nuclear, but to a lesser degree. The share of CCS in power generation is projected to be lower than in the Reference scenario in scenarios with more ambitious energy efficiency policies and a renewables target, reflecting the lower projected incentives from the ETS in those scenarios.

6.1.3. *Economic impacts*

Energy system costs increase in all scenarios compared to the Reference scenario, albeit by less than the projected increase under the Reference scenario itself. Energy system costs increases can be lower with relatively lower ambition levels for energy efficiency policies. It is noteworthy that adding a 30% renewables target to a scenario with GHG emissions reduction of 40% if combined with ambitious energy efficiency policies has a very marginal impact on total energy system costs. The components of system costs change in the scenarios compared to the Reference scenario, with more pronounced capital costs and lower operational costs due to fuel savings. This tendency is more pronounced in scenarios with ambitious energy efficiency policies, reflected in higher investment needs in such scenarios, in particular in the built-up segment.

Electricity prices are projected to be relatively similar to the Reference scenario, which in itself demonstrates significant increases, with a containing impact of energy efficiency policies in those scenarios including them. Adding a renewables target to a given scenario results in electricity price increases, although impacts are very limited in the case of a 30% renewables target. Without ambitious EE policies, the impact of higher renewables penetration on electricity prices would be higher, underlining the important interactions between the two policy areas.

The ETS price differs substantially across the various scenarios, reflecting the positive contribution of both renewables and energy efficiency to emission reductions in the ETS

sectors. At the same time, such policies reduce both costs and incentives from the ETS itself for other types of abatement.

Energy costs (including capital and operational costs) relative to added value in the energy intensive sectors increase in all scenarios, with slightly more in scenarios including explicit energy efficiency policies.

GDP impacts for scenarios reducing emissions by 40% GHG can be either negative or positive. This depends to a large extent on the future approach to auctioning and CO2 taxation in the non-ETS sectors and the use of the related revenue. Furthermore, for the scenarios evaluated in this regard, impacts on GDP are generally speaking projected to be positive in scenarios with explicit energy efficiency polices.

Impacts on the sector level differ, but the positive impact from international climate action and the possibility for international emissions trading is noticeable for most energy intensive sectors. Overall, in the case of insufficiently strong global action, the results suggest that free allocation can have a positive impact on these sectors, notably for sectors that are not including the opportunity cost of free allocation in the price of their products.

6.1.4. Social impacts

The overall net employment impacts, as for GDP, depend on the approach to auctioning in the ETS and CO2 taxation in the non-ETS sectors. Employment impacts are positively impacted by using carbon pricing revenue to lower labour costs. The analysis also suggests that the employment effect will overall be positive in scenarios with ambitious energy efficiency policies (in part through the associated investments) and renewables targets, reflecting the significant job-creation potential in these areas.

Whereas relatively small impacts on the overall employment level are expected, significant shifts in employment among or within sectors are expected. Such impacts will require the implementation of adequate labour market policies. Employment impacts are in particular projected to be negative for instance for energy extraction sectors, compensated by employment increases in for instance engineering, basic manufacturing, transport equipment, construction sector and business services.

Health impacts are expected to be positive in all scenarios due to lower pollutant emissions from the energy system, with these impacts being more pronounced in scenarios with ambitious energy efficiency policies and renewable energy targets due to the resulting higher reduction of fossil fuel consumption.

Affordability of energy for households is negatively affected under the Reference scenario, but is not significantly impacted compared to the Reference scenario in the scenarios resulting in GHG reductions of 35 or 40% (see above on energy prices). Post 2030, energy prices and costs for households are projected to increase significantly in scenarios not including ambitious energy efficiency policies. As such, 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.

6.1.5. Distributional impacts

The analysis indicates that provided that the EU as such applies a cost-effective approach to meeting the 2030 targets, the efforts needed in lower income Member States are relatively larger than for higher income countries, with relatively higher increases in investments and energy system costs compared to GDP, but also relatively higher benefits in terms of, for example, fuel savings and related impacts on trade balances, as well as for air quality and health. Several distributional mechanisms are conceivable to allow for more equitable

outcomes, such as differentiation of targets, the distribution of auctioning revenues and the use of smart financial instruments, structural funds etc. Such options should be analysed in more detail when preparing legislative proposals.

6.2. General impacts and trade-offs between policy options

As mentioned in Section 1.2, there is a broad agreement among stakeholders and Member States that the EU should agree on a 2030 target for GHG emissions, while there are diverging views on what the appropriate ambition level should be and how to relate to international developments in the climate change area.

As regards the other headline targets for 2020 (renewables share and energy savings), there are mixed views on whether the progress in this regard in a 2030 perspective would necessitate dedicated targets, and if yes, at what level such targets should be set. In this context, and on the basis of the extensive analysis in Section 5, the main policy choices centre around three issues, while at the same time recalling that other aspects of the competitiveness of the energy system and security of energy supply are equally important in a 2030 perspective:

i) only a GHG target, or also including targets for Renewable energy and Energy Efficiency;

ii) the level and coherence of the targets

iii) the interlink with global climate action

There are several important trade-offs.

6.2.1. Only a GHG target, or several targets

- A single GHG target would have the advantage of reduced complexity of the 2030 framework and would in principle allow to achieve GHG reductions cost efficiently. Nevertheless, this may risk to not sufficiently reflect the complexity of energy objectives in a 2030 perspective which in addition to environmental sustainability (including GHG reductions) are competitiveness and security of supply.
- Whatever the policy choice dedicated energy efficiency and renewables policies, including in the sectors outside the ETS will be required to transform the energy system and achieve the GHG reduction efficiently in order to address market failures, imperfect information, and investor certainty; thereby better ensuring that the necessary investment takes place.
- A single GHG target would in principle treat options for GHG reductions in a non-discriminatory and technology neutral way without preferential treatment of energy efficiency or renewable energy. However, higher efforts geared towards energy efficiency and renewable energy beyond what is needed to achieve a GHG target would result in higher benefits relating to e.g. improvements in fuel efficiency, security of supply, reduction of the negative trade balance for fossil fuels, environmental impacts and health. For example, a single GHG target without more ambitious RES and energy efficiency targets is expected to result in lower positive impacts on the EU's negative trade balance (net energy imports) in a 2030 perspective and beyond. It is also expected to result in lower GDP and employment compared to a Framework based on more ambitious targets for also renewables and energy efficiency. Macro-economic benefits associated with the recycling of auctioning revenues into lower labour costs would increase.

- A single GHG target would result in lower energy related cost increases and necessary investments if met in an optimal way as represented by the use of carbon values in the modelling approach compared to a situation with 3 targets if renewable and energy efficiency targets would be set at a level above their cost-effective potential to meet the GHG target. The containing impact on the ETS price is substantial from a Framework that would include set ambitions levels or strong policies for also renewables and energy efficiency. This would have a direct positive impact on the ETS compliance costs for sectors with a risk of carbon leakage as well as on the indirect impact of the ETS on electricity prices if objectives would be met in a cost-effective manner on the EU level. At the same time, renewables and energy efficiency investment going beyond what is needed to achieve cost-effectively a certain GHG target, would come with additional capital costs and lower operational costs only in the medium to long term, which overall would result in higher energy system costs, while the effects will differ among consumer groups depending on how these investments are financed.

6.2.2. The level of the targets

6.2.2.1. The GHG target

- A 40% GHG target would ensure that the EU is on the Low-Carbon Economy Roadmap's cost-effective track towards meeting the EU's 2050 GHG objective to reduce GHG emissions by 80-95 percent in 2050 compared to 1990, in the context of necessary reductions by developed countries as a group. While that 2050 target could in principle be reached also with a 35 percent target for 2050, the Commission's current analysis suggests that it would come with additional costs over the entire time period, up to 2050, while having lower costs in a 2030 perspective. Moreover, health benefits and impacts on the energy trade balance are larger with a higher level of ambition.
- The 2020 target implies a 20 percent reduction over three decades and a 40 percent target in 2030 would imply the same reductions in one decade, strictly looking at the targets. On the other hand, so far we have achieved 18% reduction in 22 years (1990-2012), and going to a 40% target would mean a further 22% reduction in 18 years (2013-2030).
- The EU's unilateral 20% GHG target for 2020 appears to have been more successful in inducing other countries pledges than the conditional 30% GHG target for 2020.A 40% target would give a strong message to the international community in the process leading up to the international climate conference in 2015, expected to reach agreement on the global approach to GHG abatement for the period post 2020. At the same time, keeping in mind that the EU's agreed 2050 GHG objective can only be met through international climate action it leaves the question open if the EU's initial contribution to an international agreement should be lower
- Specifically for the ETS:
  - A 35% GHG target would not require a change to the current Linear Reduction Factor, whereas a 40 or 45% GHG target would require a change.
  - In both cases the ETS will be confronted with a large surplus of allowances in the short to mid-term, which may affect investment decisions negatively and results in sub-optimal investment decisions which risks not meeting the level of the

emissions cap in 2030, indicating that a structural measure that improves the functioning of the ETS is required.

- As long as other regions do not take comparable action on climate change, continued free allocation on the basis of periodically updated benchmarks can be a suitable tool to address the risk on carbon leakage, if focussed on industries that cannot easily differentiate prices from those of outside competitors.

- A 40% GHG target, and notably if coupled with stronger energy efficiency and renewable measures, would result in stronger benefits in terms of the energy independency, the EU's external fuel bill and health impacts. This increases investments in goods and sectors that benefit the EU's GDP, employment and competitiveness in new growth sectors. There is no universal way of quantifying the economic value of such benefits and costs and the net impact to the society considering higher energy system costs and energy investments are difficult to determine.

6.2.2.2. Other targets

- As regards renewables, is clear that a high level of ambition would come with significant benefits in terms of greater reliance on indigenous energy sources and the associated benefits in terms of energy trade balance (to the extent that renewables no not replace other domestic energy sources). A high level of ambition would also better drive growth in the renewables sector. At the same time, the level of ambition must be coherent with the overall level of ambition for GHG due to the multiple interactions and not result in unwarranted impacts to continue with other low-carbon energy sources incentivised by the ETS or result in unwarranted restrictions of Member State flexibility to achieve GHG reductions outside the ETS.

- Moreover, a high level of ambition with regards to renewable energy could be expected to necessitate deployment of a broader range of renewables technologies, which could contribute to making less mature technologies cost-competitive faster, and thereby ensure their long-term and cost-efficient contribution to the transformation of the energy system also post 2030. At the same time, a level of ambition that depends on deployment of not yet cost competitive technologies would require specific measures beyond for instance the incentives coming through the ETS and could thus come with short to medium term cost increases, with associated operational cost savings more tangible in the longer term. In addition, deployment of not yet cost-competitive renewable energy may, depending on the specific supportive framework, lead to tensions with the internal energy market and cause competitiveness concerns for conventional energy sources needed also as the energy system goes through the transition.

- As regards energy efficiency, the trade-offs between different levels of ambition is similar to that of renewables in the sense that a high level of ambition could lead to short to medium term cost increases that pay off only in the medium to long run. At the same time, a high level of ambition has the potential to better contain the operational energy cost impact of higher energy prices as well as the potential cost impacts of ambitious GHG and renewables targets due to its lowering impact on reducing total energy consumption itself, which is a key concern for certain energy consumers. Moreover, given a certain GHG target to be achieved, health benefits and impacts on the energy trade balance are larger with a higher level of ambition regarding energy efficiency, which is also expected to lead to more positive GDP and

employment impacts. Again, this has to be weighed against potential impacts on short to medium term cost increases.

Table 40: Overview table with the key results for the IA for the different scenario projections

	Ref.	GHG35/EE ®	GHG37 ®	GHG40 ®	GHG40	GHG40/EE	GHG40/ EE/RES30	GHG45/ EE/RES35
	Main features scenarios							
Reference or enabling conditions	Ref.	Ref.	Ref.	Ref.	Enabling	Enabling	Enabling	Enabling
GHG reductions vs 1990	-32.4%	-35.4%	-37.0%	-40.4%	-40.6%	-40.3%	-40.7%	-45.1%
Renewables share[139] - Overall	24.4%	25.5%	24.7%	25.5%	26.5%	26.4%	30.3%	35.4%
Renewables share[140] - E-H&C	31.0%	32.6%	31.6%	32.9%	34.2%	34.1%	39.7%	47.3%
Energy savings[141]	-21.0%	-24.4%	-22.9%	-24.4%	-25.1%	-29.3%	-30.1%	-33.7%
	Other environmental impacts							
GHG emissions reduction in ETS Sectors vs 2005	-36%	-37%	-38%	-42%	-43%	-38%	-41%	-49%
GHG emissions reduction in non-ETS Sectors vs 2005	-20%	-26%	-28%	-31%	-30%	-35%	-33%	-34%
CO_2 emission reductions vs 2005	-29%	-32%	-32%	-35%	-36%	-36%	-37%	-43%
Power generation +District Heating	-47%	-48%	-49%	-55%	-57%	-48%	-53%	-66%
Industry	-22%	-23%	-24%	-27%	-27%	-26%	-27%	-31%
Residential, Services & Agriculture	-31%	-36%	-38%	-41%	-39%	-49%	-47%	-49%
Transport	-12%	-15%	-12%	-12%	-14%	-20%	-19%	-19%
Non-CO_2 emission reductions vs 2005	-19%	-28%	-38%	-43%	-40%	-38%	-33%	-35%
Agriculture	-4%	-13%	-25%	-28%	-28%	-25%	-19%	-22%
Other non-CO_2 sectors	-36%	-45%	-54%	-61%	-55%	-52%	-49%	-49%
Reduced pollution control & health damage costs (€bn/yr)[142]	n.a.	3.8 to 7.6	4.2 to 8.8	8.6 to 17.1	7.2 to 13.5	17.4 to 34.8	16.7 to 33.2	21.9 to 41.5

139 Share of RES in gross final energy consumption according to 2009 RES Directive.

140 Contribution of RES in gross final energy consumption of electricity and heating & cooling, based on the individual calculations of the RES according to 2009 RES Directive.

141 Energy Savings evaluated against the 2007 Baseline projections for 2030.

	Ref.	GHG35/EE ®	GHG37 ®	GHG40 ®	GHG40	GHG40/EE	GHG40/ EE/RES30	GHG45/ EE/RES35
Import dependency	*55.1%*	*53.7%*	*55.1%*	*54.8%*	*53.6%*	*52.8%*	*51.8%*	*52.3%*
Net Energy Imports (2010=100)	96	90	94	92	89	83	81	78
Net Imports of Gas (2010=100)	105	91	100	99	91	82	74	72
Energy Intensity[143] (2010=100)	*67*	*64*	*66*	*65*	*64*	*60*	*60*	*57*
Renewables share[144] - Overall	*24.4%*	*25.5%*	*24.7%*	*25.5%*	*26.5%*	*26.4%*	*30.3%*	*35.4%*
- share in heating & cooling	23.8%	24.6%	24.4%	25.5%	25.9%	25.8%	30.6%	35.2%
- share in electricity	42.7%	45.4%	43.1%	44.6%	47.3%	46.1%	53.1%	65.7%
- share in transport	12.0%	12.9%	12.0%	12.0%	12.8%	14.0%	14.6%	15.6%
- share in electricity – heat. & cool.	31.0%	32.2%	31.6%	32.9%	34.2%	34.1%	39.7%	47.3%
	Primary energy mix & Gross Electricity Generation							
Primary Energy Consumption (Mtoe)	*1,611*	*1,542*	*1,576*	*1,548*	*1,534*	*1,448*	*1,433*	*1,364*
- Solids share	10.8%	12.1%	10.7%	9.5%	10.1%	12.4%	12.0%	9.0%
- Oil share	32.3%	32.2%	32.7%	33.1%	32.8%	32.1%	32.5%	33.9%
- Natural gas share	24.6%	22.4%	24.1%	24.1%	22.5%	21.6%	20.1%	20.5%
- Nuclear share	12.5%	12.7%	12.4%	12.7%	13.1%	12.8%	11.0%	6.0%
- Renewables share	19.9%	20.7%	20.1%	20.8%	21.6%	21.2%	24.5%	30.6%
Gross Electricity Generation (TWh)	*3,664*	*3,531*	*3,586*	*3,534*	*3,532*	*3,431*	*3,428*	*3,279*
- Gas share	19.5%	14.2%	19.2%	19.5%	15.3%	14.2%	11.9%	13.3%
- Nuclear share	21.8%	22.0%	21.7%	22.0%	22.6%	21.4%	18.0%	9.8%
- CCS share	0.45%	0.27%	0.50%	0.73%	0.77%	0.29%	0.23%	0.25%

142 Reduction of health damage costs due to reduced air pollution compared to the reference (€bn/yr). Valuation uses value of life year lost used for the Thematic Strategy on Air Pollution, ranging €57000 to €133000 per life year lost.

143 Primary energy to GDP.

144 Share of RES in gross final energy consumption according to 2009 RES Directive.

	Ref.	GHG35/EE ®	GHG37 ®	GHG40 ®	GHG40	GHG40/EE	GHG40/ EE/RES30	GHG45/ EE/RES35
	Economic and social impacts							
Total System Costs, avg annual 2011-30 (bn €)	2,067	2,064	2,073	2,074	2,069	2,089	2,089	2,102
compared to reference (bn €)		-3	+6	+7	+2	+22	+22	+34
Total system cost as % of GDP increase compared to Reference in 2030 in % points	n.a.	-0.02%	+0.13%	+0.20%	+0.15%	+0.54%	+0.54%	+0.84%
Investment Expenditures[145], avg annual 2011-30 (bn €)	816	833	835	846	854	875	879	909
compared to reference (bn €)		+17	+19	+30	+38	+59	+63	+93
Energy Purchases, avg annual 2011-30 (bn €)	1,454	1,428	1,447	1,446	1,436	1,421	1,423	1,431
compared to reference (bn €)		-26	-8	-8	-18	-34	-31	-23
Fossil Fuel Net Imports, avg annual 2011-30 (bn €)	461	451	459	457	452	441	439	434
compared to reference (bn €)		-10	-2	-4	-9	-20	-22	-27
Average Price of Electricity[146] (€/MWh)	176	174	176	181	179	174	178	196
compared to reference (€/MWh)		-2	+1	+6	+3	-1	+2	+20
ETS price (€/t of CO2-eq.)	35	27	35	53	40	22	11	14

145 Investments expenditures include total purchases of transport equipment for households and businesses (including road and non-road transport), but not infrastructure costs.

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

Energy costs for Energy Intensive Industries[147]	41.8%	43.5%	41.9%	42.2%	42.1%	44.5%	44.0%	45.3%
Energy related expenditures of households[148]	9.3%	9.3%	9.5%	9.6%	9.4%	9.5%	9.4%	9.7%
GDP impacts	na	Typically smaller impacts than -40% GHG options		GEM E3 model: -0.45% to -0.10%[149] E3MG + E3ME models: 0.0% to +0.55%[150]				Typically higher impacts than -40% GHG
Employment impacts	na			GEM E3 model: -0.61% to 0.20%[151] E3ME model: 0.3% - 0.5%[152]				
Distributional impacts between MS	na			Lower income Member States have higher costs, but benefit more from reduced air pollution Costs spread more for options with higher system costs				

147 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.

148 Calculated as share of energy related expenditures of households (referring to stationary uses) in average household expenditure. For Reference Scenario corresponding value was 7.5% in 2010.

149 Depends on if and how carbon pricing used, with best result with auctioning in all ETS sectors and CO2 taxation in the non ETS, while using the revenues to lower labour costs.

150 Highest result takes into account the impact of energy efficiency investments.

151 Depends on if and how carbon pricing used, with best result with auctioning in all ETS sectors and CO2 taxation in the non ETS, while using the revenues to lower labour costs.

152 Highest result takes into account the impact of ambitious energy efficiency policies and renewables targets.

7. ANNEXES

7.1. The EU Reference Scenario

Context, key assumptions and overall framework

The new Reference scenario informs about the expected outcome from implementing the already agreed policies in the context of the 2020 package (serving therefore as baseline for this IA). It can therefore enlighten the policy debate on the impacts of an option with no further EU action, while laying the basis for analysing the impacts of additional policy action aimed at in the energy and climate framework for 2030. For a comprehensive presentation of methodology and results (for EU and per each Member State) see the European Commission report "EU Energy, Transport and GHG emission trends until 2050 – Reference Scenario 2013"[153].

The new EU Reference scenario modelling, finalised in 2013, was jointly supervised by DGs ENER, CLIMA and MOVE based on EU energy system and CO2 emission modelling with PRIMES, transport activity modelling as well as specific modelling related to non-CO2 GHG with GAINS and CAPRI. It involved world energy modelling for determining international fossil fuel prices as well as macro-economic and sectoral modelling – all through 2050. Member States experts had been involved in various stages, starting with replies to an extensive policy questionnaire and encompassing four rounds of commenting on economic, transport activity, energy and non-CO2 and LULUCF emission results. The energy modelling is done in five year steps starting with 2015 and based on Eurostat statistics through 2010.

The assumptions related to GDP have been taken from the joint work of DG ECFIN and the Economic Policy Committee. The 2012 Ageing report[154] provided the population and long term GDP growth projections, while the short and medium term GDP growth projections were based on DG ECFIN (following 2012 agreement reached in the Economic Policy Committee). These were then further developed for having the proper inputs for energy and transport modelling (notably value added of the various sectors and subsectors regarding energy intensive activities). The EU economy is assumed to continue growing after having overcome the economic crisis. Average annual GDP growth between 2010 and 2030 is projected at 1.5% pa, decreasing thereafter to 1.4% pa due to demographic change (ageing population). After slight growth over this and the next two decades population is stagnant from 2040 onwards.

GDP growth rates vary over time and across Member States, reflecting the crisis and the subdued prospects in some countries affected particularly hard. They also allow for greater economic cohesion with higher growth rates especially in new Member States. For example, GDP development in 2010 to 2015 ranges from significant decreases in Greece to a growth rate of nearly 4% pa in Estonia. Over the longer term from 2015 to 2030, the EU economy grows at 1.6% pa. The lowest growth in this period would materialise in Germany (0.8% pa, also due to its shrinking population) while economic activity in a couple of Member States would be growing faster than 2% pa (Poland, Estonia, Latvia, Slovakia, Spain and Ireland).

The Reference scenario has been developed in the framework of limited global climate action, especially regarding non-EU regions. It assumes that third countries live up to their Copenhagen/Cancun pledges, but there is no assumption on any further significant climate action in these countries. This is similar for the EU, which in this Reference scenario, despite

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153 E.g. http://ec.europa.eu/energy/observatory/trends_2030/index_en.htm.

154 http://ec.europa.eu/economy_finance/publications/european_economy/2012/2012-ageing-report_en.htm

implementing its unconditional GHG reduction target and renewables targets, would not be stepping up efforts in 2020 and beyond.

Fossil fuel import prices are seen increasing, so that the oil price might reach 121 $/barrel in 2030 and 143 $ in 2050 (corresponding to 110 €, all in constant 2010 prices). With 2% inflation (ECB target) this corresponds to 180 $ in 2030 in nominal terms (315 $ in 2050). Gas prices rise stronger in the short term due to increasing demand notably from Asia (China, post-Fukushima Japan), from 38 € (10)/boe in 2010 to 62 €/boe in 2020. After 2030, gas prices decouple somewhat from oil prices, among others due to shale gas exploitation in the US and some other regions; coal prices remain considerably lower by comparison (24 € (10)/boe in 2030 and 31 € in 2050).

Table 41: International fossil fuel price developments in Reference

EU fuel import prices	2010	2020	2030	2050
Oil (in $2010 per boe)	80	115	121	143
Oil (in €2010 per boe)	60	89	93	110
Gas (in €2010 per boe)	38	62	65	63
Coal (in €2010 per boe)	16	23	24	31

Source: PROMETHEUS

Technology developments are dealt with in great detail. In each period energy investment is modelled endogenously on the basis of a wide portfolio of different energy technologies, notably for power and heat generation, along with energy demand, cost and price numbers derived simultaneously in the modelling while making sure that grids and interconnector capacity allows for implementing the already agreed policies. The modelling takes also into account the potential need for delivering simultaneously electricity and heat when considering CHP investment options. Technology performance improves over time, the pace depending on the maturity of individual technologies, based on expert judgements including from JRC. Technology learning translates also into cost digression at different rates according to technologies (over 100 different ones for power generation).

The policy framework for the EU can be summarised as achieving the RES and GHG targets as agreed within the 2020 energy and climate package. Moreover, other policies agreed by spring 2012 are included (such as the CO2 standards for cars / vans, implementation measures of the Eco-design Directive, Energy Performance of Buildings Directive etc.) as well as the Energy Efficiency Directive, for which there had been political agreement in the first half of 2012.

The modelling assumptions include the following elements:

- The Grid expansion follows the latest 10 Year Development Plan from ENTSO-E, without making any judgement on the likelihood of certain projects materialising.
- The 2020 targets on RES including the RES in transport sub-target will be achieved, but there is no assumption on targets for later years. Beyond the reflection of currently adopted national policies, RES values are used as key modelling tool to ensure cost-efficient target achievement at national level.
- RES subsidies decline after 2020 starting with on-shore wind; RES aids for most technologies decline to zero by 2050, except for innovative maritime RES, such as wave and tidal energy. Increasing use of RES co-operation mechanisms will also help to reduce RES costs. Generic policies on facilitating RES penetration (e.g. streamlined authorisation procedures) continue.

- Additional energy efficiency policies are modelled along the lines of the various provisions of the Energy Efficiency Directive reflecting e.g. building insulation or the savings required from utilities and retailers regarding energy consumption at their customers' sites. The fulfilment of the energy savings obligation is modelled with Energy Efficiency Values.
- Similarly, other energy efficiency measures, notably the eco-design regulations have been taken into account influencing energy consumption increasingly over time as obsolete appliances etc. are being removed while new items, subject to eco-design standards, are entering the market.
- The ETS cap is assumed to continue declining at a linear factor of 1.74% according to the ETS Directive. As a consequence, ETS prices increase throughout the projection period as the ETS cap is decreasing and the current surplus of allowances is gradually decreasing. The different allowance allocation rules (auctioning, free allocation based on benchmarks) for the different sectors foreseen in the legislation are reflected in the modelling, including the transitional provisions to full auctioning in the power sector and the provisions for sectors at risk of carbon leakage.
- The legally binding targets GHG targets under the Effort Sharing Decision for 2020 turn out to be achieved at the EU level under Reference Scenario conditions[155], notably thanks to progress to be achieved by CO2 standards for cars and vans and energy efficiency policies and taking into account flexible mechanisms among Member States. Carbon values in the non-ETS sectors are therefore zero.
- Nuclear investment is endogenous, but non-nuclear Member States remain non-nuclear, except for Poland where some nuclear investment takes place; nuclear in Belgium and Germany is phased out according to existing legislation.
- CCS penetration is driven by ETS prices (apart from funding for demonstration plants); regulatory and acceptance issues that have come to the fore recently have been taken into account, especially regarding storage, as well as the comments from Member States during the consultation, leading to limited CCS uptake.
- Energy taxes in € per boe are constant in real terms, i.e. are assumed to rise in line with inflation. All prices and costs have been expressed in euros of 2010.

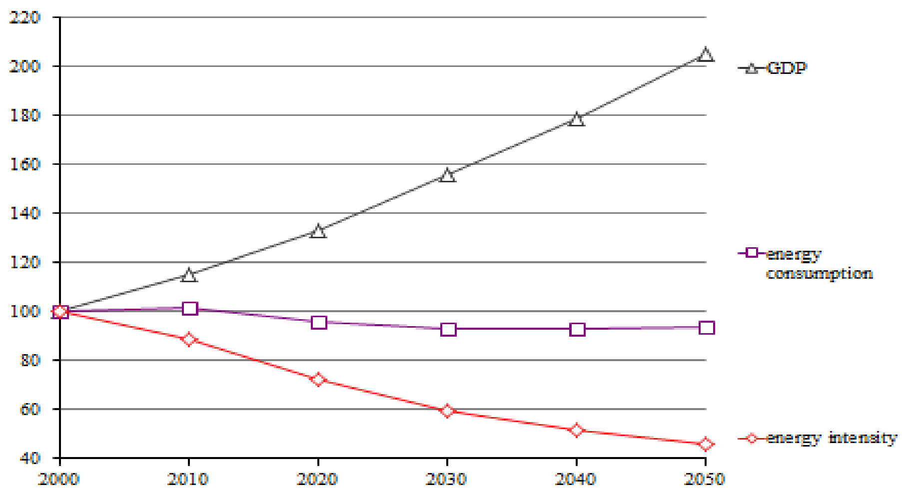
Key trends on energy consumption and intensity

Under Reference scenario conditions, total energy demand in EU-28 is expected to decline from current levels. In 2030 the EU would be using 9% less energy than in 2010, with energy consumption remaining flat thereafter.

Given significant economic growth over decades this means an improvement of energy intensity (energy consumption related to GDP) by 33% up to 2030 and by 48% in 2050, when the EU would consume only slightly more than half the energy required per unit of GDP compared with the situation in 2010.

[155] The Reference Scenario also sees lower GDP growth and stronger increase of oil and gas prices than assumed in the previous exercises before the adoption of the climate/energy package.

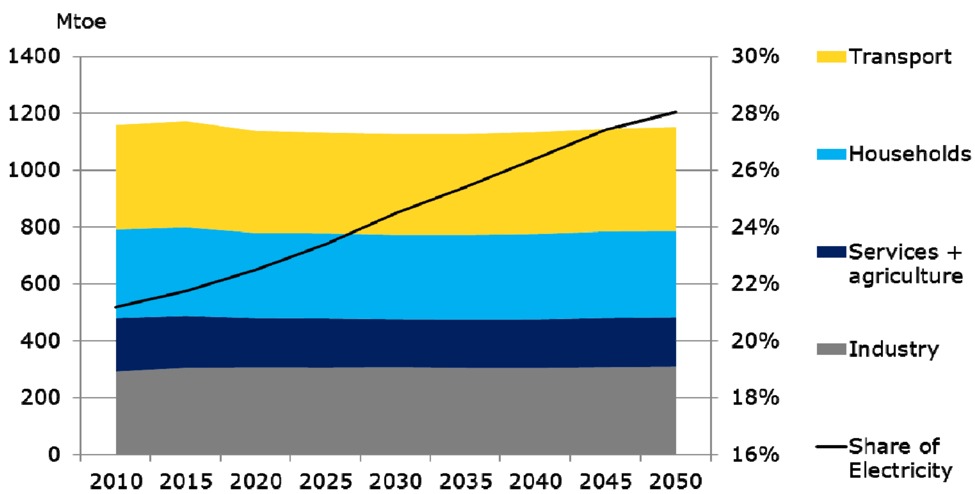
Figure 8: EU-28 GDP, energy demand and energy intensity (2000 = 100)



Nevertheless, the Reference scenario would not quite reach the indicative energy savings objective for 2020 of 20% below projections as defined by the European Council of March 2007 (in operational terms this is evaluated against the 2007 Baseline), but would yet achieve almost 17% against this earlier EU projections for 2020. Using the same metric for 2030 would give rise to energy savings of 21% below these projections made for 2030 in 2007.

Final energy consumption is expected to decline 3% by 2030 and increase again to the 2010 level by 2050. This is mainly driven by significant decreases in households, tertiary and transport up to 2030 where in particular the instruments of the Energy Efficiency Directive (EED) and the CO2 from cars regulation exert downward pressure on energy consumption overcompensating rising incomes. After 2030 the effects of these policies aimed at 2020, with some longer term effects, are overruled by the upward pressure from rising income.

Figure 9: EU-28: Final energy consumption by sector and share of electricity



Electricity demand rises 12% between 2010 and 2030, increasing further through 2050 (+32% on 2010). Driving forces for this include greater penetration of appliances following economic growth overcompensating effects of eco-design standards on new products, increasing use of

heat pumps and electro-mobility. The share of electricity in final energy consumption rises consequently from 21% in 2010 to reach 24% in 2030 and 28% in 2050.

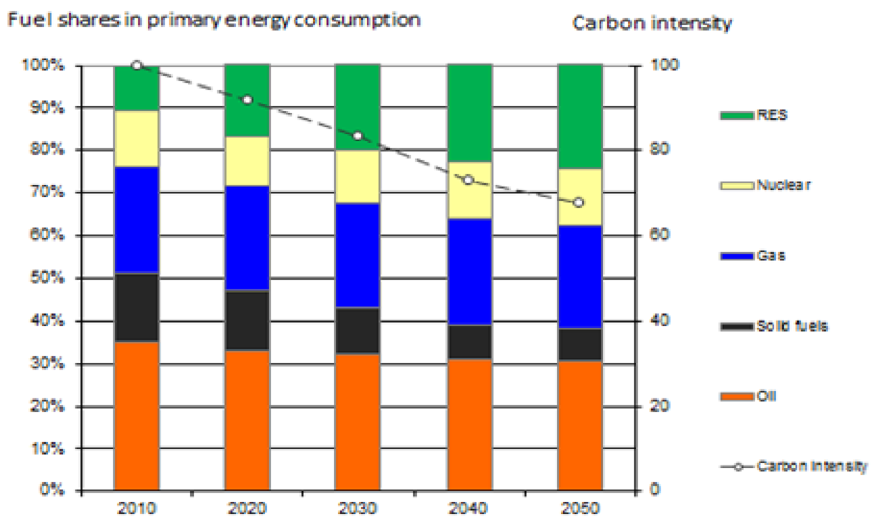
Fuel mix and implied decarbonisation

One salient feature of the Reference is the strong restructuring of the energy supply side by 2030 and even more by 2050 (in terms of primary energy). These changes are driven by strong policy efforts in this decade and a continuation of enabling measures for renewables post 2020, rising fossil fuel prices and the continuation of the ETS linear reduction factor.

There is pronounced restructuring towards RES to the detriment of all other energy sources.

- Despite losing 3 percentage points (pp) by 2030 and a total of 5 pp by 2050 oil remains the most important energy source through 2050 ;
- Solid fuels are most affected by the policy driven restructuring falling 5 pp by 2030 and a total of 8 pp by 2050, when their share would be less than half of what is was in 2010; the emergence of CCS supported by ETS in the longer term is attenuating somewhat this trend;

Figure 10: EU-28 Fuel shares in primary energy consumption, carbon intensity



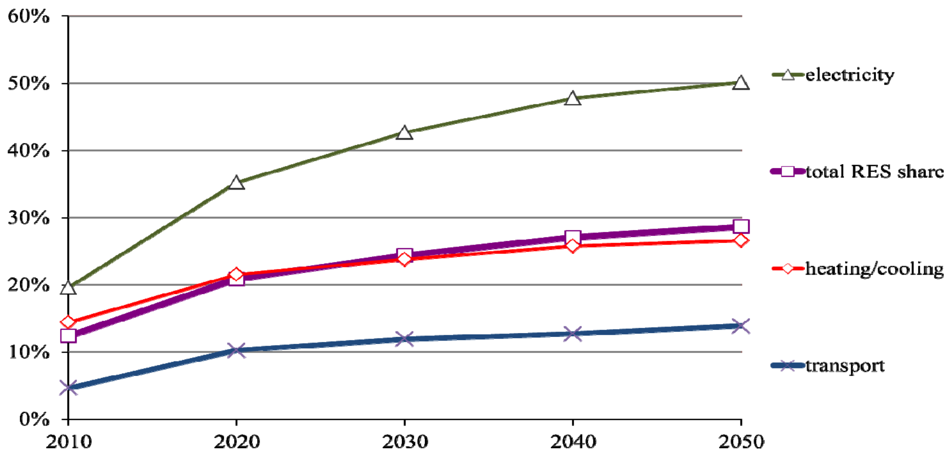
- Gas declines least of all fossil fuels keeping more or less its current share of 25% through 2030 and loosing just one pp up to 2050;
- Nuclear experiences a slight dip around 2020/30 when it will have lost one pp to return thereafter to its current share of slightly over 13%.
- RES gain 9 pp from 2010 by 2030 and 14 pp by 2050 making them the third most important primary energy source (after oil and gas) in 2030 and the second most important one (just ahead of gas) in 2050;

Using the concept of RES in gross final energy consumption (according to the RES Directive), the 2020 target might be slightly overachieved (20.9%), reflecting MS comments in the consultation; the RES share would be further rising supported by longer term effects of policies for 2020, technology progress and market trends to reach 24.4% in 2030 and 28.7% in 2050.

The RES target for transport is also expected to be achieved (10.3% in 2020) with a slight further increase of this share to 12.0% in 2030 and 13.9% in 2050. The RES contribution will be most important in electricity consumption accounting for 35.2% in 2020, 42.7% in 2030 and 50.1% in 2050. Also in heating and cooling there would be significant RES penetration reaching 21.5% in 2020, 23.8% in 2030 and 26.6% in 2050.

Biomass plays a key role in these trends. In 2010 the percentage of total primary renewable energy generated by biomass and waste was 70%. This number drops to 62% in 2020 and 56% in 2030, falling slightly below 50% in 2050. The role of wind and solar becomes more important accordingly. In absolute terms, biomass demand is increasing significantly until 2020 and keeps on growing slowly until 2050.

Figure 11: EU-28: RES share: total and by sector (RES in gross final energy consumption)



Overall, the dominance of fossil fuels in primary energy supplies diminishes with their share falling from 76% in 2010 to 68% in 2030 and 62% in 2050. As a consequence of this fuel switching and some CCS penetration, the carbon intensity of EU energy supplies decreases 17% in 2030 (32 % in 2050) from its 2010 level. Reflecting also energy intensity improvements, energy combustion related CO2 emissions decrease 24% below 2010 levels by 2030, and 37% by 2050.

The resulting sectoral trends on energy related CO2 are as follows:

- CO2 emissions from power generation are expected to fall from current levels by 41% in 2030 (71% in 2050) due to strong fuels switching and some CCS penetration;
- Transport related CO2 emissions, which increased by 26% between 1990 and 2010, would decrease only 9% between 2010 and 2030, remaining virtually flat thereafter;
- Other sector trends are also declining; they fall in between the strong decrease in power generation and the more limited one in transport. Industry is decreasing by 7% below current levels until 2030 and 18% until 2050, district heating and energy transformation emissions sink by 27% below current levels until 2030 (39% by 2050), residential falling by 21% respectively 29% and the tertiary sector by 36% until 2030 and 45% by 2050.

<u>**Power generation and capacity requirements**</u>

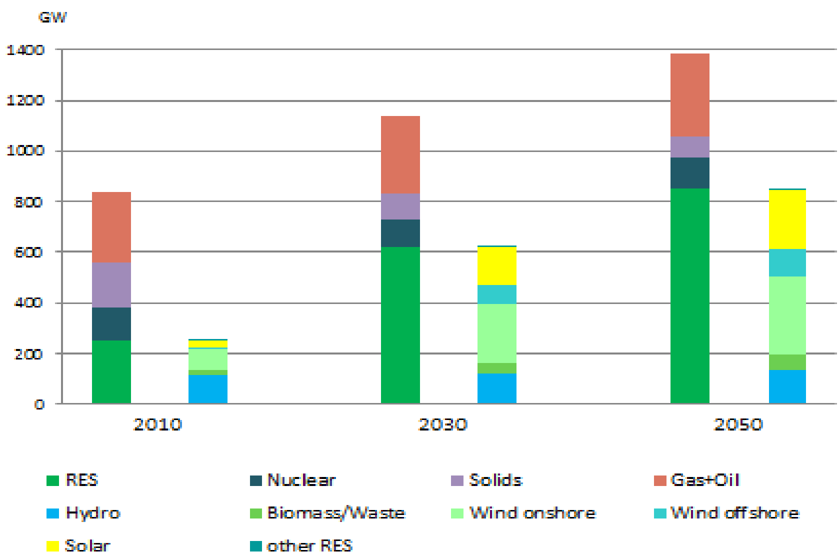
Rising electricity demand, due to its convenient features for a multitude of uses and rising incomes (leading to e.g. more widespread penetration of appliances), together with RES

policies, ETS and technological progress bring about a restructuring of electricity generation towards RES to the detriment of mainly solid fuels. RES account for almost 45% of power generation in 2030 and slightly over 50% in 2050. Following phase-out decisions in some Member States the nuclear contribution (in TWh) declines in 2020-25 but returns to the current level by 2050. Similarly, gas based power generation decreases somewhat through 2025 giving way to RES, but comes back to current levels by 2050. The downward trend for solid fuels is present throughout the projection period.

These changes in the structure of power generation have even more profound changes regarding capacity requirements, given that the strongly penetrating RES have lower load factors than e.g. coal and nuclear plants. Consequently capacities grow faster than generation, while the share of RES in capacity is even higher than in generation. Given the key role of gas as a back-up fuel for RES, there is significant growth of gas capacities between 2010 and 2050 whereas generation from gas in 2050 is virtually the same as in 2010.

Net power generation capacities become dominated by RES, which account for 55% of capacity in 2030 and 62% in 2050. The RES capacity of some 850GW in 2050 corresponds to the current total power generation capacity from all energy sources combined.

Figure 12: Net power generation capacity (with further breakdown of RES capacities in right columns)



The expansion of RES capacities throughout the projection period is mainly driven by on-shore and off-shore wind as well as solar. Tidal and wave energies penetrate in the long run in some countries having good potentials, such as France, Ireland, Portugal and UK.

Following these changes in generation structure and despite growing electricity production, power generation would further decarbonise. The share of RES and nuclear combined in gross electricity generation would increase from currently 49% to reach 58% in 2020, 66% in 2030 and 73% in 2050. In addition, CCS would make some inroads in the long run with a timid share of less than 1% until 2030 increasing however to 7% by 2050.

<u>Energy prices, system costs and investments</u>

Energy prices are increasing significantly until 2020 and show somewhat diverging trends afterwards, largely related to significantly increasing world fossil fuel prices[156] in the context of significant energy system restructuring:

Diesel prices for private transport users increase 20 % from 2010 to 2020 and rise thereafter almost 4% per decade up to 2050; mainly driven by increasing oil import prices.

Oil and gas prices for heating increase by 38% respectively 47% from 2010 to 2020. Heating oil prices continue to rise significantly thereafter (over 5% per decade up to 2050), while gas prices for households remain more or less at 2020 levels, mainly driven by the trends in oil and gas import prices, which see a decoupling of both prices only in the longer term.

Average electricity prices for end users rise more strongly by 2020, by 31%, assuming in the modelling that incurred costs (including some profit margin) are fully recovered via prices. This reflects a set of different factors: Gas and coal import prices rise by 62% and 41% respectively over the current decade; power generation investment increases significantly; old capital stock (for generation, transmission and distribution) is being replaced generally with more efficient and less carbon intensive power plants; RES targets are achieved implying lower load factors (more generation capacity for a given amount of electricity generation) and the need for back-up capacity; grid investments increase significantly to support greater market integration and RES penetration. Moreover, electricity savings (from policies and higher prices) mean lower sales levels diminishing thereby the basis for sharing out the fixed cost elements, which dominate total electricity costs, thereby increasing the cost per unit of electricity delivery. ETS allowance expenditures contribute only a marginal part, given that carbon prices are very low until 2020 with the projected carbon prices becoming important for electricity prices only in the longer run. Electricity prices for industry increase less than for other sectors: 22% between 2010 and 2020. After 2020 electricity prices are flat – actually even marginally decreasing, reaping thereby the benefits from fuel input savings (e.g. from RES and energy efficiency, which reduce fossil fuel input). Prices for industry decrease significantly, so that total industrial electricity price increase 2010 to 2030 is limited to 10%.

Affordability and competitiveness effects related to energy are ultimately not a matter of prices, but are determined by cost, i.e. the product of prices and consumption levels; notably energy efficiency policies lead to a reduction of consumption thereby alleviating adverse price effects. Total energy system costs related to GDP, which stood at 12.8% in 2010 peak in 2020 at 14.8% as a consequence of heavy energy investment, falling thereafter to 14.0% in 2030 and back to 2010 levels by 2050 (12.3%) thanks to fuel cost savings in later years.

Table 42 gives the overview of total energy system costs over time for all Member States. It shows they are comparably higher in lower income Member States, confirming that lower income Member States are also the most energy intensive EU economies[157]. Inefficiencies and obsolete infrastructure is an important reason as well as different economic structure with a relatively lower share of GDP in services and relatively larger share of household spending for meeting basic heating and cooling needs.

Table 42: Energy system costs in relation to GDP per Member State

	2010	2020	2030	2040	Change to 2030 from 2010

[156] This modelling does not assume additional global action on climate change beyond Reference. If such global action would materialise, world fossil fuel prices would decrease, reducing costs related to fuel prices in the EU in general.

[157] Eurostat: in 2011 the 10 most energy inefficient Member States were EU12, of which 8 had an energy intensity of GDP at least twice the EU average.

EU28	12,76%	14,83%	14,03%	13,08%	1,27%
BE	13,47%	16,53%	15,77%	14,39%	2,31%
BG	25,45%	30,32%	31,20%	31,36%	5,75%
CZ	19,72%	21,51%	20,38%	19,50%	0,66%
DK	10,75%	11,36%	10,81%	10,40%	0,06%
DE	12,67%	14,57%	13,96%	13,33%	1,28%
EE	20,26%	21,88%	21,17%	20,62%	0,91%
IE	10,47%	11,50%	9,97%	9,16%	-0,50%
EL	12,65%	16,45%	15,88%	15,29%	3,23%
ES	12,25%	14,36%	12,97%	12,20%	0,72%
FR	11,08%	12,69%	11,59%	10,66%	0,51%
HR	19,57%	22,22%	21,79%	20,80%	2,22%
IT	12,33%	14,78%	14,30%	13,51%	1,97%
CY	16,03%	17,42%	17,65%	15,81%	1,62%
LV	25,60%	27,78%	26,55%	25,64%	0,95%
LT	22,16%	24,11%	23,72%	21,61%	1,56%
LU	11,84%	12,65%	11,46%	10,60%	-0,38%
HU	22,24%	25,98%	26,30%	25,90%	4,06%
MT	13,38%	14,23%	14,43%	13,58%	1,05%
NL	12,19%	14,88%	14,07%	12,99%	1,89%
AT	12,22%	13,98%	13,41%	12,57%	1,19%
PL	21,08%	22,66%	23,30%	22,26%	2,22%
PT	15,95%	19,56%	18,46%	17,35%	2,51%
RO	18,82%	22,59%	23,58%	23,59%	4,75%
SI	17,80%	21,39%	21,06%	20,33%	3,25%
SK	19,78%	21,64%	20,47%	19,25%	0,68%
FI	15,46%	17,19%	17,13%	16,49%	1,67%
SE	13,72%	13,83%	11,96%	11,09%	-1,76%
UK	10,81%	12,84%	12,00%	10,52%	1,19%

Heavy energy investment is undertaken both on the supply and demand sides, notably for electricity supply and for more efficient energy using equipment as well as building insulation. Energy-related investments (excluding transport) are 47% higher in the decade 2021-30 compared to the decade 2001-10, which was marked by rather low investments; these investments in the next decade are however 21% lower than those during this decade to 2020, where strong efforts are needed for implementing the 2020 targets and policies. Transport-related investments are projected exceed those in 2001-10 by 31%, while they are expected to be 20% higher than such investment in the current decade.

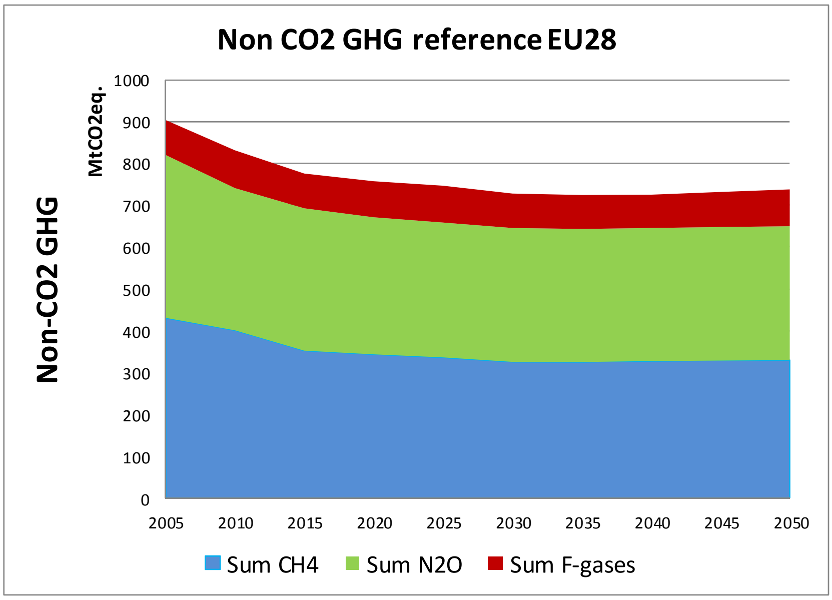
Such heavy investment that continues beyond 2030 leads to greater importance of capital expenditure (largely creating income in the EU) versus operational expenditure, notably related to fossil fuel imports.

Drivers of GHG emission trends beyond energy related CO2

Around 5% of current total EU GHG emissions excluding LULUCF are non-energy (combustion) related CO2 emissions. They stem mainly from industrial processes in the metals, minerals and chemicals sectors and are mostly covered by the EU ETS; the remainder of CO2 from non-energy combustion sources stems from fugitive emissions in energy sectors (close to 10% of such emissions) while less than 5% of them are from solvents and waste. Having decreased significantly between 1990 and 2010, non-energy related CO2 emissions might increase in the next 10-15 years, due to expected recovery of economic growth and limited remaining cheap mitigation options. With increasing ETS allowance prices after 2025, they return in 2030 to the current level. Thereafter there might be considerable CCS penetration due to sufficiently high ETS allowance prices, which combined with lower fugitive emissions from lower fossil fuel production would lead to falling total non-energy related CO2 emissions, down 63% in 2050 compared with 2010.

CH4, N20 and F-Gases, often summarised as non-CO2 emissions, account currently for 17% of total EU GHG emissions excluding LULUCF. They have decreased significantly between 1990 and 2010. They are expected to further decrease by 12% below 2010 levels in 2030 (or 19% compared to 2005) and stagnate later on. CH4 emissions are projected to decrease above average (19% due to declining trends in fossil fuel production, improvements in gas distribution and waste management) and N2O emissions fall below average (4%) until 2030, both remaining flat thereafter. F-Gases would reduce by 8% between 2010 and 2030, largely driven by EU and Member State's policies (i.e. the F-gas regulation and mobile air conditioning directive); F-gases would increase somewhat between 2030 and 2050 in line with economic developments.

Figure 13: Non-CO2 GHG emissions by gas in the EU28



The sectoral non-CO2 emission trends and their drivers vary more strongly:

- Since 2013 more than 80% of industry sector non-CO2 emissions are covered by the EU ETS (Non-CO2 emissions of nitric and adipic acid production, PFC emissions from aluminium production). The resulting price incentive and (previous) national legislation leads to sectoral emission reductions of 55% between 2010 and 2030, making full use of existing cheap mitigation options, while for the period after 2030 slight increases at low level are projected in line with economic trends.
- A similar decrease of 55% between 2010 and 2030 is expected for the waste sector, strongly driven by environmental legislation, such as the full effects of the Landfill directive and improvements in waste management. Also an increasing amount of CH4 is recovered and utilised, thereby impacting on these trends towards lower emissions. After 2030, however, a moderate increase is projected, reflecting trends in economic development.
- The agricultural sector is responsible for more than half of all non-CO2 emissions. While the agricultural non-CO2 emissions have reduced by 23% between 1990 and 2011, they are projected to roughly stabilize at current levels as a result of different trends which compensate each other, such as decreasing herd sizes but increasing

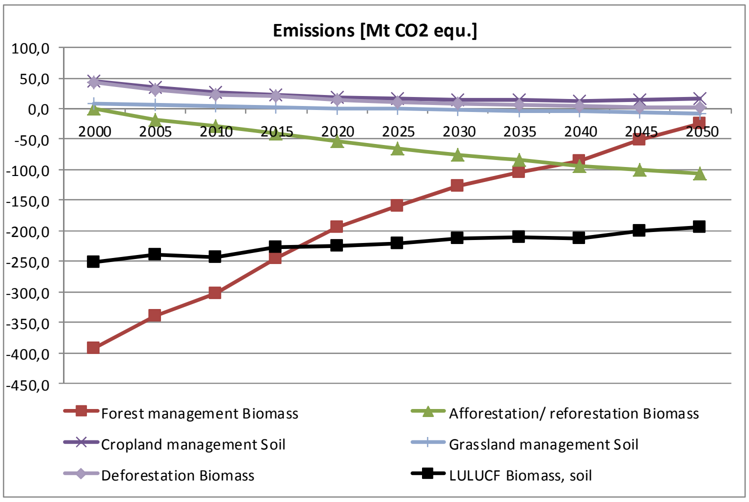
milk yields and increased use of more efficient mineral fertilisers. These trends are impacted by the EU common agricultural policy, e.g. the decoupling of direct support from production, abolishment of milk quota and cross-compliance with environmental laws, such as the nitrate directive.

- CH4 and N2O emissions from the energy sectors are expected to decrease by 28% from current levels in 2030, and further 13% between 2030 and 2050. In the absence of specific mitigation policies, this reflects mainly trends in energy activity, in particular the reduced production of coal and natural gas in the EU.
- Emissions from air conditioning and refrigeration decrease by 13% until 2030, also thanks to existing legislation (i.e. mobile air conditioning), but are projected to slightly increase after 2030.
- Emissions from the wastewater sector and remaining other sectors are projected to increase moderately in line with economic development trends.

LULUCF emissions and removals

The carbon sink composed of land use, land use change and forestry in the EU 28 is expected to decrease somewhat over time. The LULUCF sink for 2000 to 2010 is estimated to be around 250 Mt CO2eq including harvested wood products (see LULUCF biomass, soil in the figure). The sink is expected to decline to around 200 Mt CO2eq in 2030. This result comes from several opposing trends. In forestry, afforestation is increasing resulting in an increasing sink over time. Deforestation is declining resulting in a decreasing source. The forest management sink, however, decreases over the time horizon. The main driving force is the expected increase in timber demand especially but not exclusively for energy purposes. Whereas total timber demand increases by more than 15% between 2005 and 2030 timber demand for energy purposes would increase by more than 40%. The harvested wood products stock however increases from around 10 Mt CO2eq. in 2005 to 60 Mt in 2030. Cropland emissions are expected to decline over time whereas grassland emissions remain more or less stable mainly as a result of the expected conversion of land from other purposes to grassland.

Figure 14: LULUCF emissions in the EU28



7.2. Conditions enabling cost-effective decarbonisation and their modelling

Greenhouse gas emission reductions in line with the EU's long term climate objective imply structural changes in all sectors of the economy and good coordination of these changes. Public acceptance of structural change is also crucial, which relates to issues such as transmission lines, smarter grids and carbon storage. In the absence of such co-ordination and public acceptance of strategic elements for bringing about strong decarbonisation in a process over several decades, other interlinked elements of the EU decarbonisation strategy, such as strong RES penetration, may be significantly delayed. This could impact negatively on technical features and the cost-effectiveness of achieving the long term climate objective in 2050 as well as an appropriate emission trajectory up to 2050 and beyond, restraining substantially the cumulative additions from emissions to GHG concentrations with a view to contributing towards achieving the 2 degree objective.

As analysed in detail in the modelling for the 2050 roadmaps, decarbonisation is a long-term process which depends on coordinated decisions and implementation of measures by numerous actors, including energy consumers, energy producers and distributors, infrastructure investors and regulators, technology developers and providers of R&D and innovation funding. Some of the measures may be contentious as they affect the interests of local populations. Nevertheless deep decarbonisation at the pace needed for achieving the 2 degrees objective requires that crucial infrastructure elements such as those on transmission lines are put in place in time. Good anticipation of future climate change mitigation commitments is of crucial importance for all actors to make decisions enabling deep structural changes and for the coordination of these decisions.

Typical market coordination issues between different actors arise in the decarbonisation process: technology and equipment providers need to anticipate strong market development to undertake investment enabling learning and economies of scale; customers need to see infrastructure development and accept technologies to massively uptake the new technologies; and infrastructure developers need to anticipate the expected massive uptakes to make the appropriate infrastructure investment in a timely manner. Timing is another essential factor linked to effective decarbonisation for which good anticipation and coordination are essential: in many cases, particularly for infrastructure, the development often has to occur prior to their justification by demand and this will only occur if there is good anticipation. In other cases the momentum created by the policies implemented until 2020 should not be lost when these policies end and also this can only be assumed to occur under good anticipation of strong emission reductions in the time period post 2020.

The conditions enabling cost-effective emission reduction through market coordination and good anticipation clearly depend on public action and policy. Predictability depends on strong policy commitment over a long term schedule of greenhouse gas emission reduction and the enforcement mechanisms of measures aiming at implementing this reduction. A climate and energy policy framework is a key facilitator for such a coordination, and targets underpinned by specific instruments like the EU ETS giving carbon price signals and specific energy efficiency and renewable energy policies provide both direction and key incentives. However, as the analysis for the Roadmap for moving towards a competitive low carbon economy in 2050 and the Energy Roadmap 2050 has shown, in case of relevant market coordination issues, appropriate measures go beyond. To ensure better policy and market coordination, enabling public policies include strengthened and perhaps refocused *R&D and innovation* funding fostering infrastructure investment through regulatory policies. There are synergies

with more specific sectoral policies, especially regarding the adoption of standards for technologies to facilitate market uptake and acceptance.

Decarbonisation under poor enabling conditions, which are approximated with reference settings for modelling, implies that actors could, in view of policy and market uncertainties, opt for decisions that in the long term prove sub-optimal, resulting in technology and infrastructure lock-ins and higher costs of climate mitigation. Such decisions without a long term decarbonisation horizon would also imply lower technology progress and lower exploitation of cost-effective potentials. Obviously the costs and feasibility of deep emission reductions and the necessary magnitude of economic incentives such as carbon prices will be significantly higher if market coordination failures and poor anticipations prevail during the long decarbonisation process.

Enabling conditions stemming from a vigorous overall decarbonisation strategy need however to be delivered through policy efforts, including specific sectoral policies on the removal of market failures and barriers to efficient energy consumption and GHG reduction. Enabling conditions set the framework so that specific policy measures in areas such as energy, industry, transport, agriculture, environment and climate policies can work smoothly in a co-ordinated way for achieving deep decarbonisation in a timely manner, while working towards the other objectives of these sectoral policies, such as competitiveness and energy security.

Enabling conditions were underlying most of the decarbonisation scenarios of the Low carbon economy and Energy roadmaps 2050 (except the scenarios assuming delays in certain actions and technologies). In the following, the enabling conditions underlying the 2030 policy scenarios in line with the long term decarbonisation objectives are further specified and explained. The enabling conditions are modelled by altering modelling parameters with respect to those included in the Reference scenario (reference settings). The enabling conditions are presuppositions that act independently of carbon prices/values or economic or regulatory incentives for renewables and energy efficiency. The enabling conditions include the following:

Enabling cost-effective decarbonisation of power generation

For enabling a near complete decarbonisation of the power sector, a combination of appropriate improvement of infrastructures, fostered technological innovation and social acceptance for key technologies is modelled:

Intelligent grids and metering: intelligent IT systems in power distribution and in metering, as well as for managing recharging of car batteries are assumed to develop at large scale so as to become common practice before 2030; they help demand response in power markets, thus inducing further energy efficiency; they support better integration into network operations and wider diffusion of decentralised RES; they support micro-CHP and they ensure management of battery recharging/discharging bringing significant benefits for smoother load curves and higher system stability while providing even the possibility to have the electricity stored in car batteries function as a (limited) buffer. Smoother load curves also improve the economics of capital intensive power technologies, facilitating carbon-free and low-carbon power generation investments. Although the effects of the developments regarding intelligent grids and metering can only be observed in the time period after 2030, it is essential for the developments to occur already in the time period 2020-2030, as only such a development can lead to a large scale and quick uptake of the above mentioned technologies in the time period after 2030. The commitments for 2030 and 2050 must be firm in order to incite/oblige infrastructure developments before these are justified by demand. A strong market coordination is necessary as well as strong commitments by regulated bodies such as DSOs, as it is difficult to assume that these developments would occur entirely based on initiatives of

privately owned institutions. Safety and security of supply must be broadly tested and be operational in order for the large scale transformations after 2030 to occur.

Infrastructure to harvest decentralised as well as remote RES for power generation: higher RES potentials and earlier availability of this potential is assumed, especially for decentralised RES and remote areas offering big potential for wind and maritime RES; this is enabled by a portfolio of synergetic developments involving streamlining of permitting procedures, higher investment in and timely availability of grids (both high voltage, incl. DC lines for e.g. remote wind areas, and smart grids supporting management of decentralised RES, storage of RES generated electricity in form of hydrogen as well as electricity demand response to high RES availability through appropriate price signal by smart and net metering (that also accounts for RES/CHP electricity flowing from consumers to the grid); these policies, despite not including financial support to RES, imply higher potential at equal cost levels, hence higher uptake of RES technologies, compared to Reference, in the period after 2020. The enabling conditions imply that the total potential of RES increases between 4 and 6% by 2030 compared to the Reference scenario for wind –onshore, wind-offshore and solar PV. The additional potential is mainly in highly decentralised RES (which depend on distribution grid infrastructure, discussed above) and in large scale offshore wind in remote areas (which depends on long distance DC systems to be also developed). The developments and the supporting infrastructure are assumed to develop before 2030 and to accelerate after 2030. The higher RES potential by 2030 allows approx. 3 p.p. higher RES-E share in 2030 compared to a scenario without enabling setting with equal emission reduction target in 2030.

Carbon transportation and storage infrastructure and acceptance: the development of CCS is not only linked to the development of the technology to capture the carbon at various stages of the combustion or industrial processes but is also critically linked to the availability of infrastructure for the transportation and storage of carbon. Higher potential of CCS compared to Reference is assumed for the time period from 2030 onwards; the enabling policies ensure timely development of transport and storage infrastructure which helps removing uncertainties easing CCS investment in power generation. It is also assumed that a stable long term EU commitment on the need for deep decarbonisation as well as good anticipation of strong emission reduction commitments induce higher acceptability of CCS in the EU than under the Reference scenario conditions; however regarding cost-quantity curves for storage the assumptions indicating relatively high storage costs in many MS are maintained.; the importance of the enabling setting is the preparation for large scale adoption and penetration of CCS beyond 2030 when the technology has also become more mature. Further the wider enabling environment and the higher acceptance of CCS can be seen by a wider geographical distribution of CCS: e.g. some countries do not have CCS in the Reference scenario in 2030 while carbon is stored in the context of scenarios under enabling conditions. Without the enabling setting already in the time period to 2030 large scale adoption after 2030 would be further delayed, making the achievement of the decarbonisation targets more cumbersome.

Gas and hydrogen: technological progress enabling mix of hydrogen and bio-gas in gas supply and possibility to use hydrogen-based storage for balancing RES power and so exploiting variable at larger scale; these options develop after 2035, although testing for safety and security of supply must occur already in the previous decade anticipating the strong commitments for emission reductions.

The analysis of enabling conditions does not deal with the institutional and regulatory issues, addressed above, to bring about such conditions, but is clearly highlights the need for such outcomes.

Enabling decarbonisation and electrification of transport

In the transport sector thanks to the anticipation of strong commitments towards emission reductions and successful market coordination electrification is enabled by a combination of the development of battery recharging infrastructure, and R&D to improve the performance and costs of batteries for vehicles This allows specific policy instruments, such as regulatory measures on CO2 standards to be more effective in bringing about market acceptance and uptake of electric vehicles as key means to achieve decarbonisation of transport. Similarly strengthened R&D being up to the challenge of deep decarbonisation objectives supports innovation in biofuel supply, which facilitates decarbonisation in transport uses without electrification option.

Battery technology development: Substantial R&D is assumed to take place in the decade 2020-2030 allowing for the cost of batteries to decrease compared to the Reference already in 2030; costs for batteries are assumed to be around 15% lower than in the Reference scenario already in 2030. Lacking this development even if infrastructure were available the penetration of electric vehicles in the transport sector would remain limited, due to the high costs of the vehicles. At the basis of the R&D developments is the assumption of successful market coordination policies to build confidence so as battery technology providers and car manufacturers succeed great progress in battery costs and performance so as to make EV cars competitive, together with the assumption about the development of recharging infrastructure.

Transport sector-recharging infrastructure: Battery recharging infrastructure is assumed to develop in a timely manner, achieving shortly after 2030 a sufficient coverage to allow customer confidence about recharging not only in houses or city centres but also in public areas in wider metropolitan areas and on highways. The enabling environment, driven by the anticipation of strong emission reductions, pushes toward stronger market coordination, which leads to the development of transport recharging infrastructure (and the necessary changes in the grid infrastructure-see below) as well as R&D for vehicle batteries. The development of infrastructure particularly regarding safety, large scale demonstrations, etc. are all assumed to occur in the decade 2020-2030; if such developments triggered by strong coordination would not occur, the large scale development of infrastructure and the large scale penetration of electric vehicles beyond 2030 could not materialise. The cost of achieving the same emission reduction in transport in a scenario which fails to deliver such an infrastructure and a similar scenario including enabling and subsequent development of recharging infrastructure for transport would be approx. five times higher.

Market acceptance: Beyond 2030, CO_2 regulations for vehicles are assumed to become sufficiently strict so as to enable transport electrification developing, the more significantly, the more the stronger the enabling conditions are to support specific policy instruments such as CO2 standards[158]. The availability of both recharging infrastructure and mature battery vehicles at affordable prices leads to higher market acceptance of the new technology and therefore high market penetration beyond 2030, which is possible thanks to the coordinated activity pursued by diverse actors in the decade 2020-2030.

Innovation in biofuels: In particular in order to enable strong emission reduction in transport activities for which electrification is not possible, such as long distance truck haulage, ships and aviation, biomass related innovation policies and agriculture policies are assumed to develop appropriately so as to allow the development of new generation bio-energy feedstock (basically lignocellulosic crops) at large scale already in early years of the 2020-2030 decade.

158 In all decarbonisation scenarios with enabling conditions therefore in the modelling the same post 2030 values for CO2 standards for cars (60g CO2/km in 2035; 35g in 2040 and 25g in 2050) and LDVs (90 g CO2/km in 2035, 70 g in 2040 and 60g in 2050) are applied.

The developments in agriculture are assumed to take place at the same time as large scale improvements in advanced biofuel production, initially targeted at the road transport sectors; the earlier developments of the road transport sector already around 2025 allow for a significantly larger scale deployment of fungible bio-fuels mainly after 2030. The share of advanced biofuels in total biofuels increases typically by 10 percentage points in a scenario with enabling settings in 2030 compared to a scenario without the enabling setting. A new industry would emerge with vertical integration ranging from agriculture, industrial-scale collection and pre-treatment, bio-refineries with new conversion technologies, product standardization and commercialisation.

Enabling substantive emission reductions in other demand side sectors

Overcoming some market barriers to Energy Efficiency in Buildings: In anticipation of strong emission reduction commitment until 2050, the energy efficiency effort regarding thermal integrity of houses and buildings is assumed to continue after 2020 at a moderate pace, contrasting deceleration of such efforts after 2020 as assumed under Reference scenario conditions given that related ambition levels in the Energy Efficiency Directive and Effort Sharing Decision are only defined until 2020. The enabling environment is driven by the fact that renovations continue to be undertaken in an energy efficient manner even if no specific regulatory obligations were implemented at EU level because actors believe that e.g. energy efficient renovated buildings will continue to have a significantly higher value on the real estate market, in view of strong emission reductions to 2050. It is important that such building modernisation action continues and is not delayed beyond 2030 as it would otherwise not be possible for the building stock to achieve high enough renovation rates to compensate for the previous inactivity. Given the longevity of the building stock and the low renovation rates, the enabling setting mainly ensures that on-going renovations post 2020 are used to also improve thermal integrity even if direct policies or economic incentives are not strong in the decade 2020-2030 at an EU level. The intensity of the assumed effort in the context of the enabling settings is however lower than the existing potential and it includes only highly cost-effective energy saving cases. Specific energy efficiency policies at both EU and MS level have to come in addition for actually exploiting the building renovation opportunities for decarbonisation up to its economic potential. Enabling conditions encompass just the highly cost-effective decarbonisation within a deliberate long term GHG reduction strategy. Enabling conditions imply higher investment in thermal integrity of houses/buildings after 2020, facilitating efficiency improvements compared to a scenario without the enabling policies. The efficiency effort is assumed to accelerate at a faster pace after 2030 compared to the decade 2020-2030. This continued action after being also encouraged by the recently adopted EE Directive creates an enabling environment which partly overcomes some of the market barriers which are particularly strong in the building sector. A more substantial removal of market barriers can only occur through relentless and ambitious targeted action/EE policies as mirrored in some of the scenarios which include policies going beyond the enabling settings.

Heating equipment and appliances technology uptake in the domestic sector: more accelerated uptake of efficient technologies in the households and tertiary demand sectors reflecting increased acceptance and stronger innovation is enabled by lowering perceived cost parameters and by assuming higher learning rates of demand side technologies as a result of a stable long term EU commitment on deep decarbonisation leading to better anticipation of future emission reduction commitments. Enabling policies ensure better acquaintance of customers with advanced technologies, including heat pumps which allow for higher use of electricity in heating/cooling applications, higher efficiency and thus lower emissions. This is particularly the case for heating/cooling equipment where the stronger renovations also lead to a faster renewal of equipment. Faster renewal and higher uptake of advanced technologies

bring benefits in terms of unit costs as the learning potential is exploited earlier than in the absence of the enabling policy. Yet the assumptions for the enabling settings leave significant potential untapped regarding efficiency progress for energy equipment and appliances, which are additionally developed in the context of ambitious emission reduction scenarios, in particular and to a greater extent in those that include ambitious and very ambitious energy efficiency policies.

Energy efficiency innovation diffusion in Industry: the acceptance and adoption of best available techniques in industry and in combustion applications is assumed to accelerate after 2020 at a pace above the Reference scenario due to the anticipation of strong commitments for emission reductions; the assumed enabling environment would be mainly based on a better innovation and technology policy framework and also through hedging against future emission costs by the industry as result of higher predictability about strong emission reduction commitments in the future. Best available techniques uptake in industry is assumed to become common practice and to accelerating mainly after 2030; the effects of the industrial BAT enabling setting are assumed to be limited until 2030, compared to potential. The enabling context is modelled by assuming higher market acceptance of advanced technologies earlier in the period after 2020, compared to the Reference scenario, notably in the domain of heat recovery techniques, cogeneration, low enthalpy heat processing and horizontal systems controlling and managing energy in industry. Thanks to lower perceived costs, the industry accelerate the uptake of advanced technologies which implies that learning potential is tapped on earlier, bringing benefits in terms of cost reductions. Only very cost-effective BAT in industrial applications are assumed in the context of the enabling conditions; obviously additional drivers such as carbon prices and direct policy measures would lead to further uptake of BAT in industry.

Interactions: Obviously there are synergies between the above mentioned enabling conditions. For example the conditions allowing power generation to further reduce emissions also facilitate energy efficiency and emission reduction in final demand through substitutions of fossil fuels for electricity. Similarly, conditions better managing RES in power sector through hydrogen storage also reduce emissions in gas supply when some of the excess hydrogen with respect to storage capacity is fed into the natural gas grid easing thereby emission cuts at final demand level. The system-wide synergies have significant effects even in the absence of high carbon prices/values or specific RES or energy efficiency incentives.

All the above mentioned cases require long-term predictability and long-term commitment of investors, in particular for infrastructure development but also for enabling a faster pace of technology progress and uptake, thus removing market barriers preventing the tapping of or full realisation of cost-effective potentials. The long-term commitment of investors and the active participation of all actors to the enabling settings can only be achieved if there is long term regulatory certainty about the commitments for 2030 and 2050 and in particular good anticipation of the strong emission reductions beyond 2030. It is clear that the majority of the benefits deriving from the enabling environment settings are felt in the time period after 2030 in the context of strong decarbonisation commitments.

7.3. Decarbonisation scenarios based on Ambitious Energy Efficiency policies

Role of Energy Efficiency (EE) in decarbonisation scenarios

The Energy Roadmap 2050 has demonstrated that EE is a major component of any decarbonisation strategy and can therefore be called a no regret option. It is present to a very significant degree in any such scenario, but its magnitude can change - not least in correspondence to the decarbonisation ambition. With given GHG ambition (target), the magnitude of EE varies according to the recourse that is made on switching directly or indirectly (via the use of low carbon electricity in end use sectors) to fuels with no or few CO_2 emissions (e.g. RES, nuclear, fossil fuels with CCS) The type of energy efficiency measures involved is also important, on which this note provides a lot of details.

In the EE focused decarbonisation scenarios the strong EE policies modelled are either ambitious or very ambitious regarding the level of GHG reduction and reflect direct policy interventions rather than generic action such as carbon pricing (which may be implemented complimentary to more specific measures). This note will address EE policies and measures under a 40 GHG reduction target for 2030 compared with 1990 (ambitious EE) and even more EE policies under a 45% reduction target (very ambitious).

Decarbonisation scenarios differ with respect to EE, mainly by the extent to which market barriers to cost-effective energy efficiency are addressed.

Addressing Market Barriers to EE

Market barriers limit the uptake of energy efficient investment in cases where such energy efficient investment decisions would be undertaken by fully rationally deciding agents if there were not one or more of the following market barriers and distortions. Such market barriers concern purchasing (or capital budgeting) situations, in which new and highly efficient technology with high upfront capital costs is confronted with fuel and electricity savings that materialise only in later years, while there is uncertainty about future technology performance as well as on the availability of related infrastructure (e.g. smart grids, recharging of electric vehicles). Such situations do not only occur in case of purchasing equipment, appliances, vehicles, etc. but are also present in case of high capital costs for renovation/construction investments.

Market barriers are present in all demand sectors with the probable exception of heavy industry where the share of energy costs in production costs is so high that the majority of efficiency saving is undertaken already in a reference scenario context as it improves economic competitiveness of the sectors. In the household sector purchases and investments regarding energy efficient solutions, which would be economic in the medium and long-term, are often not made due to limited access to capital funding as well as the uncertainty and lack of information available to decision makers. Moreover, there are split incentives, which arise for instance in situations, in which the tenant of a house/dwelling would greatly benefit from better insulation or heating boilers, but cannot make the investment. While the owner of the building could make such investments, he might not have a proper incentive, since the savings in fuel costs do not accrue to him. In other sectors of the economy, such as services and smaller industries, the share of energy expenditure in total costs is not sufficient to ensure that energy saving investments are made on fully rational economic grounds; decision making on non-energy related issues is generally considered more important so that often the available capital is spent for purposes other than energy efficiency.

Specific energy efficiency measures have been developed and implemented to address such barriers, thereby enabling higher effectiveness of market instruments than in the absence of such efficiency measures. Policy interventions for removing such barriers work through many channels including the reduction of the high subjective discount rates of consumers preventing the choice of normally cost-effective energy efficient solutions. A more detailed list of policies and measures can be found below.

The modelling mirrors these bottom-up energy policy instruments with specific modelling instruments which are described in detail later in this section. In this context it is important to note here that explicit EE policies, in the form of additional strong specific action, act differently to generic instruments favouring energy savings such as energy taxes or carbon pricing. While these approaches are not mutually exclusive, the following note focuses on specific EE action. More generic approaches use carbon pricing as the main instrument to achieve decarbonisation. Such carbon pricing approaches, while achieving fuel switching and some energy savings by increasing variable energy costs, does not explicitly address market barriers. This means that in such carbon pricing approaches a part of the energy saving potential remains untouched.

Including carbon pricing on energy use acts in two directions: overall reduction of energy demand and on switching to fuels that emit less or no CO2 (including electricity, the production of which is also influenced by the carbon price). There is a complex interplay of many factors, which requires comprehensive modelling. This energy system and market modelling deals with all interactions and side effects, which results in a market equilibrium, including on the carbon price, that fulfils the needs of suppliers and demanders and reduces the CO2 emissions by the economically optimal amount. Such an optimum does however not necessarily lead to an optimal situation regarding the level of energy consumption (as this is a different objective). Moreover, carbon prices, like energy prices, cannot address market barriers to EE. This requires specific EE policies, which are dealt with in this note.

Energy Efficiency (EE) interacts with the energy system in three ways, through:

(1) The overall setting, i.e. the EE dimension of an overall long term policy setting that enables reaching the European Council's decarbonisation objective for 2050 (at least 80% GHG reduction on 1990 with a view to the necessary EU contribution to reach the overall 2 degrees objective) and a sustainable, secure and competitive energy system;

(2) Additional policy measures to promote EE with different instruments in all sectors of the economy (specific and generic ones);

(3) Indirect effects stemming from changes in the EU ETS and energy product prices as well as changes in fuel mix that have also EE repercussions.

Energy Efficiency policies and measures

EE policies and measures already adopted relate to a variety of areas including:

- Energy performance of buildings Directive (EPBD)
- Energy Efficiency Directive (EED) with many individual provisions and measures
  - Building renovation
  - Exemplary role of public authorities including increased Renovation rates in central government buildings
  - Purchasing by public bodies

– Energy efficiency obligation on energy distributors and/or retail sellers (energy efficiency obligation schemes) or alternative policy measures (e.g. financing, fiscal, voluntary, and information measures)

– Energy audits and energy management systems

– Better metering and billing

– Consumer information and empowering programme

– Supply side energy efficiency including CHP and grid requirements and promotion of demand response

– Greater role of Energy Service Companies (ESCOs)

- Eco-design Directive and all implementing Regulations
- Energy Labelling Directive and its delegated Regulations
- CO_2 standards in transport
- Excise and emission taxes, fiscal incentives (e.g. tax rebates)

In addition measures like the EU ETS, road pricing and congestion charges, local policies to encourage walking, cycling and public transport use as well as measures to promote the development and use of innovative technologies help improving energy efficiency, sometimes as welcome side effect. There are furthermore fiscal incentives (e.g. tax rebates) for final consumers and businesses as well as the support through programmes, such as the Intelligent Energy Europe Programme, technical assistance facilities the Cohesion Fund and the Framework Programmes for RTD. All these on-going activities have been taken into account in the calibration of the model to the latest statistical data and the estimation of behavioural equations and parameters. Strengthening of such framework conditions in these decarbonisation scenarios with strong EE is dealt with under "overall settings" and "financial support" below.

The Reference scenario includes all the adopted energy efficiency policies both at national and EU level up to late spring 2012[159] including the EED, on which political agreement was reached by that time. On the latter the modelling has taken a rather conservative view, since there has not been yet a transposition in national legislation while for the energy savings obligations there are several alternative measures possible – albeit within limits. With the EED focusing on 2020 and older eco-design standards becoming less effective regarding energy consumption over time (when old items have been replaced with those fulfilling the eco-design standards of e.g. 2010), EE effects from policy after 2020 in a reference scenario setting would diminish. Assuming a strong additional policy impetus from a 2030 energy/climate framework can change this situation in two ways: first, the implementation of the EED can become stronger and there might be follow-up legislation beyond 2020. Therefore in the context of a 2030 framework, the policies along the lines of those listed above are continued in the modelling up to 2030 and beyond, and are intensified in the ambitious and very ambitious EE scenarios. Ambitious EE policies represent a level of EE policies that, in the modelling, act as the main ingredient in non-ETS sectors for reaching 40% GHG reduction in 2030 compared with 1990. Very ambitious EE polies in such EE focused scenarios ensure large parts of the necessary non-ETS contribution for reaching GHG reductions of 45% in 2030 (for more details see below). The modelling has considered EE action in all sectors, including stationary and mobility energy uses, electricity and heat supply.

159 National policies have a slightly earlier cut-off date in early spring 2012.

GHG targets give a strong additional impetus on pursuing EE that has also intrinsic other benefits in terms of economic efficiency (competitiveness, affordability), energy security and reduction of non-GHG related pressure on the environment.

Overall settings

The changes stemming from reconfirmed commitments for a strong decarbonisation strategy related to EE are part of the **"enabling settings",** which is assumed for the scenarios describing developments under a long term strategic vision of policy makers that is well communicated to stakeholders, so that the necessary strong changes in infrastructure and framework conditions are broadly accepted (see Annex 7.2 for more details).

A contrasted set of scenarios (**reference settings**) does not assume such enabling settings, but keeps the relevant policies at the level already adopted with a view to 2020 (which exhibit also a significant level of ambition[160]), while looking at the long term consequences of the adopted policies when combined with new initiatives undertaken for extending current policy developments to 2030. For details on the reference setting and its impact on policy scenarios see Annex 7.1 and the forthcoming publication: "EU energy, transport and GHG trends to 2050 – Reference scenario 2013".

Impacts of EE via the "enabling setting"

This Section deals with the EE measures that are present in all decarbonisation scenarios that are based on a long term decarbonisation strategy to 2050 and beyond - i.e. all scenarios that do not assume a "reference setting".

EE measures as part of the enabling setting (used for a wider range of scenarios) include:

- Up to 2020, a vigorous implementation of the current policy framework, notably
  - the Energy Efficiency Directive,
  - the Energy Performance of Buildings Directive,
  - the extension and tightening of Ecodesign and Labelling requirements

  The modelled implementation and reaction to some measures, notably regarding eco-design standards projects slightly faster uptake of more improved and advanced technologies than under pure reference scenario setting driven by better anticipation by consumers with respect to long term decarbonisation
- After 2020, developments are in line with the 2050 Roadmaps framework and assume commitment to decarbonisation in this time horizon. Consequently, the policy ambition in energy efficiency is gradually scaled-up, creating the "enabling settings" for the decarbonisation (including on grid extension, reinforcement and smartening, hydrogen storage and better conditions for CCS). With respect to energy efficiency the "enabling settings" include :
  - continuation of energy efficiency policies mostly at national level after 2020, contrasting the assumptions of reference that no additional policies are added

160 E.g. regarding grid expansion according to the ENTSO-E Ten Years Network Development Plan, on which delivery has still to be ensured

after 2020; this implies higher investment in thermal integrity of houses/buildings after 2020, compared to the reference[161];

– more accelerated uptake of efficient technologies in the demand sectors enabled by lowering perceived cost parameters and by assuming higher learning rates of demand side technologies, including development of highly efficient CHP for industrial applications;

– enabling transport electrification in the longer term via recharging infrastructure, progress in battery technology starting from 2025 and developing mainly after 2030;

In addition to the elements above a continuation of the framework conditions with regard to access to finance present in the "reference settings" also post 2020 is assumed. This includes adjustment of public accounting rules, standardisation of adapted financing tools and certain fiscal incentives, but also:

- A wider deployment of soft loans, grants, credit lines, loan guarantees, and special funds, modelled through the reduction of the discount rate to show more availability of funds, etc. with lower risk to household.
- Favourable tax regime for households investing in more energy efficient renovation and vehicles.
- A wider deployment of risk guarantees, credit lines, and other mechanisms to standardise and bundle project types, and awareness and capacity building efforts among the finance community.
- Continued support from Structural Funds, mainly channelled thanks to the setting of an appropriate legal framework (EED, EPBD), including the removal of legal barriers to the use of energy performance contracting (adjustment of rules on accounting of public deficits). Standardisation of adapted financing instruments also play a role in reducing the risk perceived by private investors.
- Support from the EIB on the technical assistance, direct loans or loan guarantees for energy efficiency projects, risk-sharing facilities.

Modelling instruments in PRIMES related to EE policies

Given the complex interactions of millions of energy suppliers and hundreds of millions of energy consumers that bring about the efficiency of the energy system in the EU, the PRIMES modelling - representing such interactions in a stylised way - deploys an extended set of modelling instruments dealing with EE aspects. In contrast to procedures in other models, which apply simple optimization approaches, the PRIMES model takes into account different investment behaviours regarding energy use and its ensuing efficiency in the various sectors. This enables the model to represent barriers and distortions as well as their removal as a result of policy intervention.

The PRIMES model represents energy efficiency by simulating different measures with different techniques. These model specific instruments affect the context and conditions under which individuals, in the modelling represented by stylized agents per sector, make their decisions on energy consumption. These modelling instruments include:

[161] The additional energy efficiency effect of these assumptions and those on technology uptake (next bullet point) is modest when compared to ambitious EU wide energy efficiency policies post 2020 (see below);

- Model parameters mirroring technology performance or the effects of building codes or eco design regulations over time, where ambitious policy approaches justify making strong assumptions about enhanced technical and economic performance of future technologies that are made available for future choices by consumers within the model projection.
- Factors that affect perception of net energy costs (investment costs minus perceived benefits) including risk factors (e.g. risk related to maintenance costs or technical reliability of advanced technologies if chosen prior to fully established commercial maturity of such technologies), which are influenced by energy efficiency policies (awareness raising instruments, education, labelling, etc.); such changes influence the mix of different technologies delivering the same type of energy services that exists in reality and is therefore also reflected in the modelling; The policy induced changes assumed in the ambitious and very ambitious EE scenario for household appliances lead to perceived cost decreases in the more advanced technology options of between 10% and 40% (with the higher values being attributed to very efficient heating/cooling equipment) compared to the costs that are perceived under reference scenario settings, which themselves are between 12 and 20% lower (depending on equipment type) than would have been perceived in the absence of the energy efficiency policies.
- Reduced discount rates for certain sectors, reflecting changes in the decision making conditions and constraints of e.g. households and services (e.g. replacement of layman's dealing with energy consumption by optimized provision through energy service companies (ESCOs); the (high) subjective discount rates which prevail in capital-budgeting decisions when such decisions are taken solely by individuals are reduced, moving closer to business interest rates ; the involvement of ESCO and the obligation for energy distributors and retail sellers to facilitate energy efficiency investment at the premises of final customers enable individuals to make more cost-effective choices thanks to the professional support of e.g. ESCOs and utilities that are obliged to achieve energy savings with their customers. (Lower discount rates reduce the high weight that initial investment costs have compared with future energy cost savings). In addition, these measures also induce lower technical and financial risk, hence reducing the perceived costs of new technologies and saving investments, (see also point above on perception of costs). In PRIMES the discount rate for household consumers are assumed to be at 17.5% under business-as-usual conditions following extensive literature review on discount rates of private consumers. In the context of the Reference scenario this rate was progressively decreased to 12% from 2020 onwards throughout the entire projection period to reflect the Energy Efficiency Directive. Scenarios with more ambitious EE policies have even lower discount rates (see below).
- Efficiency values (EVs) reflecting a variety of broad and sometimes un-identified instruments that bring about efficiency improvements; in the most concrete form they would represent the price of White Certificates, reflecting the marginal costs of reaching an energy savings obligation, e.g. for energy distributors and retail sellers regarding EE at final customers sites, or a large range of other pertinent measures, such as energy audits, good energy advice to consumers on the various benefits of EE investment and better practices, targeted energy efficiency education, significant voluntary agreements, etc.

In addition there are intrinsic model features, such as rational decision making by actors based on transparency regarding prevailing prices (which is aimed at by energy related labelling). Moreover, the modelling deals explicitly with excise and emission taxes and the effects of the EU ETS on fuel and electricity prices through taking them into account in the formation of consumer prices.

EE in energy supply (e.g. generation, transmission, storage, distribution, CHP, refining, etc.) is dealt with directly in the various supply modules that represent supply chains and their complex interactions directly in a detailed way.

Some of the policies measures listed above focus on specific sectors (e.g. building directive, regulations on eco-design of appliances, mandatory audits for large companies), whereas others are generic in nature (consumer information, ESCOs, energy efficiency obligations for distributors/retailers regarding their final energy consumers, financial schemes, improved efficiency of network tariffs and regulations, promotion of demand response). Therefore, sectors are generally affected by more than one policy measure and might therefore also require the application of more than one modelling instrument. A given policy often affects various sectors directly (generic measures) or indirectly through interdependencies in the modelling. Policy instruments inter-act providing synergies, but have also overlaps.

Ambitious and very ambitious EE policies/measures – changes in modelling parameters

The ambitious and very ambitious policy scenarios focus on enhanced removal of market barriers in a direct way to allow greater penetration of energy efficient practices. These scenarios encompass ambitious EE policies, which go well beyond the enabling setting (which is already significantly stronger than the EE context in the Reference scenario). Such policies include:

- Measures speeding up the buildings renovation rate. The enhancement of the building renovation rate is driven by cost-optimality considerations under the requirement of near-zero energy standards for new buildings, which are assumed also for renovations on the basis of standards or intrinsic incentives for such course of action (Such high standards for new building are already present in the enabling setting and largely in the Reference scenario thanks to the Energy Performance of Buildings Directive). The increased rate of building renovation is mainly supported by the energy efficiency obligations on utilities and retail sellers (see below), through wide use of Energy Performance Contracting (ESCOs) and thanks to the removal of regulatory barriers, as well as other measures, for example an obligation that whenever a dwelling is sold or rented it has to meet a certain efficiency level. The extent of renovation in the model is determined by cost-effectiveness considerations[162];

[162] Cost effective renovation is characterized by achieving significant savings on variable cost to recover the initial capital investment taking into account cash flow issues. The cost-effective potential was estimated by undertaking a number of sensitivity cases with different amounts of assumed energy savings. The direct efficiency investments were compared with to the annual variable cost reduction in all these cases, retaining such renovation levels where the ensuing recovery time at an acceptable internal rate of return (from literature some 9 %) suggests such renovation to be cost-effective. A similar approach has been followed for selected case studies in the Ecofys, Politecnico di Milano/eERG, University of Wuppertal study "Towards nearly zero-energy buildings"(February 2013, see:
http://ec.europa.eu/energy/efficiency/buildings/implementation_en.htm).
The modelling represents the various synergies among different policy measures that can bring about strong EE progress and estimating their cost-effective potential. In that sense the modelling is less

- Energy management systems in all new construction from 2015 in the very ambitious EE scenario, while under ambitious EE policies, such systems are introduced more gradually over time.
- Extended and more ambitious energy efficiency obligations. Energy efficiency obligations are extended beyond 2020 and their post-2020 ambition is increased through obligations going beyond 1.5% savings per year (enshrined in current legislation only up to 2020 including a great deal of flexibility for on alternative measures and further provisions that can reduce the cumulative savings effect). The strong energy efficiency scenarios take a less conservative view on the implementation of these obligations up to 2020 (less use of flexibility provisions than under Reference scenario conditions). Moreover, they assume the removal of such (transitory) flexibilities and assume in addition the enhancement of such strengthened obligations beyond the time period to 2020. The average annual energy savings in 2020-2030 amount to a 2.0% savings per year with ambitious EE policies and to 2.3% pa with very ambitious EE policies. The expected savings in 2030, calculated as reduction of final energy consumption without transport and ETS sectors from a hypothetical non EE projection and expressed as percentage reduction relative to 2010 consumption level, reach 23% in the ambitious EE scenario and 26.4% in the very ambitious EE scenario, much above the 7.7% projected in the reference 2013 scenario. Compared to scenarios which assume only carbon prices which drive equally high GHG emission reductions, the EE scenarios, which include in addition the EE bottom-up measures, are projected to add approximately 10 percentage points in terms of the EE indicator (as calculated above).
- The measures in these EE policy areas (three bullets above) are most strongly driven by a modelling instrument named "Efficiency Values (EV)" to trigger energy savings. EV represent the marginal cost of achieving one further unit of energy savings (e.g. reduction of heat needs in building by one tonne of oil equivalent). The higher the EV, the more energy savings are realised taking into account upward sloping and progressive marginal cost relationships. The EV essentially mirrors the implementation of energy saving obligations, which could be mechanisms, such as white certificate systems, or other direct obligations enforcement approaches. The average EV in the ambitious EE scenario increases from 261.5€/toe in 2020 to 343.5€/toe in 2025 and 693€/toe in 2030 further increasing to 2108€/toe in 2050 (1283€/toe in 2040). In the very ambitious EE scenarios EVs reach the following somewhat higher levels after 2020: 356€/toe in 2025, 793€/toe in 2030, 1394€/toe in 2040 and 2284.5€/toe in 2050. (EV are the same in 2020 in both strong EE scenarios).
- The efficiency standards for products driven by Ecodesign Regulations and their possible further strengthening are continuously tightened regarding existing requirements, broadening of the categories of the products covered and by applying requirements to not yet regulated products to cover all energy product categories represented in the model. This does not involve speculation on technology breakthroughs. On the contrary, new minimum requirements for products are set at today's best available technology level, which over time correspond to the least life-cycle cost outcome of consumer choices taking account of economies of scale,

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detailed than analysis of case studies but has the merit to be comprehensive, to avoid double counting and to include rebound effects.

technology progress, better craftsmen skills in installation, maintenance and management of such products in more complex energy efficient configurations. This is further supported by the broad introduction of smart appliances. All these EE changes are driven by regulation, learning from best practices, other supportive measures such as efficiency labelling, support by obliged utilities that have to save energy at their customers' sites, ESCOs and other synergetic soft measures.

- Wide deployment of energy performance contracting (EPC) and strong penetration of ESCOs, which is mirrored by a further reduction of discount rates for households from in 2020 under Reference scenario conditions to 11 % in 2025, 10% in 2030 and 9% from 2040 onwards, where the rate remains through 2050. For services, offering particular high potential for EPC, the discount rate goes down from 10% in 2020 to 9.5% in 2025 and 8.5% in 2030 to 2050.
- Further strengthening of other measures under the EED concerning e.g. EE fostering practices of public authorities, energy audits and management systems, consumer information.
- National energy efficiency measures are assumed to continue throughout the projection period at the same intensity as in 2020.
- Various additional measures on industry regarding the implementation of BAT (best available techniques) in industry including the assumption of stricter application of existing and future legislation, for which a strengthening over time in line with the improvement of the best available technology has been assumed; such strengthened legislation would reduce investors uncertainty and thereby risk premiums for such advanced investment; this particularly influences heat recovery in various energy uses, various specific processes and horizontal measures such as energy management and control systems; further enhancement of resource efficiency (more recycling for metals, glass and paper).
- Additional support for smart grids and efficiency standards for power networks, allowing further reduction of losses in transmission and distribution both for power networks and steam distribution resulting in further efficiency improvements in transmission, storage and distribution efficiency
- Lower electricity demand brought about by EE policies leads to lower transmission losses in the grid due to the fact that the loss fraction is not linked proportionally to the transmitted power (losses have a power relationship to the amount of electricity transmitted: in cases of lower electricity demand and less frequent high demand, losses are strongly reduced as is the case in the ambitious and very ambitious scenarios)
- Wider deployment of CHP and district heating/cooling through measures for enabling distributed heating/cooling and steam (infrastructure), early deployment of highly efficient CHP in industry (incentives and control policies) and facilitation of high efficient CHP in the electricity markets, modelled as part of the EED obligations on MS to guarantee transmission and distribution from high efficient co-generation, provide priority or guaranteed access to the grid from such cogeneration as well the national supportive schemes to increase the CHP share; the modelling reflects such obligations and ambitions for a strong CHP penetration when simulating electricity and heat supplies and their combined production and distribution.

- Stronger CO2 standards for passenger cars post 2020 reaching 85g CO2/km in 2025, decreasing to 70g in 2030 and 60g CO2/km in 2035; 35g in 2040 and 25g in 2050[163].
- More stringent standards for LDVs reaching 110 g CO2/km in 2030 and after that further decreasing to 90 g CO2/km in 2035, 70 g in 2040 and 60g in 2050.
- For HDVs improvements in specific fuel consumption are assumed to reach about 1.1% per year between 2010 and 2030 and 2030-2050 due to technological improvements including new rules to allow manufacturers to develop more aerodynamic lorries[164], the wide adoption of eco-driving, deployment of intelligent transport systems, and the internalisation of external costs.
- Standards on specific CO2 emissions of motorcycles and mopeds.
- Other additional transport related measures with energy efficiency benefits (i.e. internal market measures, infrastructure for CNG, electricity, hydrogen and LNG[165], taxation, internalisation of local externalities), as reflected in the White Paper on Transport, which start being effective already before 2020[166] but given their long term nature might have a particularly strong impact after 2020. Taxation related measures cover CO2 based vehicle taxation, removal of the favourable tax treatment of company cars and the implementation of the proposal for a revised Energy Taxation Directive, plus financial incentives linked to environmental performance (e.g. bonus/malus). Internal market measures covering the further opening of transport markets and removing regulatory, administrative and technical barriers and the wide deployment of intelligent transport systems. Other soft measures like eco-driving and fuel efficiency labelling are also considered.
- Improvements in non-road mobile machinery are driven by the generic measures related to internal market measures (see above).

[163] These post 2030 values for CO2 standards for cars and LDVs and the assumed CO2 standards for motorcycles do not only foster energy efficiency, particularly through increased fuel efficiency up to 2030, but also drive electrification in the PRIMES modelling tool after 2030. They are therefore also applied in the scenarios with GHG targets as the driver for electrification post 2030.

[164] Proposal for a Directive on new EU rules for safer and more environmental lorries, adopted in April 2013.

[165] These infrastructure measures serve three objectives: diversification of transport fuels, energy efficiency and decarbonisation; the latter area they improve the effectiveness of other measures, such as CO2 standards, allowing for more cost-effective decarbonisation helping to exploit possible synergies in a long term decarbonisation strategy. They are therefore mostly already included under enabling settings (see Annex 7.2).

[166] Measures in some of these areas have been recently adopted by the European Commission (i.e. Clean Power for Transport package, adopted in January 2013; Forth railways package, adopted in January 2013; New EU rules for safer and more environmental lorries, adopted in April 2013; Single European Sky (SES2+), adopted in June 2013).

7.4. State of affairs and main lessons learnt from the 2020 framework

7.4.1. Summary

7.4.1.1. The 20% GHG emissions reduction target and dedicated policies

1. The EU has achieved substantial GHG emission reductions and is on track to meet and even exceed the 20% target

2. The EU ETS has produced an EU-wide carbon price signal to achieve emission reductions cost-effectively and a European carbon market which complements the completion of the internal energy market. The inclusion of aviation as a further step towards a global carbon market has led to criticisms from third countries.

3. The Effort Sharing Decision ensures that non-ETS sectors contribute their target share in a flexible way. The EU is on track to meet the -10% target below 2005 levels, however 13 Member States need to make additional efforts to meet their respective national 2020 targets or make use of the flexibility mechanisms.

4. The ETS has adapted flexibly to the crisis but has and will continue (in the foreseeable future) to have a large surplus of emissions allowance, largely as a result of the sustained economic recession and a large inflow of international credits

5. The surplus has resulted in an ETS price signal too weak to significantly affect the price of fossil fuelled power generation, which if unaddressed will have a long lasting effect on the ability of the ETS to provide an incentive to invest in low carbon energy technologies such as renewables. In combination with today's high gas to coal price ratio, it can lead to carbon lock-in.

6. The low ETS price has also increased the need for public funding to achieve longer term emission reductions. However, while a (higher) carbon price is an important driver, it alone may not be enough to provide sufficient incentives for developing innovative low carbon technologies and related infrastructures.

7. The current impact of the ETS price on power prices is marginal. Its influence on demand side energy savings is therefore limited. However, at substantially higher levels of the ETS price, the impact on power prices and on electricity savings could be considerable.

8. Free allocation to energy intensive sectors and along with low carbon prices have resulted in a very low risk of carbon leakage at present. State aid for electricity intensive industries can be an effective way of preventing indirect impacts but has given rise to concerns by some stakeholders regarding distortions of competition across Member States.

9. A number of EU policies, high fossil fuel prices and reduced demand due to the crisis have contributed to GHG emission reductions. Well-designed, specific, energy savings measures addressing non-price barriers such as split incentives, high private discount rates, limited access to finance or imperfect information are complementary to price signals. The CO2 and cars regulation is a good example of such effective complementary regulation.

10. The low ETS carbon prices and corresponding auctioning revenues, the overachievement of the effort sharing targets at the overall EU level combined with access to international

credits on prices of emission allocation transfers between Member States reduce related redistribution effects envisaged in the climate and energy package.

11. Regulatory uncertainty about the way forward and concerns about a lack of effectiveness of the ETS have reduced the confidence of carbon market participants and are in some cases already leading to a fragmented approach to decarbonisation within the EU which would be contrary to the internal energy market.

12. The obligation of the amended Fuel Quality Directive for all fuel suppliers to reduce the life cycle greenhouse gas emissions from their supply of road fuels by 6% in 2020 has proven to be complex to implement but has the benefit that it will apply equally to importers and domestic producers of fuels.

13. The pledges under the Copenhagen Accord and Cancun decisions have led to a variety of national policies and measures, including carbon markets. However, the existing pledges are not delivering sufficient reductions by 2020 and no new comprehensive international climate agreement has been achieved yet that ensures that the global community as such is on track to keep global warming below 2ºC.

7.4.1.2. The 20% renewable energy target and implementing measures

1. The renewable target has contributed to good progress in penetration of renewable energy in the EU energy mix

2. The EU has made good progress towards the 2020 target, but not all Member States are likely to meet their respective targets without additional efforts

3. The efforts to promote a range of renewable energy technologies have significantly reduced the costs of these technologies

4. The 2020 renewable target is expected to contribute to significant reductions in GHG emissions.

5. Between 1990 and 2011, renewable energy production in the EU is likely to have contributed to decreased import dependence, having grown by 90 mtoe per year during that period. Renewables production also helps to reduce fuel costs.

6. Renewable energy production in the EU has created or maintained somewhere between 800,000 and 1.2 million gross jobs by 2011

7. Increasing renewable energy in the power generation mix has contributed to reduced wholesale power prices but its support mechanisms have contributed to increased retail prices.

8. While the financing costs of renewables remain high, in markets in which predictable long-term policies are in place, the business case is strong and there are many circumstances in which renewables can be competitive

9. Though essential to ensure uptake and long-term development, support for renewables alongside an ETS, notably for renewable electricity, has the potential to drive down the carbon price and in turn reduce the incentive for investments in renewables.

10. One important challenge is the integration of more variable renewable power generation in the electricity grid. It is clear that greater market integration of renewables is necessary,

together with adaptation and modernisation of the electricity grid and market functioning to adapt to a system of sustainable electricity production.

11. Renewable electricity generation (with low marginal costs) also poses new challenges for the operation of traditional "energy only" electricity markets

12. Support schemes for renewable energy need to be fit for purpose and efficient. The costs of developing renewable energy have been unnecessarily increased in some cases by poorly designed support schemes.

13. While the promotion of conventional biofuels has been successful in terms of quantities produced, it has been a costly way to achieve GHG emission reductions and there are increasing concerns on their sustainability; certainty about the long term perspectives of advanced sustainable biofuels is necessary to ensure deployment, as biofuels can be important for energy security, rural employment and renewable energy uptake in the transport sector.

7.4.1.3. The energy efficiency target and implementing measures

1. Significant progress has been made towards meeting the 20% energy efficiency target

2. Going forward, the Energy Efficiency Directive will help to ensure progress, but it is doubtful that the 2020 target will be met with current policies (even if the gap is projected to be now only 3 percentage points vs 11 percentage points projected in 2010).

3. Challenges in maintaining progress in energy efficiency include ensuring proper implementation and mobilising funds

4. The 2020 target for energy efficiency has been instrumental in ensuring progress, although a relative target for some sectors might better reflect the structural dynamics of the EU economy

5. Energy efficiency measures are expected to contribute to some reductions in GHG emissions by 2020, in particular in the non-ETS sectors.

6. Some energy efficiency measures, notably those impacting electricity consumption, have the potential to drive down the carbon price and to make the achievement of GHG emissions reductions more costly than they would otherwise be. However, the current surplus of allowances in the ETS is largely driven by other factors...

7. ... on the other hand, if cost-effective energy efficiency opportunities are not exploited, a

higher carbon price is needed to deliver the same level of emissions reductions...

8. Specific efficiency measures are also necessary to correct certain market and behavioural failures which a carbon price alone will not correct

9. Energy efficiency measures can positively contribute to energy security and competitiveness

7.4.2. The 20% GHG emission target, dedicated policies and policy interactions

1. The EU has achieved substantial GHG emission reductions and is on track to meet and even exceed the 20% target

In 2011, EU 28 emissions in the scope of the climate and energy package (including international aviation) were 16.9 % below the 1990 level, and 2012 emissions are estimated to have fallen by 18% below the 1990 level. Excluding international aviation (Kyoto Protocol scope), the EU 28 reduced emissions in 2011 by 18.3% below the 1990 level[167].As illustrated by the new reference scenario, over-achievement of the overall GHG target of 20% even seems possible at the EU level (see Annex 7.1). National GHG projections submitted under the Monitoring Mechanism Decision in 2013, quality checked and aggregated by the European Environmental Agency, also point in this direction[168].

2. The EU ETS has produced an EU-wide carbon price signal to achieve emission reductions cost-effectively and a European carbon market which complements the completion of the internal energy market. The inclusion of aviation as a further step towards a global carbon market has led to criticisms from third countries.

The 20% GHG reduction target for 2020 is in part implemented via the EU Emissions Trading System (EU ETS). The 2020 cap for the sectors covered by the ETS, reflecting a 21% decrease of electricity and industry ETS emissions below 2005 levels is expected to be met. This is illustrated by the new reference scenario, which also takes full account of the temporal flexibilities in achievement of the cap (banking and use of banked allowances).

The ETS has produced an EU-wide, uniform, carbon price signal that influences daily operational and strategic investment decisions of large industrial installations and in the power sector. It covers and creates a level European playing field for more than 10,000 installations and nearly 50% of all EU GHG emissions. The new institutional framework with auctioning and EU-wide harmonised benchmarks for free allocation has been in place since 2013 and constitutes a significant improvement compared to the previous trading periods that still had national based allocation plans.

Since 2012, aviation has also been included in the EU ETS. Unlike the cap on the number of emission allowances for fixed installations (which decreases yearly), that for aviation is fixed at 5% below a 2004-2006 average emission level baseline. The legislation applies also to incoming and outgoing international flights in the EU. This resulted in criticism from third countries opposing the inclusion of flights of foreign operators originating from their countries into the EU ETS. To provide negotiation time for the adoption of an internationally agreed solution by the ICAO (International Civil Aviation Organisation) General Assembly in autumn 2013, international flights into and out of Europe in 2012 were temporarily exempted from enforcement. The EU legislation is designed to be amended in the light of a global agreement.

3. The Effort Sharing Decision ensures that non-ETS sectors contribute their target share in a flexible way. The EU is on track to meet the -10% target below 2005 levels, however 13

[167] For further details, see the Report on PROGRESS TOWARDS ACHIEVING THE KYOTO AND EU 2020 OBJECTIVES (COM(2013)698).

[168] COM(2013)698 and EEA: Trends and projections in Europe 2013 – Tracking progress towards Europe's climate and energy targets until 2020.

Member States need to make additional efforts to meet their respective national 2020 targets or make use of the flexibility mechanisms.

The Effort Sharing Decision (ESD) sets national targets for GHG emissions in the sectors not covered by the EU ETS. National targets for 2020 are distributed between Member States according to economic capacity. Some need to reduce emissions compared to 2005 while others are permitted a limited growth in emissions. In addition, a trajectory of corresponding absolute emission limits is defined for each Member States for the years 2013 to 2019.

The combined target aims to achieve a 10% emission reduction at the EU level in 2020 compared to 2005. In aggregate, the EU is on track to achieve the 10% reduction target, but significant differences exist between Member States. 13 Member States need to make additional efforts to meet their respective national 2020 targets under the ESD, or make use of the flexibility mechanisms foreseen therein[169].

The ESD enables Member States to meet their targets for each of the years 2013-20 flexibly, be it through the acquisition of international credits or through trade with Member States outperforming their targets. This should enable reductions at least cost. Given the temporal flexibilities in achievement of the target trajectory, given that the ESD has been in force for only a few months and given also that 2013 emission limits can be met by most Member States, to date trade between Member States has not yet occurred. The importance of the foreseen flexibilities was also highlighted in several responses to the stakeholder consultation.

4. The ETS has adapted flexibly to the crisis but has and will continue (in the foreseeable future) to have a large surplus of emissions allowance, largely as a result of the sustained economic recession and a large inflow of international credits

The deep and protracted macro-economic crisis has significantly reduced demand for allowances. The ETS has adapted flexibly to changed economic circumstances and lowered compliance cost for sectors covered by the scheme. However, as a result of this reduced demand in combination with the accelerated inflow of international credits and what in some cases has been an over-allocation of allowances by Member States for phase 2 covering the period 2008 to 2012, an imbalance between supply and demand has resulted in a surplus of around 2 billion allowances building up since 2008[170].

While from 2014 onwards the rapid build-up of the surplus is expected to come to an end, the overall surplus is not expected to decline significantly during phase 3. The magnitude of the surplus by 2020 will depend significantly on longer term energy developments, such as the penetration of renewable energy and on-going efforts to increase energy efficiency, as well as on the speed of economic recovery.

While the use of international credits has been part of a cost effective solution to emission reductions and a first step towards a global carbon market, it has also contributed to uncertainty on what effort is required domestically, as well as having contributed to the surplus of allowances in the ETS. Furthermore, EU industry and governments via the Clean Development Mechanism have indirectly supported technological modernisation in competing sectors, especially in emerging economies such as China, India and Brazil.

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169 According to national projections submitted under the Monitoring Mechanism Decision in 2013, quality checked and aggregated by the European Environmental Agency. For further details see COM(2013)698.

170 Carbon Market Report COM(2012) 652 and SWD(2012) 234.

5. The surplus has resulted in an ETS price signal too weak to significantly affect the price of fossil fuelled power generation, which if unaddressed will have a long lasting effect on the ability of the ETS to provide an incentive to invest in low carbon energy technologies such as renewables. In combination with today's high gas to coal price ratio, it can lead to carbon lock-in.

When the three 2020 targets were agreed, the expectation was that there would be a positive impact from the GHG target and in particular from the ETS on both energy efficiency and renewables by increasing notably the price of electricity generation based on fossil fuels and the resulting price signal to energy consumers and a comparative advantage for generators of electricity from renewable energy sources.

Indeed, by creating an incentive for companies to invest in technologies that cut emissions as well as by increasing notably the price of electricity generation based on fossil fuels, the ETS is meant to be a key driver of investments in low carbon technologies[171]. The market price of allowances - the 'carbon price' – creates a greater incentive the higher it is[172].

But the recent level of the ETS price has been too low to produce such incentives. The combination of an increasing supply of allowances and international credits on the one hand, and low demand on the other, has been reflected in the observed ETS price evolution since 2008. From a high of just short of 30 €/t CO2 in 2008, the ETS price reached a historic low of 3 €/t CO2 in May 2013, slightly increasing to around 5 €/t CO2 since then.

According to many companies included in the ETS, the ETS price at current levels has become increasingly less important for investment decisions[173]. And this is in spite of the fact that the ETS emission cap decreases to around -21% by 2020 compared to 2005 and continues to decrease at the same pace after 2020, in principle giving a legal guarantee that major low carbon investments will be needed.

The low carbon price has been one of the driving factors, along with falling coal prices and a correspondingly increasing gas to coal price ratio, for the recent growth in the consumption and imports of coal witnessed in the EU, alongside falling consumption of natural gas[174]. This provides one illustration of how the EU ETS is at current low prices not incentivising switching away from the more polluting forms of power generation.

6. The low ETS price has also increased the need for public funding to achieve longer term emission reductions. However, while a (higher) carbon price is an important driver, it alone may not be enough to provide sufficient incentives for developing innovative low carbon technologies and related infrastructures.

A low carbon price does not only negatively affect low carbon investments, it also increases the need for public support for low carbon technology development necessary to achieve emissions reductions.

Taking the example of carbon capture and storage (CCS), the lower the carbon price, the higher the public funding required to install CCS in a new pulverised coal plant. At 5 €/t CO2 and the current stage of technology development, more than €800 million of public finances

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171 European Commission, 2012, the State of the EU Carbon Market in 2012

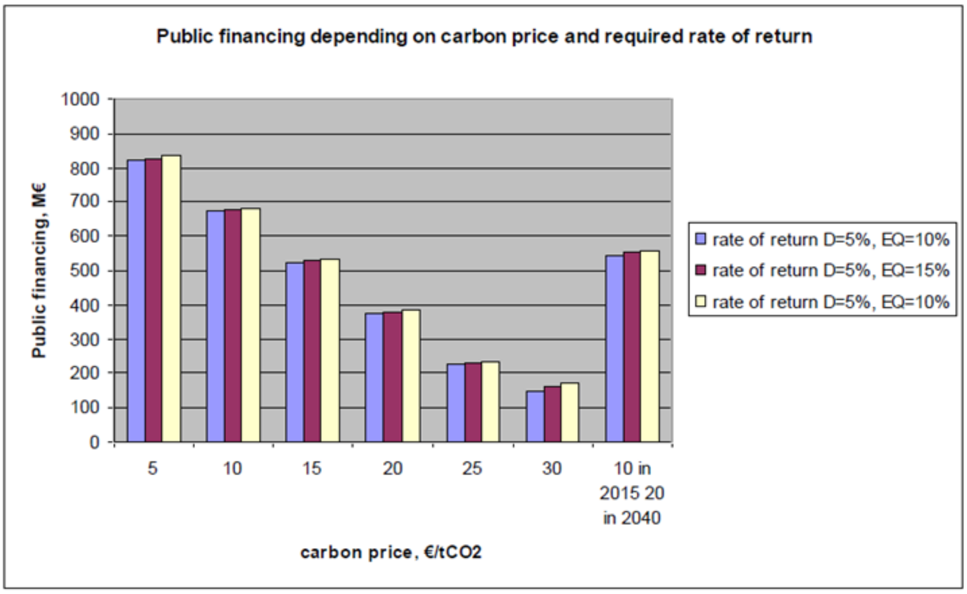
172 European Commission, 2013, EU ETS Factsheet 2013

173 Conclusion from survey conducted in 2012 by Thomson Reuters Point Carbon of 363 EU ETS operators.

174 Annual natural gas consumption in 2012 was 4% lower than in 2011. In contrast, EU consumption of coal has remained relatively stable over 2012, while imports of hard coal went up by approximately 8% in 2012 compared to 2011.

would be required to install CCS in a coal plant, while this amount falls to less than €200 million for a carbon price of 30 €/t CO2[175].

Figure 15: Upfront subsidies required to install CCS in a new build pulverised coal plant



(D=debt taken on to finance the project; EQ=equity part financing the project)

Source: PROPORTIONATE IMPACT ASSESSMENT accompanying the document Commission Regulation (EU) No .../.. of XXX amending Regulation (EU) No 1031/2010 in particular to determine the volumes of greenhouse gas emission allowances to be auctioned in 2013-2020

Also, an increasing value of ETS allowances would directly benefit a limited number of available investments in low carbon projects as of the 300 million allowances from the EU-wide new entrants reserve for phase 3 that are available to stimulate the construction and operation of large-scale demonstration CCS projects as well as innovative renewable energy technologies (NER300 programme), 100 million allowances are to be monetised by the end of 2013. This means that every €1 increase (or avoided drop) in the carbon price in 2013 will lead to a €100 million increase in revenue available for these types of projects[176].

Irrespective of the level of the carbon price, some commentators have argued that carbon pricing by itself is insufficient to drive investment in research and development of new technologies[177], while others have reflected that while the carbon price can contribute to the financial viability of a low-carbon project, uncertainty about the future carbon price may complicate decision-making particularly for financing of projects[178]. Empirical studies found some impacts of the EU ETS on innovation, however with limited scope[179].

175 See http://ec.europa.eu/clima/policies/ets/cap/auctioning/docs/swd_2012_xx2_en.pdf.
176 See http://ec.europa.eu/clima/policies/ets/cap/auctioning/docs/swd_2012_xx2_en.pdf
177 See "The case for carbon pricing", Grantham Research Institute, 2011
178 Climate Policy Initiative, 2011, Carbon pricing for low-carbon investment
179 E.g. Rogge K.S., Schneider, M. Hoffmann, V.H. (2011): The innovation impact of the EU Emission Trading System — Findings of company case studies in the German power sector. Ecological Economics, Vol. 70, pp 513–523; Calel, R., Dechezlepretre, A. (2012): Environmental Policy and Directed Technological Change: Evidence from the European carbon market.

In addition, the ETS price is only one element in the economic decision to invest or not in low carbon technologies. The optimal investment solution is always specific to the demand and supply situation of the investor and the expectations he or she has about the evolution of electricity, fuel and carbon prices as well as other operational costs, demand levels and profiles, the behaviour of competitors and the stability of the regulatory and market framework.

One survey[180] revealed not only that the ETS alone may not be sufficient to drive low-carbon investments, but also that there are a variety of other factors that companies consider more important or as important as the ETS for investment choices. For instance, power generators reported that access to fuel and public perception that affects the permitting process are important factors for investment decisions, and power technology companies reported that technology-specific policies such as feed-in tariffs, where they exist, are the most important factors for sales and R&D investments.

7. The current impact of the ETS price on power prices is marginal. Its influence on demand side energy savings is therefore limited. However, at substantially higher levels of the ETS price, the impact on power prices and on electricity savings could be considerable.

The impact of carbon prices on power prices has typically been measured by considering the CO2 transfer factor for power supplied by combustion plants. The transfer factor is defined as the increase in the annual average power wholesale price associated with a CO2 cost of 1 €/ton CO2, i.e. the transfer factor is measured as €/MWh per €/ton CO2.

The average transfer factor in a thermal power system is the average of the marginal CO2 cost for all hours during the year. In a thermal system with a mix of different technologies and fossil fuels, it has been estimated that the average transfer factor lies between the transfer factor for gas power generation (0.4 tCO2/MWh) and coal power generation (0.8-0.9 tCO2/MWh)[181].

However, if the share of renewable electricity generation increases or the system has a high share of older, less efficient, coal generation facilities, the average transfer factor may be outside this range. For Combined Cycle Gas Turbine (CCGT's) plants for example, which are expected to be the thermal power plant of choice in the future to act as back-up for renewable energy power plants, the transfer factor can be even lower than 0.4 tCO2/MWh.

In the recent Impact Assessment (IA) on backloading, an average CO2 emissions factor from power production in the EU of 0.465 tCO2/MWh is used. This was also the CO2 emissions factor used in the IA for the state aid measures in the ETS and in the IA relating to the 2010 carbon leakage decision. Making the simplifying assumption of full cost pass through, it would mean that a 1 Euro increase in the carbon price would translate into an increase in the electricity price of € 0.465/MWh.

The cost of electricity for EU industry as an end-user in 2012 was between € 94/MWh and € 226/MWh with an average of around € 137/MWh[182]. Thus assuming a transfer factor of 0.465 tCO2/MWh, a €5 increase in the carbon price would lead to a €2.3/MWh increase in electricity prices, amounting to 1.7% of €137/MWh, which must be considered insignificant

180 ISI Fraunhofer, 2011, Relative Importance of Different Climate Policy Elements for Corporate Climate Innovation. Activities: Findings for the Power Sector

181 Poyry and Thema consulting group, 2011, Carbon Price Transfer in Norway. The Effect of the EU-ETS on Norwegian Power Prices, Poyry and Thema consulting group

182 Eurostat numbers for the second semester of 2012 for the middle industrial consumption band (Ic: 500 MWh < Consumption < 2 000 MWh). The average is a simple, non-weighted, mean average.

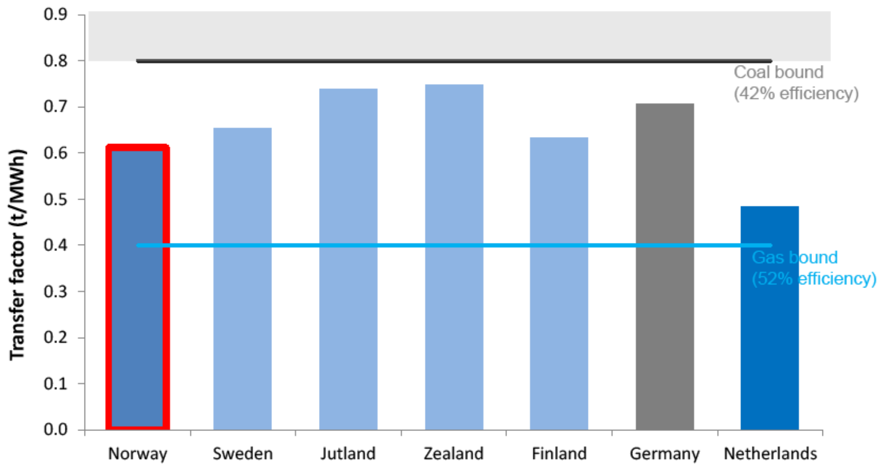
in relative terms, not least given the conservative assumption of full cost pass-through. The relative impact on wholesale prices would however of course be greater.

On this basis, it is clear that the ETS at present price levels only has a marginal impact on wholesale electricity prices. The impact from the ETS is dwarfed by the fluctuations and modest upward trend of wholesale prices noticed over the last three years (largely driven by other factors than the ETS), let alone changes in end-user prices over the same period. In addition, there is some evidence that short term price elasticity of electricity demand and hence the short term effects of price changes on energy savings are limited (see point 9).

However, even if energy demand is deemed relatively price inelastic in the short term, it cannot be concluded that any price increases will not have an impact on behaviour. Significantly higher carbon and/or energy prices could change the price elasticity of demand observed, providing much increased incentives for consumers to invest in more energy efficient products.

It should also be highlighted that CO2 transfer factors vary considerably between Member States, and can be quite considerably higher than the EU average. As an example, estimated transfer factors for the power market areas in North West Europe (Nordics, Germany and the Netherlands) are illustrated in Figure 16 below[183].

Figure 16: Estimated CO2 transfer factors for Norway and power markets in NEW



Source: Carbon Price Transfer in Norway, Poyry/Thema Consulting Group, 2011.

All transfer factors in the Figure above lie between the typical emission factors for gas (0.4 tCO2/MWh) and coal generation (0.8-0.9 tCO2/MWh), shown by the horizontal lines in the Figure. The highest transfer factor in this group is in Denmark (Zealand = 0.76 tCO2/MWh), which has the highest share of coal power generation, and the lowest transfer factor is in the Netherlands (= 0.5 tCO2/MWh), with the highest share of gas power generation.

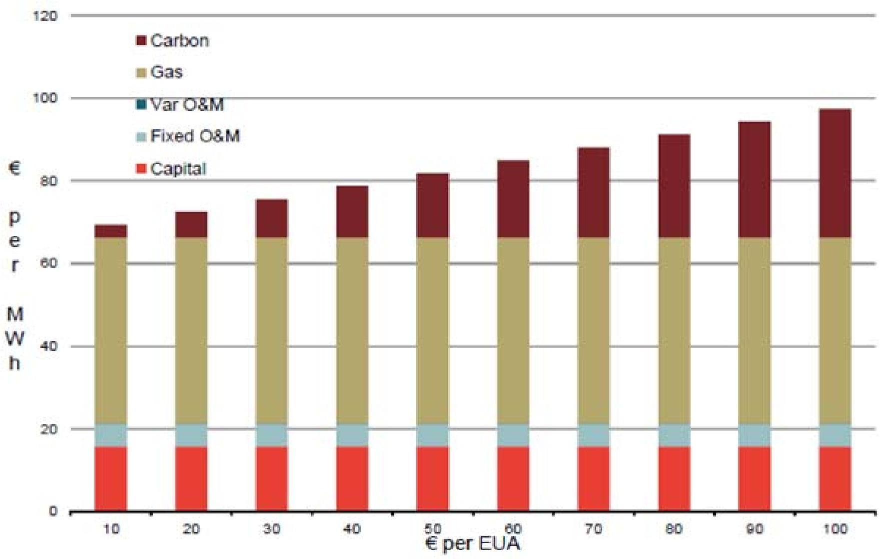
Note that the estimated transfer factor for Norway (=0.6 tCO2/MWh – also shown in Figure 16) appears to be high given that Norwegian power generation is almost 100% based on renewables and as such, practically CO2 free. This is because of the high interconnectivity of the Norwegian market with neighboring, Nordic markets, which have substantial thermal power generation. There is thus a spill-over effect of the carbon intensity of power generation on neighboring, interconnected markets, and the more interconnected the markets, the greater

183 Poyry and Thema consulting group, 2011, Carbon Price Transfer in Norway. The Effect of the EU-ETS on Norwegian Power Prices

the convergence in national transfer factors from CO2 into electricity prices (as well as electricity prices themselves)[184].

But even with a transfer cost at the low end of these estimates, it would not take a very high carbon price before the impacts on the costs of power generation become substantial. An analysis undertaken by Frontier Economics for Business Europe[185] assuming a (rather low) transfer factor of 0.3 tCO2/MWh for a CCGT plant, a relatively high ETS price of €50/t of CO2 would amount to around 20% of the total costs of gas-fired generation, and a more modest level of €20/t of CO2 would still equate to around 9% of total costs (see Figure below)[186].

Figure 17: Impact of carbon prices on cost of gas-fired generation.



Source: Frontier Economics, 2013.

For such transfer factors to have an impact on consumers however, the degree to which such costs are passed through to either household or industrial consumers must be assessed. As long as price regulation persists in parts of the EU as it still does today, and as long as the completion of the internal energy market continues to be further delayed, consumers in a number of Member States will continue to be artificially insulated from such cost increases and the incentive effect of the ETS dampened.

8. Free allocation to energy intensive sectors and along with low carbon prices have resulted in a very low risk of carbon leakage at present. State aid for electricity intensive industries can be an effective way of preventing indirect impacts but has given rise to concerns by some stakeholders regarding distortions of competition across Member States.

184 Poyry and Thema consulting group, 2011, Carbon Price Transfer in Norway. The Effect of the EU-ETS on Norwegian Power Prices

185 Frontier Economics report prepared for Business Europe, May 2013, Lessons learnt from the current energy and climate framework

186 The calculation assumes a gas price of €26 per MWh (thermal). Other assumptions are a plant efficiency of 58% and cost of capital of 8% (real, weighted average cost of capital consisting of debt and equity).

See for more background information to the study 'Carbon Leakage Evidence Project - Factsheets for selected sectors'[187].

9. A number of EU policies, high fossil fuel prices and reduced demand due to the crisis have contributed to GHG emission reductions. Well-designed, specific, energy savings measures addressing non-price barriers such as split incentives, high private discount rates, limited access to finance or imperfect information are complementary to price signals. The CO2 and cars regulation is a good example of such effective complementary regulation.

It is not possible to say how much of the total EU GHG emissions reductions is directly attributable to the ETS. GHG emissions have also decreased due to the impact of the economic crisis and high fossil fuel prices, which have given additional incentives for fuel efficiency. Emissions reductions have also been achieved through the other policies implemented in the Climate and Energy Package[188] and related EU law, notably energy efficiency measures such as the eco design framework setting minimum energy efficiency standards for a range of domestic and industrial appliances and the fossil fuel displacement generated by strong growth in the use of renewable energy, also driven through specific support measures.

Further reductions in particular in non-ETS sectors have been generated by other supporting national and sectoral EU policies and range for the EU from policies that regulate CO2 emissions and improve energy efficiency for cars and vans, to the Regulation on certain fluorinated greenhouse gases and Mobile Air-Conditioning Systems Directive to specific waste, environmental and agricultural policies.

Supporting the logic of a combination of carbon pricing as a broad-brushed tool and complementary EU energy efficiency policy measures, the IEA[189] argues that carbon pricing does not address several market and behavioural failures such as split incentives, high private discount rates, limited access to finance or imperfect information in areas such as appliance electricity use, road fuel consumption and building heating and cooling energy use and considers that policies which address such failures can therefore be considered complementary to carbon pricing.

Low price elasticity of energy demand[190] in the EU is an oft-cited reason for a possible ineffectiveness of carbon (or energy) prices to address certain energy efficiency barriers[191], with some evidence that price elasticities of residential energy demand in the short term are

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187 Carbon Leakage Evidence Project: Factsheets for selected sectors, Ecorys, 23 September 2013. http://ec.europa.eu/clima/policies/ets/cap/leakage/docs/cl_evidence_factsheets_en.pdf

188 This includes: Directive 2009/28/EC on the promotion of the use of energy from renewable sources (which divides the 20% renewables target by 2020 into targets per Member State); Decision No406/2009/EC on the effort of Member States to reduce GHG emissions (which defines targets per Member State for sectors not included in the ETS. Together with the emissions cap in the ETS directive this results in a 20% GHG reduction in 2020 compared to 1990); Regulation (EC) No 443/2009 on emission performance standards for new passenger cars (which regulates average levels of CO2 emissions of newly sold cars in the EU); Directive 2009/30/EC (Fuel Quality Directive) to reduce the carbon content of fuels sold in the EU over their life cycle; Directive 2009/31/EC on the geological storage of carbon dioxide to create an enabling framework for carbon capture and storage.

189 IEA, 2011, Summing up the parts: Combining Policy Instruments for Least-Cost Climate Mitigation Strategies

190 The extent to which a change in final energy prices will lead to a change in energy consumption is measured by the price elasticity of energy demand. The higher the elasticity, the more energy users will react to changes in price.

191 IEA, 2009, Gadgets and Gigawatts: Policies for Energy Efficient Electronics

generally low, with some variations by country and region. The high price needed to achieve changes in residential energy demand only by price changes would lead to challenges on other issues, i.e. distributive effects, economic impacts, equity issues[192]. Such low elasticities can be explained as follows: with regard to heating, while residential consumers can switch between several sources, in reality switching is deemed too costly an investment, even in the long term[193]. Moreover, many residential energy users are faced with financial constraints that limit the possibility to make upfront energy saving investments even if such investments would pay back in a relatively limited period of time.

On the other hand, several studies for the transport and building sectors indicate that in the long term energy demand can be rather elastic, with price elasticities being significantly higher than in the short term[194]. Other studies have found that the combined impact of information and price instruments increases effectiveness most[195].

Such evidence provides some support for an EU approach which combines instruments to achieve GHG emission reductions via improvements in energy efficiency, in particular in non-ETS sectors. However, given that certain specific measures reducing energy demand also impact on quantity-based carbon pricing instruments such as the EU-ETS, care has to be taken to take account of these interactions when designing the measure [196].

Another way in which the EU ETS can have an effect on energy efficiency is via auctioning revenues used to fund energy efficiency measures. One example is Germany, which has earmarked ETS auctioning revenues to be deposited into a “Special Energy and Climate Fund”, which will serve the purpose of financing various environmental and energy efficiency policies[197]. The French government has also announced recently that all the proceeds from ETS auctioning will finance the renovation of at least 500,000 homes per year, with a scope to achieve the EU energy efficiency objectives[198]. The carbon price plays an important part, as it will determine how much funds become available for such measures.

10. The low ETS carbon prices and corresponding auctioning revenues, and the impact on prices of emission allocation transfers between Member States of the overachievement of the effort sharing targets at the overall EU level combined with access to international credits reduce related redistribution effects envisaged in the climate and energy package.

See the detailed analysis of distributional effects under lower carbon prices as assumed in the Climate and Energy Package in the Member State results analysis of options beyond 20%

[192] McKinsey Global Institute, 2007, Curbing Global Energy Demand Growth: The Energy Productivity Opportunity, McKinsey Global Institute, San Francisco; IEA, 2011, Summing up the parts: Combining Policy Instruments for Least-Cost Climate Mitigation Strategies

[193] McKinsey Global Institute, 2007, Curbing Global Energy Demand Growth: The Energy Productivity Opportunity, McKinsey Global Institute, San Francisco.

[194] .E.g. P. Geilenkirchen, K. Geurs (PBL); H.P. van Essen, A. Schroten, B. Boon (CE Delft): Effecten van prijsbeleid in verkeer en vervoer. Bilthoven ; Delft : Planbureau voor de Leefomgeving (PBL) ; CE Delft, 2010; Reinhard Madlener, Ronald Bernstein, Miguel Ángel Alva González (2011) Econometric Estimation of Energy Demand Elasticities. E.ON Energy Research Center Series. Volume 3, Issue 8, October 2011.

[195] See e.g. Scholl, G. et al. (2010): Policies to promote sustainable consumption, Natural Resources Forum, Vol. 34, pp 39-50

[196] IEA, 2011, Summing up the parts: Combining Policy Instruments for Least-Cost Climate Mitigation Strategies

[197] European Parliament, 2013, Energy Efficiency and the ETS.

[198] European Parliament, 2013, Energy Efficiency and the ETS.

GHG emission reductions[199]. The now projected overachievement of the Effort Sharing Decision at EU level in reference highlights the salience of this issue.

11. Regulatory uncertainty about the way forward and concerns about a lack of effectiveness of the ETS have reduced the confidence of carbon market participants and are in some cases already leading to a fragmented approach to decarbonisation within the EU which would be contrary to the internal energy market.

Some Member States concerned about the evolution of the ETS have taken, or are considering taking national measures, such as carbon price floors or taxes for carbon intensive fuels in ETS sectors. There is a concern that the regulatory uncertainty about the way forward with the ETS is increasing the risk of policy fragmentation, in turn threatening the Single Market, with national and sectoral policies undermining the role of the ETS and the level playing field it has created.

12. The obligation of the amended Fuel Quality Directive for all fuel suppliers to reduce the life cycle greenhouse gas emissions from their supply of road fuels by 6% in 2020 has proven to be complex to implement but has the benefit that it will apply equally to importers and domestic producers of fuels

The Fuel Quality Directive (FQD), as amended in 2009 as part of the Climate and Energy package[200], introduced an obligation for fuel suppliers to reduce the life cycle greenhouse gas emissions from their supply of fuels used in road (and non-road mobile machinery) by 6% in 2020 from a 2010 baseline. The FQD target is expected to be met by substituting fossil fuels with a) lower GHG intensity fuels including sustainable biofuels, Liquefied Petroleum Gas (LPG) and methane (Compressed Natural Gas, Liquid Natural Gas and bio-methane), b) with electricity and hydrogen, and c) by reducing upstream emissions of fossil fuels in and outside of the EU.

While the methodology for calculating the greenhouse gas emissions for biofuels was included in the FQD at the time of adoption, the methodology to be used by suppliers for calculating the lifecycle greenhouse gas intensity of fossil fuels was left to be developed through comitology. The methodological challenge is to ensure fuel suppliers can calculate life cycle emissions, incorporating an adequate level of accuracy but balancing the associated administrative burden. The development and evaluation of such a methodology is complex.

In this context, a draft implementing measure harmonising the method for calculating greenhouse gas emissions from fossil fuels and electricity in road vehicles was submitted to the Fuel Quality Committee of the Member States on 4 October 2011. The Committee vote on the implementing measure held on 23 February 2012 resulted in a "no opinion", given that a number of Member States claimed to be unable to finalise their position in the absence of an assessment of the economic impacts of the proposed measures. In accordance with the relevant comitology procedure, an impact assessment considering a number of options was finalised in August 2013, and will be followed by a new Commission proposal to the Council.

Other major economies are reviewing proposals for or have/ has adopted similar legislation: The states of California and Oregon in the USA and the province of British Columbia in Canada have adopted legislation for reducing life cycle greenhouse gas emissions from transport fuels; commonly known as Low Carbon Fuel Standards (LCFS). In addition the governors of the state of Washington and eleven other north-eastern states have either directed their respective departments to evaluate and develop a similar LCFS or have joined to

199 SWD (2012)5

200 Directive 2009/30/EC

evaluate and develop one standard for their region. The latter includes the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New York, New Hampshire, New Jersey, Pennsylvania, Rhode Island and Vermont.

One benefit of such a policy is that it will apply equally to importers and domestic producers of fuels.

13. The pledges under the Copenhagen Accord and Cancun decisions have led to a variety of national policies and measures, including carbon markets. However, the existing pledges are not delivering sufficient reductions by 2020 and no new comprehensive international climate agreement has been achieved yet that ensures that the global community as such is on track to keep global warming below 2ºC.

More than 110 countries, accounting for 85% of global emissions and including all major economies in the global community have formally pledged to take action to mitigate climate change in the context of the UNFCCC.

The EU ETS is at present the largest functioning carbon market, but others are being implemented and developed. For example, Australia adopted its Carbon Pricing Mechanism legislation; China is pushing ahead with the design of its seven emissions trading pilots which could begin in late 2013; South Korea is developing its trading scheme.

Major economies have enhanced their fuel economy standards (in US, China, Japan, and India is considering new policies) and some countries undertaken significant reforms of their tax and subsidies to improve their energy security (Iran, Indonesia, South Africa, India). Over 100 countries have renewable energy policies, and especially fast-growing economies are developing support schemes to enable investments in renewable energy (ex: Philippines, China and Chile).

But the existing pledges are not delivering sufficient reductions by 2020 to be on track to prevent a dangerous 2º C rise of temperature. At the UN Climate conference in Durban in 2011, the need to act collectively, and with greater urgency and ambition was recognised. All parties agreed to negotiate by 2015 a global climate regime applicable to all after 2020 and agreed to enhance mitigation efforts to close the pre-2020 mitigation gap.

7.4.3. The 20% renewable energy target and implementing measures

1. The renewable target has contributed to good progress in penetration of renewable energy in the EU energy mix

By 2011, renewable energy represented 12.7 % of the EU's gross final energy consumption. The key instrument for achieving this progress has been the Renewable Energy Directive[201] and the national measures implementing it. The share of renewable energy has increased in every Member State since 2005. By 2010, 20 Member States had already exceeded the indicative 2011/2012 targets.

Member States have also progressed towards meeting the 10% by 2020 renewable energy target in transport. In 2010, renewable energy use in the transport sector was 4.7% of the energy consumed in that sector (above 95% of which was biofuel - amounting to 4.5%), only marginally falling short of the planned 2010 EU share of renewable energy in transport (of 4.9%).

[201] Directive 28/2009/EC.

The Directive established national legally binding targets which have provided the incentives to national governments to undertake a range of measures to improve the uptake of renewable energy. These include improvements to national planning and equipment/installation authorisation processes and electricity grid operations (connection regimes etc.), some of which are explicitly required by the Directive. Financial support has also been used by Member States to increase uptake, compensating for the various market failures that result in suboptimal levels of renewable energy.

2. The EU has made good progress towards the 2020 target, but not all Member States are likely to meet their respective targets without additional efforts

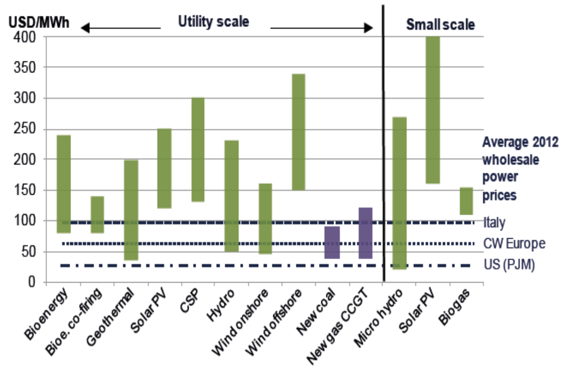
The progress to date means that the EU has met its interim target. However, as the trajectory grows steeper, more efforts will still be needed from Member States in order to reach it[202]. In addition, not all Member States are on track to meet their respective targets, and recent evolutions such as for instance retroactive changes to support schemes is causing concern as to whether the overall EU target will be met.

3. The efforts to promote a range of renewable energy technologies have significantly reduced the costs of these technologies

Some renewable technologies in certain markets are already competing with state of the art fossil-fuelled power generation, even at low levels of the ETS price[203].

Figure 18 below shows the latest IEA estimations of the levelised costs[204] of power generation in the OECD.

Figure 18: Levelised costs of power generation (USD per megawatt hour), first quarter 2013



Notes: MWh = megawatt hour; CCGT = combined cycle gasification turbine. Costs are indicative and ranges reflect differences in resources, local conditions and the choice of sub-technology. Wholesale power prices are expressed as the annual average of daily traded, day-ahead base-load power prices. CW Europe refers to annual average of power prices in France, Germany, Austria and Switzerland. United States (US) PJM refers to the regional transmission organisation covering parts of 13 states in the mid-Atlantic and mid-west portion of the United States.

Source: IEA, 2013, Medium Term Market report on Renewable Energy

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202 See the Commission Renewables Progress Report.

203 See IEA, 2013, Medium Term Market report on Renewable Energy.

204 The levelised cost approach is a financial model used for the analysis of generation costs. It focuses on estimating the average levelised costs of generating electricity over the entire operating life of the power plants for a given technology, taking into account main cost components, namely capital costs, fuel costs and operations and maintenance (O&M) costs. This analytical framework is flexible and allows specific cost factors (e.g. contingency, decommissioning, carbon prices) to be considered. The LCOE is equal to the present value of the sum of discounted direct costs divided by the total production of the generating unit (IEA).

Within the cost ranges for different technologies shown in the chart, OECD Europe is included, taking into account the prevailing carbon price in the first quarter of 2013, which has been very low. And yet, it can be seen that at the lowest end of the range, a number of RES technologies (geothermal, hydro and onshore wind, for instance) are in some cases already competing with new coal and gas power generation, even at very low carbon price levels.

At the other end of the scale, those renewable technologies which would clearly need a strong carbon price signal to compete without additional support include solar PV (in particular small scale) and offshore wind.

However, the costs of decentralised solar PV systems are becoming lower than retail electricity prices that system owners would otherwise pay in places such as Spain, Italy, southern Germany, southern California, Australia and Denmark[205].

And according to the latest data on Germany, solar PV currently receives a feed-in tariff equivalent to only 137 $/MWh (102 €/MWh)[206]. For countries further south in Europe with more sunlight the costs could be even lower.

4. The 2020 renewable target is expected to contribute to significant reductions in GHG emissions.

Just as it is not possible to say exactly how much the ETS has contributed to reductions in GHG emissions, attributing exact reductions to specific renewable policies is not possible. The extent of the effect also depends on the extent to which renewable policies impact more the ETS or the non ETS sectors.

However, in general renewable energy substitutes other forms of energy, including fossil fuels with considerable greenhouse gas emissions. Model runs done by the IPCC indicate that each GJ of additional renewable energy leads to a reduction in primary energy of 400 kg/GJ of CO_2 (average for all forms of renewable energy)[207].

Estimates have been carried out of how much the 2020 renewable target is expected to contribute to overall emission reductions by 2020. Over the period between 2008 and 2020, Member States' renewable energy development programmes are expected to reduce gross emissions by 2 GtCO2[208], with over 80% of this amount from the electricity sector (Figure 19). This would represent 40% of the 5 GtCO2 reduction effort required from the ETS sectors between 2008 and 2020, as established when the Climate & Energy package was drawn up or almost half (-9.3%) of the total GHG emissions reductions required, which is considerable[209].

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205 See IEA, 2013, Medium Term Market report on Renewable Energy.

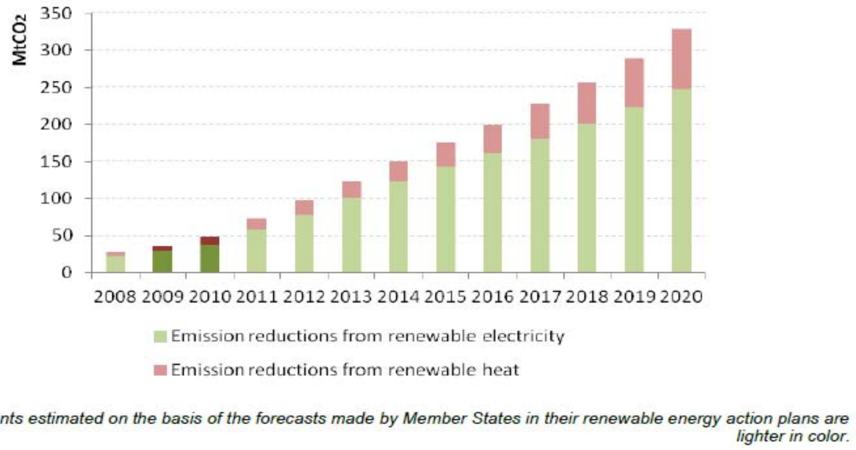
206 Http://www.bundesnetzagentur.de/cln_1912/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/Photovoltaik/DatenMeldgn_EEG-VergSaetze/DatenMeldgn_EEG-VergSaetze_node.html#doc405794bodyText4

207 IPCC – Special report on renewable energy (2012): http://srren.ipcc-wg3.de

208 This estimate, calculated by CDC Climate Research, was obtained by multiplying the additional amounts of renewable energy provided for in national action plans for 2008 and for the period between 2011 and 2020 by the emission factor of alternative energies used by Member States in their report to the Commission.

209 "Energy Efficiency, Renewable Energy and CO2 Allowances in Europe: A Need for Coordination", Climate Brief, no. 18, CDC Climat Research, September 2012.

Figure 19 - Annual CO2 emissions reductions caused by the RES Directive



Source: CDC Climate Research

The cost of reducing GHG emissions through specific renewables measures can be substantially different than the marginal short term cost of reducing emissions required to reach the cap in the ETS sector (reflected by the ETS price) but at the same time is delivering additional benefits beyond GHG reductions, and can improve long-term cost efficiency by encouraging the development of new technologies.

5. Between 1990 and 2011, renewable energy production in the EU is likely to have contributed to decreased import dependence, having grown by 90 mtoe per year during that period. Renewables production also helps to reduce fuel costs.

Much increased renewable energy consumption in the EU has been achieved through developments in EU renewable energy production, which has the potential to contribute to lower energy import dependence and, therefore, a lower energy import bill.

EU production in renewable energy has increased significantly in recent years (by 231% between 1990 and 2011). At the same time, the production of non-renewable energy sources has fallen (by -27%).

Over the same period (1990 to 2011), the EU's net energy imports increased by 24%. Without the contribution of (increasing) domestically produced renewable energy, the EU's net energy imports would have possibly increased by more. While the exact contribution of renewables to reduced import dependency cannot precisely be estimated, it should be noted that 90 Mtoe is the difference between renewable energy produced domestically in the EU in 2011 and 1990. Increased renewable energy production may also have reduced energy demand, and will to some extent also have displaced production of domestic non-renewable sources.

Altogether, the avoided costs of imported fuel saved thanks to the use of renewable energy are estimated to amount to around €30 billion in the EU in 2010 compared to an external trade deficit in energy products that year of €304 billion[210]. This estimate applies rather cautious assumptions and should be considered as a low estimate.

Looking forward, it is expected that the avoided fuel costs will rise in the coming years due to increasing production of renewable energy in the EU and a projected increase in EU fossil import prices[211].

[210] Report on economic aspects of energy and climate policies, 2013, European Commission, DG ECFIN

[211] Report on economic aspects of energy and climate policies, 2013, European Commission, DG ECFIN

6. Renewable energy production in the EU has created or maintained somewhere between 800,000 and 1.2 million gross jobs by 2011

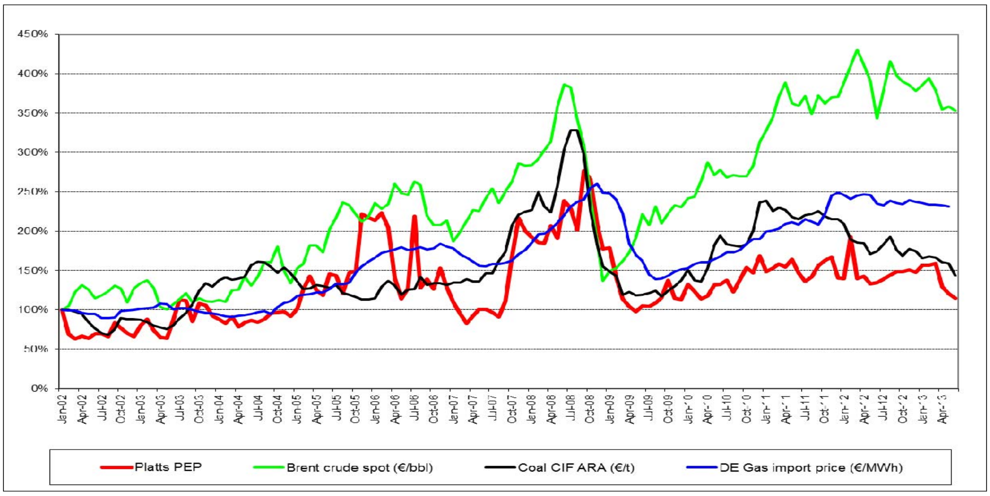
According to a report[212] commissioned by the European Commission, energy supply sectors in the EU in 2010 employed 2,413,500 persons. Of that amount, it is estimated that the renewable energy sector directly employed between 320,000 and 440,000 workers. Including indirect jobs, it is estimated that the renewable energy sector sustained between 800,000 and 920,000 workers in 2010. This compares to an estimate of 1.2 million jobs in 2011 in an earlier report for the European Commission[213].

7. Increasing renewable energy in the power generation mix has contributed to reduced wholesale power prices but its support mechanisms have contributed to increased retail prices.

The increasing deployment of renewable energy sources − mainly solar and wind power generation – has had a beneficial impact on the operational costs of power generation costs, further weakening the link between power prices and fossil fuels.

As the Figure below shows, parallel to increases in the share of renewable energy in power generation, wholesale power prices have risen less than the prices of oil and gas, and until recently coal, suggesting that the increased share of renewable electricity may have contributed to lessening increases in prices.

Figure 20: Comparison of European wholesale power, oil, gas and coal prices. January 2002=100%



Sources: Platts, BAFA, ENTSO-E.

Platts PEP: Pan European Power Index (in €/MWh), Coal CIF ARA: Principal coal import price benchmark in North Western Europe (in €/Mt)

DE gas border import price is the average price of natural gas on the German border (in €/MWh)

In some markets where hydro generation is significant, the combination of rainy weather and high levels of hydro generation can result in very cheap wholesale power prices, as could be observed most recently in Spain during March-April 2013 or in the Nordic market in the summer of 2012[214].

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212 Employment Effects of selected scenarios from the Energy roadmap 2050, COWI, Forthcoming.

213 Eurobserver and Commission Communication "Towards a job-rich recovery" COM(2012) 173 final"

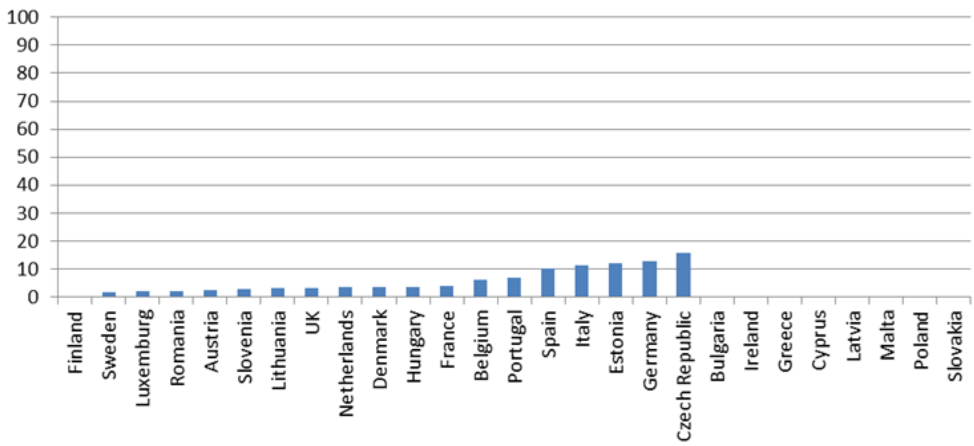
214 See second quarter 2013 issue of the Quarterly Report on European Electricity Markets, European Commission.

Increasing share of wind and solar power generation can also contribute to the reduction in the difference between the baseload and peakload period prices, especially when the peak of the variable power generation coincides with peak power demand hours. In many markets, the daily average peakload price is less than the daily baseload average price on many trading days for this reason.

While there has been a positive impact on wholesale prices from renewable energy, the costs of the renewables support mechanisms that have been put in place throughout the EU have typically been passed through to final consumers, as an additional component of the power price.

Renewable surcharges as a proportion of final household electricity prices vary significantly in the EU, as can be seen in the Figure below. The 2011 average for the 18 Member States for which data is available is 5.6%. It ranged from representing only 0.2% (Finland) to 15.9% (Czech Republic) of final household electricity prices. Member States with a relatively low burden of renewables surcharges relative to final electricity price (less than 5%) include also Sweden, the UK, France and Romania. On the other hand, in Member States such as Germany, Spain, Italy and Estonia, renewable surcharges represent between 10% and 12.7% of the final household electricity price[215].

Figure 21: Renewable surcharges as a proportion of household electricity price, 2011, in %



Source: CEER.

8. While the financing costs of renewables remain high, in markets in which predictable long-term policies are in place, the business case is strong and there are many circumstances in which renewables can be competitive

In recent years, both high fossil fuel prices and a supportive regulatory framework have provided support for low-carbon technology investments.

On the other hand, higher investment rates have tended to penalise more heavily capital-intensive, low-carbon technologies such as nuclear, renewables or coal with CC(S) due to their high upfront investment costs, and comparatively favour fossil-fuel technologies with higher operating costs but relatively lower investment costs, especially gas CCGT[216].

215 Data from the Council Of European Energy Regulators, 2012 Report on Renewable Energy Support in Europe

216 IEA–NEA "Projected costs of generating electricity", 2010

Recent estimates of long-term and current discount rates currently employed for low-carbon power generation range from 9.1% - 9.6% for onshore wind, 10 to 11% for nuclear and 10 to 15% for CCS[217] which reflect the risks still associated with such investments.

At a recent IEA workshop specifically on RES financing[218], it was concluded that technology risk is no longer seen as the main barrier to investment in renewable energy technologies; it is rather policy uncertainty which is perceived by developers and investors as the main risk that they are unable to manage, and that markets in which predictable long-term policies are in place, the business case is strong and there are many circumstances in which renewables can be competitive.

Market design is also highlighted as important, and markets based on competition over long-term contracts are one way to ensure sustained investment in capital-intensive low-carbon technologies[219].

A number of the IEA's reflections on RES financing in a selection of EU countries are as follows:

- France: In 2012, onshore wind and biomass energy remained economically attractive. Onshore wind is competitive with newly built natural gas power plants in many locations, though it remains more expensive than wholesale power prices.
- Germany: feed-in tariffs for onshore wind and bioenergy are broadly in line with new-build gas and coal plants, an indicator of competitiveness for these renewable options. Still, changes in coal and gas prices as well as proposed changes to incentive schemes may alter this picture over the medium term.
- Italy: Despite some attractive project economics, the availability and cost of finance for renewable deployment may remain a significant constraint in Italy over the medium term. The challenging macroeconomic situation has resulted in finance becoming increasingly scarce and more expensive in general.
- Spain: In 2011, wholesale electricity prices increased, reaching on average EUR 50/MWh. However, they decreased in 2012, averaging EUR 47/MWh. With a LCOE over EUR 80/MWh, this situation does not make new wind projects economically attractive for investors. Some solar PV projects for self-consumption can still be attractive over the medium term taking into account increasing retail electricity prices, but this may depend on the adoption of net metering. Still, financing is expected to remain a major challenge to the deployment of renewables over the next few years.

9. Though essential to ensure uptake and long-term development, support for renewables alongside an ETS, notably for renewable electricity, has the potential to drive down the carbon price and in turn reduce the incentive for investments in renewables.

Measures to promote renewable energy (and energy efficiency) can lower the carbon price by weakening the demand for emission allowances in the ETS. Recent econometric analysis has

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217 "Technology supply curves for low-carbon power generation", Poyry, June 2013

218 Conclusions of workshop which took place on the 9th of April 2013, organised by the IEA Renewable Energy Working Party and with the participation of members of its Renewable Industry Advisory Board and an audience of 140 senior decision makers from the key players worldwide.

219 Conclusions of workshop which took place on the 9th of April 2013, organised by the IEA Renewable Energy Working Party and with the participation of members of its Renewable Industry Advisory Board and an audience of 140 senior decision makers from the key players worldwide.

confirmed such an impact of renewables on ETS carbon prices[220]. Furthermore, at very low levels of the carbon price, short term emission reductions can be carried out cheaply via the purchase of allowances. And any extra measures taken to reduce emissions further, be they investments in renewable energy, energy efficiency measures in transport or housing, will in relative terms be more costly. With a low carbon price, investments in such measures are therefore difficult to justify for delivering short term emissions reductions.

Specifically with regard to the promotion of renewable power generation (RES-E), such concerns have been raised by industry representatives[221] which are critical of the combination of such measures with a volume cap on CO2 emissions. They consider that via such a combination, renewable power has no incremental impact on emissions reduction, and that, instead, overall carbon avoidance costs are increased by building expensive RES-E technologies, while at the same time other low cost avoidance options within the conventional power generation or industrial sectors are not used since those market participants only receive the weak EU ETS price signal diluted by the impact of RES-E promotion.

It should be highlighted that the impact of the achievement of the 20% renewables target on the ETS and carbon prices was anticipated and taken into account in the design of the climate and energy package[222].

Taking the emissions reduction benefits of renewables in isolation, it could be considered that even if, historically, support for renewables has achieved costly CO2 reductions relative to the carbon price, in due course, falling technology costs will contribute to progressively cheaper renewables options. Whether they become a relatively cheap means to decarbonise compared to the carbon price will depend on both the evolution of the costs of renewables and that of the carbon price.

In addition, such arguments also fail to consider another crucial aspect of the longer term perspective of GHG reductions, that of providing investor certainty via policy stability. For instance, without the EU's renewable energy policy, there would have likely been less investment in certain renewable technologies such as solar PV, as the technology risk and the sunk costs would have been too considerable. In this regard, the Renewable Energy Directive has removed the first mover disadvantage by forcing the EU collectively to support the development of renewable energy technologies, ensuring that renewable energy does not only develop in some Member States and with little effort sharing.

10. One important challenge is the integration of more variable renewable power generation in the electricity grid. It is clear that greater market integration of renewables is necessary, together with adaptation and modernisation of the electricity grid and market functioning to adapt to a system of sustainable electricity production.

A key challenge of the increasing penetration of renewable energy in the power grid is its integration into the EU's energy system. This constitutes a particular challenge in the case of wind and solar power as these have inherently different characteristics from conventional sources (e.g. in terms of cost structure, availability and size) and do not always fit into existing market structures and network infrastructures.

[220] Forthcoming Publication: European Economy, "Energy Economic Developments in Europe". DG ECFIN, European Commission.

[221] See e.g. Lessons learnt from the current energy and climate framework, Frontier Economics report prepared for Business Europe, May 2013

[222] SEC(2008) 85; http://ec.europa.eu/clima/policies/package/docs/climate_package_ia_Annex_en.pdf

One sign of the need for increased flexibility in the integration of renewable energy in the power grid, is the occurrence of negative pricing on European power markets at times of high levels of renewable powered generation[223]. Negative prices occur when, despite excess supply of electricity, utilities with inflexible generation capacity prefer to pay to sell the generated power, rather than ramp down or close their power stations. Flexibility to adjust both supply and demand for electricity, from demand side response (smart grids), flexible generation capacity, more interconnections and energy storage will help in solving this problem.

11. Renewable electricity generation (with low marginal costs) also poses new challenges for the operation of traditional "energy only" electricity markets

The low (close to zero) marginal cost of variable renewable electricity has a similar impact to that of low marginal cost nuclear power production, and also poses challenges for long term market design, as wind and solar may face the dilemma that they have high up-front investment costs, but on sunny and windy days the power price will approach zero, thus not reflecting the long-term cost of electricity production.

Some stakeholders argue that the rapid deployment of variable sources of renewable generation (rising from 2.2% in 2005 to 7% in 2011) has affected the "energy only" electricity markets' ability to provide adequate revenue streams for appropriate investments and has to a varying extent displaced flexible generation capacities (gas power).

In this context, the question arises how the necessary investment for system flexibility and back-up capacity can be maintained. The capacity mechanisms considered by some Member States as alternatives to market-based resource allocation could distort the internal market for electricity.

Moreover, large-scale electricity generation from renewable sources of energy far from consumption centres – as planned by many Member States – poses challenges in terms of electricity transport. With a grid network designed for a different distribution of power generation and consumption, this can create congestion within some Member States, sometimes also with consequences for neighbouring countries.

The implementation of Trans-European Energy Infrastructure Guidelines will help to remedy this in the long term. Decentralised and smaller scale renewables generation can also help to mitigate the problem. However, system operators' fears for grid stability are likely to increase in the short term if the development of wind and solar electricity generation continues more rapidly than grid modernisation and expansion.

In this context, it is clear that adequate, integrated smart and reliable energy networks are prerequisites for secure energy supplies to households and business alike, in a 2020 perspective and beyond.

12. Support schemes for renewable energy need to be fit for purpose and efficient. The costs of developing renewable energy have been unnecessarily increased in some cases by poorly designed support schemes.

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[223] Recent examples in Germany include: on the 16th of June 2013, on a Sunday afternoon, when the combined share of wind and solar assured more than 60% of power generation, reaching an all-time high in the country. This resulted in several hours of negative power prices (falling below -100 €/MWh in Germany and Belgium); on the 24th of March 2013, for the first time in the German EPEX market history, there were four hours of negative hourly prices during the afternoon hours, a phenomenon which has only occurred during night hours in the past. This was also the result of the simultaneously high level of wind and solar power generation that day.

The support schemes implemented by Member States have triggered strong growth that has contributed to bringing down costs of different technologies (as reported above). The broad approach to renewable energy technologies have led to the development of a range of technologies, including those that initially were much too expensive to be cost competitive.

However, the rigidity of some support schemes means that support levels have adapted only slowly to cost decreases or have not adapted to surges of installation capacity, which has resulted in strong growth and significant cost increases with resulting impacts on end-user prices of electricity or, in some instances, on Member States' public budgets. In this context, it is important to avoid overcompensation, to improve cost efficiency and to gradually adjust supports schemes in order to allow for renewable generators to respond to short term price signals and avoid subsidy dependence.

To avoid distortions to the internal energy market it is also important to improve the consistency of different national support measures and to enhance the use of the cooperation mechanisms between Member States. The national character of Member States support schemes has resulted in less cost-efficient deployment of new renewables capacity and from many perspectives work against market integration. With a future share of renewables in EU electricity generation expected to be around 35% in 2020 and 43% in 2030 also in the absence of new policies (EU reference scenario), a national approach to renewables support (such as feed-in tariffs related to production capacity on national territory rather than consumption) effectively cuts off a substantial part of the electricity market from further integration.

13. While the promotion of conventional biofuels has been successful in terms of quantities produced, it has been a costly way to achieve GHG emission reductions and there are increasing concerns on their sustainability; certainty about the long term perspectives of advanced sustainable biofuels is necessary to ensure deployment, as biofuels can be important for energy security, rural employment and renewable energy uptake in the transport sector.

In the transport sector, Member States have generally been successful in promoting the consumption of conventional biofuels produced from agricultural crops, while the development of alternative sources of renewable energy in transport such as advanced biofuels from waste, residues and algae is still in its infancy.

Biofuels were promoted in the beginning of the last decade, in a world of increasing fossil fuel prices and low agricultural prices (the EU had a set-aside policy to limit over-production). A 10% target for renewable energy in transport, predominantly from biofuels, was politically agreed as part of the renewable energy Directive and fuel quality Directive negotiations.

However, as food prices increased and in some cases spiked, biofuels became increasingly unpopular and the debate became highly polarised. The public debate on the benefits of biofuels was heated, and progress in science, while still yielding different results, lead to increasing concerns with regards to the sustainability of conventional biofuels. The truth about the benefits and impacts of biofuels is as complex as the relationships between ecosystems and climate for the entire agricultural and forestry sectors. A lesson to be learnt is that policy stability can be more important than ambitious but controversial targets.

The Commission's scrutiny of Member States' transposition of the biofuel sustainability criteria shows that there are some gaps, and legal proceedings have begun to ensure that effective sustainability regimes are in place in all Member States. At the same time, 13 "voluntary schemes" for certifying the sustainability of biofuels have been approved by the Commission, enabling biofuel producers around the world to comply with high EU standards.

The Commission and Member States' monitoring of the need for specific measures for air, soil and water protection generally find that all current EU agricultural practices obligatory under EU Common Agricultural Policy and environmental legislation apply to biofuel feedstock production. In fact, the current sustainability regimes and voluntary schemes often include requirements of good agricultural practice and so best agricultural practice for air, soil and water protection is encouraged by the schemes. However, as pressure on agricultural resources increases, it will be important to ensure protection measures in place continue to be adequate, and so the Commission will continue to monitor such impacts.

It is due to growing evidence about the indirect land use change impacts associated with crop based biofuels that the Commission proposed amendments to the Renewable Energy and Fuel Quality Directives in October 2012. Through limiting the incentives to food and feed based biofuels to current consumption levels and increasing them for advanced biofuels, the EU expects to improve the greenhouse gas emissions savings provided by the biofuels consumed in 2020.

Work carried out by the IEA (technology roadmap)[224] show that advanced biofuels are likely to become cost-competitive with fossil fuels in the medium term. Economic parity may be achieved even faster and earlier if externalities such as GHG emissions are factored in. From an environmental and resource efficiency perspective, advanced biofuels such as those made from waste and residues are more sustainable since they do not compete with food and feed production. From an economic perspective conventional biofuels are unlikely to ever reach parity with fossil fuels, because their feedstocks - which determine most of the variable costs and which are also serving the food and feed markets - will always trade at a price premium to fossil fuels. This is a key concern since for those sectors that are most reliant on renewable liquid fuels for their decarbonisation, such as aviation, economic sustainability of alternative fuels is key. Cost-competitiveness of capital-intensive advanced biofuels based on low-value biomass, however, hinges on economies of scale depending on the size of the investment to be made upfront. These economies of scale can only be reaped if investors trust that the market volume will be large enough.

Certainty about the long term perspectives of advanced biofuels is necessary to ensure deployment, and rapid adoption of the proposal will help. In this context, the Commission believes that only the consumption of advanced biofuels should be incentivised post 2020.

Some stakeholders have raised the concern that a specific target for renewables in the transport sector reduces Member State flexibility in meeting their overall target, and that it could lead to more costly attainment of the 20% target as such. On the other hand, such a target has direct impacts on the consumption of fossil fuel based transport fuels, and the EU's import dependence of oil.

7.4.4. The energy efficiency target and implementing measures

1. Significant progress has been made towards meeting the 20% energy efficiency target

Member States committed to achieving the 20% European energy efficiency target at the March 2007 European Council[225] but the target was legally defined and quantified as the "Union's 2020 energy consumption of no more than 1,474 Mtoe of primary energy or no more than 1,078 Mtoe of final energy" in the new Energy Efficiency Directive (EED)[226]. It is an EU

[224] http://www.iea.org/roadmaps/

[225] 7224/1/07, REV 1.

[226] Directive 2012/27/EU. With the accession of Croatia the target was revised to "1 483 Mtoe primary energy or no more than 1 086 Mtoe of final energy" in Directive 2013/12/EU

objective and Member States have to set themselves national indicative targets and implement a number of policy measures following a set of European Directives and Regulations.

After years of growth, EU-27 primary energy consumption peaked in 2006 at 1,706 Mtoe and has been decreasing since then to reach 1,583 Mtoe in 2011.

This shift in trend is partly due to the economic crisis and partly due to the effectiveness of existing policies such as the Energy Performance in Buildings Directive (EPBD)[227], the Ecodesign and Energy Labelling Directives[228] and their implementing regulations, and the Regulations setting emissions performance standards for new passenger cars and for light commercial vehicles[229] regulations. It is also due to the reduced energy intensity of the EU economy, which was at 144 toe/MEUR in 2011, down from 171 in 2000 and 165 in 2005.

2. Going forward, the Energy Efficiency Directive will help to ensure progress, but it is doubtful that the 2020 target will be met with current policies (even if the gap is projected to be now only 3 percentage points vs 11 percentage points projected in 2010).

The outlook for meeting the 2020 energy efficiency target was rather negative in 2011 but the adoption of the Energy Efficiency Directive (EED) in 2012 and other measures – including implementation of measures contained in the Transport White Paper, and further strengthening of the adopted Ecodesign and Labelling measures – have helped provide a more positive outlook.

Still the Commission's preliminary analysis based on energy modelling and indicative national energy efficiency targets submitted by Member States suggests that with current policies, primary energy consumption may be around 17% lower in 2020 compared to projections. There are however some grounds for expecting that a smaller gap between the target and the outcome (than 3 percentage points) is possible given that neither the modelling nor the targets submitted by Member States in 2013 assume a very ambitious application of the provisions included in the Energy Efficiency Directive and the other relevant legislation. On the other hand, unambitious implementation could also lead to a higher gap.

Following the adoption of the EED, the Commission is required to assess, by 30 June 2014, the progress made towards the 2020 target and, if necessary, to accompany this assessment with proposals for further measures.

3. Challenges in maintaining progress in energy efficiency include ensuring proper implementation and mobilising funds

A major challenge in ensuring progress so far has been to ensure proper implementation of EU initiatives at the Member State level. Delays and incompleteness of national measures implementing EU directives (e.g. some provisions of the EPBD) risk undermining agreed objectives.

Another major challenge has been to mobilise the funds needed to ensure continued progress. Constrained public budgets have accentuated the importance of leveraging public funds with private investment, in particular in the building sector. The question therefore arises how to effectively leverage public money with private investment.

The complete and timely implementation of EU legislation at the national level – in particular the transposition and enforcement of the provisions of the EED and EPBD, the Market surveillance mechanisms under the Energy Labelling and Ecodesign Directives, the

[227] Directive 2010/31/EU
[228] Directives 2009/125/EC and 2010/30/EU
[229] Regulations 443/2009 and 510/2011

implementation of the measures in the Transport White paper and the smart metering roll-out and smart grid deployment with the resulting demand response – coupled with higher use of cohesion funds and innovative financing mechanisms, will provide the necessary instruments for this change.

In addition, due to the long-lasting impact of energy efficiency measures, the current approach of looking only as far as the 2020 horizon may need to be reconsidered.

4. The 2020 target for energy efficiency has been instrumental in ensuring progress, although a relative target for some sectors might better reflect the structural dynamics of the EU economy

The Commission's experience so far is that a quantified target for energy efficiency has provided political momentum, guidance for investors and a clear mandate for the Commission to come forward with proposals to ensure progress, such as the EED.

However, an absolute consumption target (as specified by the EED) does not explicitly take changes of economic activity over time into account. While an absolute target for 2020 better ensures meeting a certain ambition level, a relative target (such as energy consumption relative to GDP, e.g. energy intensity) would better reflect the structural dynamics of the EU economy. A "mixed" target could also be an option (absolute for those sectors where energy consumption is less dependent on economic activity, such as buildings, and relative for those sectors, such as industry, where these two elements are more closely correlated).

5. Energy efficiency measures are expected to contribute to some reductions in GHG emissions by 2020, in particular in the non-ETS sectors.

Measures to achieve the 20% energy efficiency target in 2020 are intended to be complementary to, as well as to provide support for the greenhouse gas reduction target, in particular in non-ETS sectors[230].

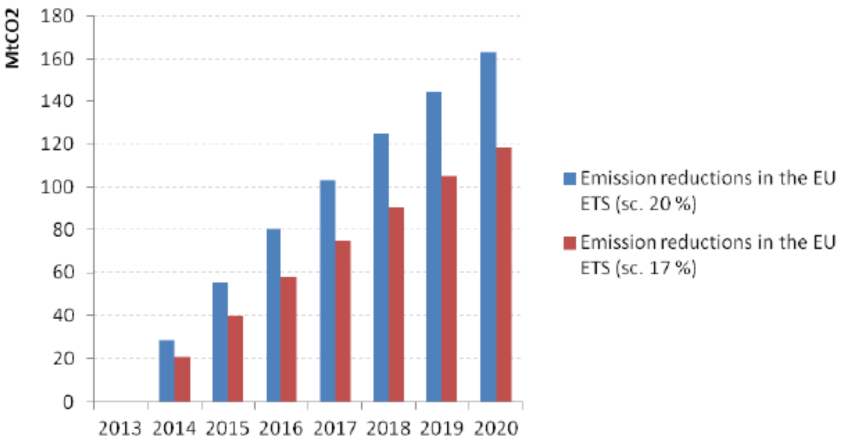
The Impact Assessment of the Energy Efficiency Directive concludes that achieving the 20% energy saving target will result by 2020 in GHG emission reductions compared to a 2009 (PRIMES) baseline ranging from -10% in the case of the Baltics to -21% in the case of Mediterranean Member States (with the Nordic countries, Central and Eastern Europe and Western Europe all registering GHG emission reductions within that range).

According to estimates[231], the additional binding measures in the EED and the Transport White paper would correspond to around 500 MtCO2 emissions' reduction by 2020 (see Figure below), which represents 10% of the 5 GtCO2 emission reduction target envisaged by the Climate & Energy Package. This corresponds to about a quarter of the possible impact of the renewables target on consumption (of 2 GtCO2 corresponding to 40% of the reduction target). The extent of additional emission reductions depend on the extent of the incidence of the efficiency measures in ETS or non-ETS sectors.

Figure 22: EED and Transport White paper annual reduction impact on CO2 emissions

[230] IA EED, SEC/2011/779

[231] "Energy Efficiency, Renewable Energy and CO2 Allowances in Europe: A Need for Coordination", Climate Brief, no. 18, CDC Climat Research, September 2012.



Source: "Energy Efficiency, Renewable Energy and CO2 Allowances in Europe: A Need for Coordination", Climate Brief, no. 18, CDC Climat Research, September 2012.

6. Some energy efficiency measures, notably those impacting electricity consumption, have the potential to drive down the carbon price and to make the achievement of GHG emissions reductions more costly than they would otherwise be. However, the current surplus of allowances in the ETS is largely driven by other factors.

Measures to promote energy efficiency (and renewable energy) can lower the carbon price by weakening the demand for emission allowances in the ETS. Furthermore, at very low levels of the carbon price, short term emission reductions can be carried out cheaply via the purchase of allowances. And any extra measures taken to reduce emissions further, be they investments in renewable energy, energy efficiency measures in transport or housing, will in relative terms be more costly. With a low carbon price, investments in such measures are therefore difficult to justify for delivering short term emissions reductions.

The authors of an EP study on energy efficiency and the ETS[232] highlight that covering the same activities by two instruments can amount to double regulation, thereby blurring the carbon market signal, and making the achievement of GHG emissions reductions more costly than they would otherwise be "whilst under the ETS, firms can optimise their investment over the longer term – they have a choice between investing and buying allowances – under the EED they are forced to apply technological solutions to comply with the regulation. This may be in conflict with the optimising investment over the longer term".

Modelling exercises carried out in preparation of the Commission's EED were not conclusive regarding possible impacts on the price of ETS allowances[233]. In terms of additional costs to the total energy system, these were projected to rise by between 2.6% and 4.7% compared to the reference scenario in a 2020 perspective. In the longer term, these investments will reduce system costs due to the corresponding reduction in fuel costs. Electricity price increases in the short term directly resulting from increasing energy efficiency (due to the need to finance the fixed costs of energy efficiency measures) were however projected to be negligible. In conclusion, the additional costs of achieving the overall 20% target through the set of measures proposed were considered to be proportionately small.

[232] Energy Efficiency and the ETS, European Parliament, 2013

[233] The E3ME model run projects a drop to zero of the ETS price in 2020 whereas the PRIMES scenarios project a much lower impact (a reduction from €16.5/t to €14.2/t in 2020). This lower ETS price impact until 2020 in PRIMES is explained among other things by a higher share of modelled measures with GHG reductions materialising in non-ETS sectors, and the assumption of full market foresight and an unlimited ETS banking flexibility until 2050.

This said, in the EED, the Commission committed itself to monitor the impact of the new energy efficiency measures on Directive 2003/87/EC establishing the EU's emissions trading directive (ETS) in order to maintain the incentives in the emissions trading system rewarding low carbon investments.

There is thus recognition in the EED itself that energy efficiency measures could have some impacts on the ETS price. According to the report prepared for the European Parliament on interactions between the EU energy efficiency policy and the ETS[234], the impact very much depends both on the market fundamentals and the market expectations, the latter being "particularly important in the EU ETS as opposed to other markets as it is a market created by governments. As a result, the market tends to react very strongly on actual or perceived government policy changes".

Thus the authors explain some of the sudden and significant changes of the ETS price which have been witnessed in the past (such as a 20% fall in June 2011) as resulting from market perceptions of how willing politicians and regulators are to intervene in the market, rather than to the real effect of interventions.

They however conclude that the ETS price is only to a limited extent affected by actual or potential interactions between the EU energy efficiency policy, including the EED, and ETS. The EU ETS covers around 40% of GHG emissions (mainly electricity production and consumption and energy intensive industry) while EU and Member State policies directed at energy efficiency in principle aim to a significant extent at the other 60%, i.e. the ‘effort sharing’ sectors buildings, land transport and small industry. Hence, the interactions between the ETS and energy efficiency measures can be limited.

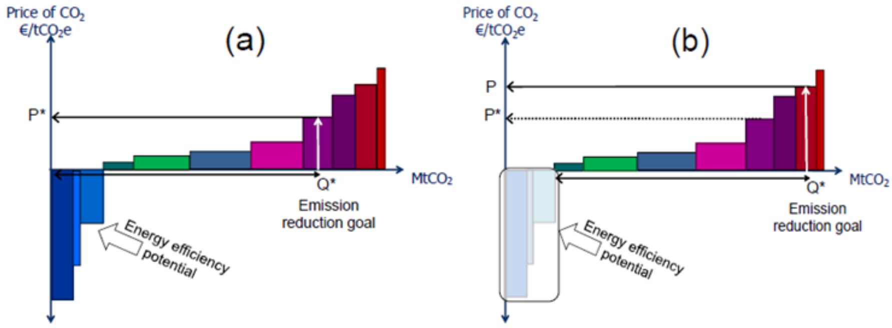
7. ... on the other hand, if cost-effective energy efficiency opportunities are not exploited, a higher carbon price is needed to deliver the same level of emissions reductions...

On the other hand, the IEA[235] argue that if cost-effective energy efficiency opportunities are not exploited, a higher carbon price is needed to deliver the same level of emissions reductions, increasing the cost of the policy response (in Figure 23 below, the carbon price required is increased from P* to P if energy efficiency is left untapped).

234 Energy Efficiency and the ETS, European Parliament, 2013

235 Summing up the parts: Combining Policy Instruments for Least-Cost Climate Mitigation Strategies, IEA, 2011

Figure 23: Ignoring energy efficiency potential can lead to higher carbon price



Source: IEA, 2011

The IEA considers that even if technology deployment policies increase costs in the short-term, their purpose is to deliver significant reductions in the cost of new technologies over the coming decades, with the goal of significantly lowering the long-term cost of achieving deep emissions reductions.

8. Specific efficiency measures are also necessary to correct certain market and behavioural failures which a carbon price alone will not correct

(See point 9 of Section 7.4.2 on the GHG target).

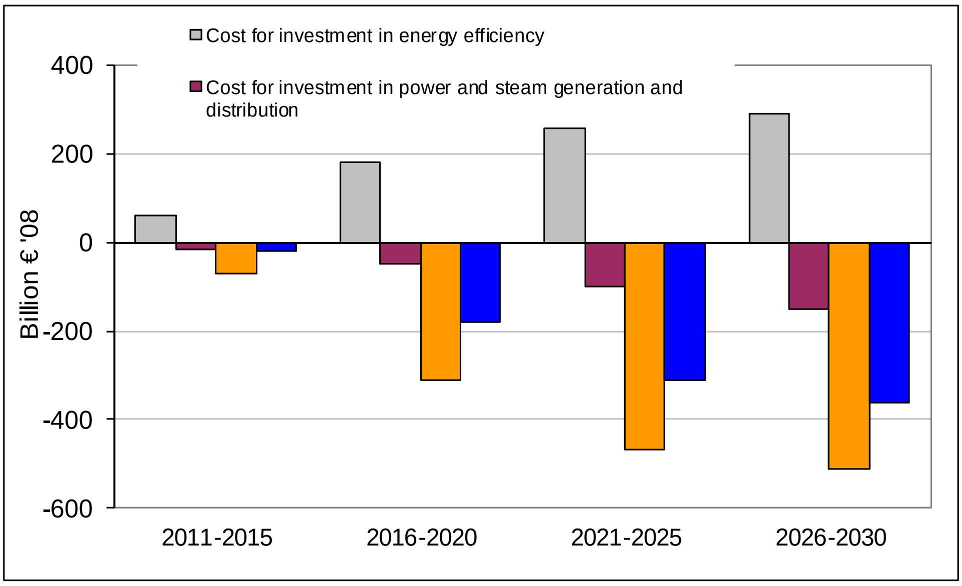
9. Energy efficiency measures can positively contribute to energy security and competitiveness

An evaluation of the impact of the Energy Efficiency Directive[236] revealed that increased costs due to investments in energy efficiency of €24 billion annually would be offset by reduced costs in terms of investments in energy generation and distribution amounting to an average of €6 billion annually and reduced fuel expenditure amounting to an average of about €38 billion annually as a result of lower demand. Given the large amount of imported fuels, this also reduces the import bill for fossil fuels and related energy security issues considerably.

The overall effect on the GDP compared to a baseline scenario would be a gain of €34 billion and employment is projected to increase by 400,000 jobs. These figures will need to be validated by ex-post assessments once the policy framework is mature enough.

236 Non-paper of the Services of the European Commission on the Energy Efficiency Directive, Informal Energy Council, 19-20 April 2012. The estimates were performed using the E3ME and PRIMES models.

Figure 24: Estimates of direct and avoided costs linked to the implementation of the Energy Efficiency Directive



7.5. Summary report on the analysis of the debate on the green paper "A 2030 framework for climate and energy policies"

On 27 March 2013, the European Commission adopted a Green Paper on "A 2030 framework for climate and energy policies"[237].

This document launched a public consultation that lasted until 2 July 2013, allowing Member States, other EU institutions and stakeholders to express their views. The aim of the Green Paper was to provide impetus to the on-going debate and to consult stakeholders in order to obtain evidence and insights to support the development of the 2030 framework for energy and climate policies.

The Green Paper begins with an overview of the current framework for climate and energy policies and what has been achieved, followed by an outline of the issues where stakeholder input is sought. The experience and views of stakeholders are important in the following five areas: lessons learned from the current framework; targets; other policy instruments; competiveness; and the different capacity of Member States and consumer groups to contribute to the transition towards a competitive, secure and sustainable low carbon energy system and economy. The 2030 framework must draw on the lessons learned from the current framework, backed up where possible with sound evidence, and identify where improvements can be made. The 22 questions of the green paper revolved accordingly around five main themes:

- Which lessons from the 2020 framework and the present state of the EU energy system are most important when designing policies for 2030?
- Which targets for 2030 would be most effective in driving the objectives of climate and energy policy?
- Are changes necessary to policy instruments and how they interact with one another, including between the EU and national levels?
- Which elements of the framework for climate and energy policies could be strengthened to better promote competitiveness and security of supply?
- How should the new framework ensure an equitable distribution of effort among Member States?

The replies to this consultation will be an essential part of the Impact Assessment for the Commission's preparations for more concrete proposals for the 2030 framework by the end 2013.

7.5.1. Process and quantitative results of the Public Consultation

Process of the public consultation

The public consultation lasted from 27 March 2013 until 2 July 2013. A dedicated web page including the link to the Green Paper was created.

The consultation process took place in parallel with discussions with other EU institutions and public events organised during this period through various forums. The following general groups responded to the consultation: Member States, national parliaments, citizens, companies, various stakeholder groups, and representatives of civil society such as non-governmental organisations, trade unions, and business and consumer organisations.

[237] COM/2013/0169 final, http://ec.europa.eu/energy/green_paper_2030_en.htm

The Commission participated in a number of events to promote the consultation process. In addition, a High-Level Stakeholder Conference was organised on 19 June 2013 in Brussels, with Commissioners Oettinger and Hedegaard present. The results of all events at which the Green Paper and its follow-up actions were discussed were taken into consideration in preparing this report.

Box 3: High Level Stakeholder Conference: A 2030 framework for Climate & Energy Policies

> The Commission organised a full-day high-level conference to share opinions on the 2030 climate and energy framework with the stakeholder community. The agenda was defined in a way to encourage a constructive debate and multiple interactions between stakeholders and the public.
>
> Welcome and introductory speeches were given by DG ENER and DG CLIMA, the Irish Government and by the Chair of the EP Committee on industry, Research and Energy of the European Parliament.
>
> The first session was dedicated to the lessons learned in view of achieving 2020 targets and targets for 2030, chaired by the European Environment Agency. The panel was composed of representatives from Eurelectric; Climate Action Network Europe; the Institute for Structural Research (IBS), BusinessEurope and the European Renewable Energy Council (EREC).
>
> The second session was dedicated to competitiveness and security of supply, chaired by DG ENER. The panel was composed of representatives from Dow Benelux B.V., Dong Energy, The Council of European Energy Regulators (CEER), the European Climate Foundation and the European Alliance to Save Energy (EU-ASE).
>
> The third session was dedicated to instruments and distributional aspects, chaired by DG CLIMA. The panel was composed of representatives from the Centre for European Policy Studies (CEPS), the French Ministry for Ecology, Sustainable Development and Energy, the Italian Ministry of Economic Development and the Energy Ministry of Lithuania.
>
> Connie Hedegaard, European Commissioner for Climate Action, and Günther Oettinger, European Commissioner for Energy drew the final conclusions.
>
> A video recording of the stakeholder conference is available at the following website: https://scic.ec.europa.eu/streaming/index.php?es=2&sessionno=96b250a90d3cf0868c83f8c965142d2a

This report summarises the responses to the Green Paper. It is available, on the web page[238] of the Green Paper, together with the contributions received.

Methodology

A thorough analysis of the contributions was carried out, using an approach which allowed for a precise evaluation of the opinions of contributors, as described below.

The analysis was carried out separately on each of the five main priority areas of the Green Paper and its respective questions. All contributions were analysed in a large matrix subdivided into these priority areas, and in turn, each question was analysed separately. Each contribution was compared with the Green Paper text, noting positive or negative comments. New ideas, which emerged and could help the Commission for further policy design, were specifically highlighted. For clarity, this report has been structured following the outline of the Green Paper.

[238] http://ec.europa.eu/energy/consultations/20130702_green_paper_2030_en.htm

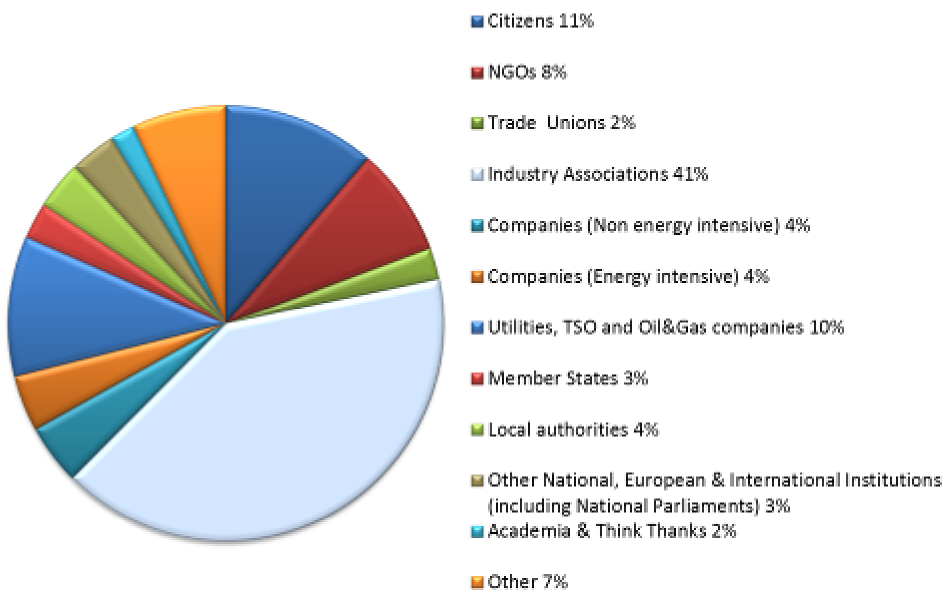
Quantitative results of the consultation

In total 557 responses were received. The consultation registered a strong participation from industry associations and private companies, with 41 % of overall replies from Industry Associations. 10% of replies came from energy utilities, transmission system operators and oil and gas companies, and another 8% from other private companies, with a balanced representation between energy intensive and non-energy intensive companies.

The consultation also registered a strong participation from civil society: 8% of overall replies came from NGOs, mostly European environmental organizations, whereas trade unions accounted for 2% of replies. Private citizens represented 11% of the received replies.

A number of public authorities have also responded to the consultation. 15 Member States have submitted official statements[239]. Along with Member State contributions, several national parliaments have reacted to the Green Paper. Several regional and local authorities have also responded, representing a significant share of overall respondents (4% of the total). Other national, European and international institutions and public agencies represented 3% of total replies.

Figure 25: Stakeholders profiles – Based on 557 replies



Geographical distribution

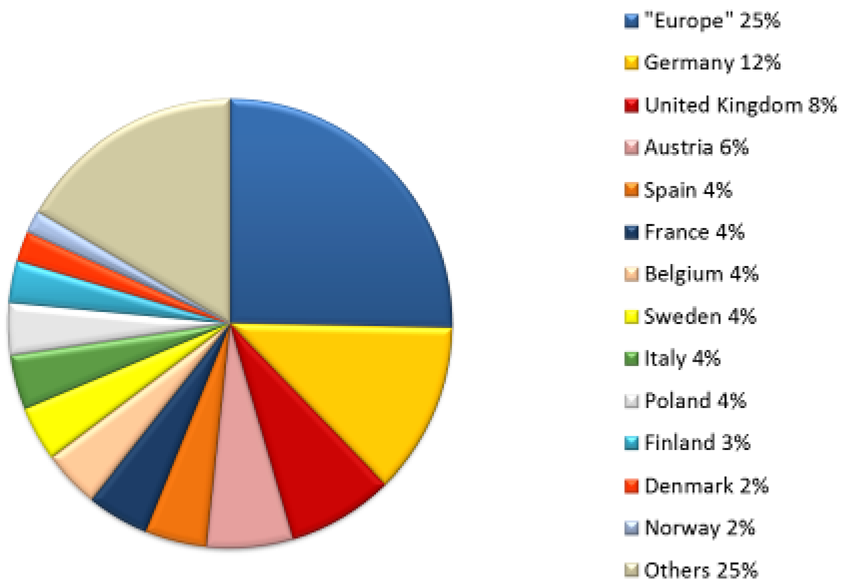
[239] This analysis considers as Member States official replies statements expressed either by central Governments or sent by single national Ministries. Some Member States also underlined that their submission may not fully reflect the final position of their Government.

Regarding the geographical distribution of replies, European umbrella associations and institutions represent the highest share of responses (26% of all replies).

At the Member State level, stakeholders from the biggest Member States are generally well represented: Germany (12%), United Kingdom (8%), France (4%), Spain (4%), Italy (4%), Poland (4%).

A relatively strong participation can be noted from Austria (6%), Belgium (4%) and the Nordic countries (Finland, Denmark and Sweden accounted for more than 9% of overall replies) whereas Norway represents the highest participation among non-European countries (2 % of overall replies).

Figure 26: Stakeholders geographical distribution –Based on 557 replies



7.5.2. Qualitative assessment of the consultation and main findings

From the public consultation responses a number of general conclusions can be drawn.

Stability, predictability and coherence

Stakeholders are asking the EU to provide direction on what policies will follow the 2020 agenda for climate and energy. The definition of a new framework should reduce uncertainty among investors, governments and citizens, further contributing towards growth and jobs in Europe while promoting sustainability, competitiveness and security of supply. It is frequently pointed out that the EU needs to continue working on its longer term climate objectives with a coherent set of instruments and needs to secure greater commitment from other major emitters.

More Europe

Throughout the consultation, there was a strong support for the development of a common European energy policy. National energy and climate policies are often seen as fragmenting the market and thus creating unfavourable conditions for companies and investors, whereas common EU policies have the potential to create a level playing field for companies and investors alike. The EU Emissions Trading Scheme (ETS) and EU legislation on the Internal Energy Market are seen as two central aspects for future EU climate and energy polices. From

the consultation there clearly emerges the role of a renewed *EU energy infrastructure to coordinate and optimise network development on a continental scale.* An integrated European infrastructure is perceived as a fundamental tool to ensure that European citizens and businesses have access to affordable energy.

Decarbonisation efforts and the ETS should remain at the centre of EU energy and climate policy

There is a very broad consensus that climate change should remain at the core of EU policies and the need for a 2030 greenhouse gas (GHG) emissions reduction target is widely accepted. Almost all stakeholders agree that this target should remain central in the 2030 framework. Most stakeholders also have the opinion that the ETS should remain the major instrument for the transition to a low carbon economy and in particular to reach the GHG emissions reduction target. Some stakeholders also bring up the importance of strengthening the Effort Sharing Decision[240]. Many stakeholders agree that additional policies and instruments can be utilized to reduce emissions for non-ETS sectors, such as EU-wide product performance standards for cars and appliances, or policy to lower emissions of existing buildings, via increased energy efficiency. Overall, stakeholders note that in order to decarbonize in the most cost-efficient way, a balance between EU wide instruments and flexibility provided to Member States needs to be reached.

More focus on competitiveness and security of supply

Stakeholders clearly emphasised the need for climate and energy policy to continue to take into account the three common goals of security of supply, competitiveness and sustainability. Many Member States and stakeholders stress that EU climate and energy policy should give greater consideration to the consequences of the on-going economic crisis and international developments, in particular their potential adverse effects on competitiveness. As Europe has a prominent industrial base and needs to strengthen it, the energy system transition should avoid adverse impacts on competitiveness, especially since energy remains an important cost factor for energy intensive industries. At the same time, climate and energy policies could also give a boost to economic growth by helping retain Europe's leadership position in low-carbon industries such as renewables and efficient equipment providers and by limiting energy costs via increased energy efficiency and reduced dependence on imported fuels.

Adopt a cost-effective approach

From the consultation replies a general concern emerges about the increasing cost of some climate and energy policies, in particular related to the support of renewables from Member States and stakeholders alike. There is a general consensus that many public support schemes have to be revised in order to be more in line with changing costs of deploying renewables. Many contributions also suggest that public support schemes should be revised in order to establish a more technology neutral approach.

Security of energy supply

Many stakeholders agree that Europe should further diversify its energy supply sources and routes, though there is no consensus on the sources with some stakeholders focusing on shale gas, while others note that focus should be on indigenous renewables resources and energy efficiency. The EU needs to take a strong, effective and equitable position on the international stage to secure the energy it needs, while promoting free and transparent energy markets and

[240] The Effort Sharing Decision establishes binding annual GHG emission targets for Member States for the period 2013–2020. These targets concern emissions from sectors not included in the EU Emissions Trading System (EU ETS), such as transport (except aviation), buildings, agriculture and waste.

contributing to greater security and sustainability in energy production and use worldwide. Some stakeholders see climate and energy policy as key in support the development of local renewable resources that would increase the security of supply by reducing dependence on imported fossil fuels.

The Internal Energy Market

The benefits of the internal energy market were broadly recognised. The completion of the internal market for energy is seen as a key strategy for minimising the cost of energy and securing supply. To tackle Europe's energy and climate challenges and to ensure affordable and secure energy supplies to households and businesses, the EU should ensure the competitive, integrated and liquid functioning of the internal energy market, in order to provide a solid backbone for electricity and gas flowing where it is needed. The vast majority of stakeholders also stress that its completion through a *higher rate of interconnections,* including smarter infrastructures, should be a crucial aspect for EU climate and energy policies. Infrastructures fully integrated in the energy system will reduce the costs of making the low-carbon shift in particular through integrating renewable energy sources (RES), through economies of scale for individual Member States, in addition to improving security of supply and helping to stabilise consumer prices by ensuring the distribution of electricity and gas throughout Europe.

Innovation

To support European climate and energy policies, there is a common vision among stakeholders that the EU’s energy technology and innovation policy needs to deliver on reducing costs rapidly and speeding up the introduction of new sustainable technologies to the market. There is a need to accelerate developments in cutting-edge technology and innovation, as well as speeding up market deployment. A greater focus on innovation is seen as essential to ensure the flexibility and security of the European energy system and to further develop a portfolio of cost-effective and sustainable energy options.

On the basis of this summary of the main messages emerging from the consultation, the following Sections focus on the detailed stakeholder views for the specific issues raised by the Green Paper.

7.5.3. Which lessons from the 2020 framework and the present state of the EU energy system are most important when designing policies for 2030?

The various stakeholders draw different conclusions on the lessons learned from the 2020 framework. There is an overall agreement that a clear framework going forward is needed to give clarity to the economic actors but nonetheless there are divergent views of changes that need to be implemented based on past experience.

Competitiveness

From the consultation it emerges that many stakeholders, including *Member States*, ask for increased focus on competitiveness due to the economic crisis and changing international circumstances such as shale gas development in the USA. *Industrial organizations*, *energy intensive representatives* and *oil* and *gas companies* as well as some *citizens* agree that there is need for better coordination of the three energy policy objectives: security of supply, competitiveness and sustainability to ensure that all are given equal attention.

Many *business organizations* and *energy intensive companies* point out that the EU has not been successful in securing an ambitious international climate agreement, which should be a priority in the 2030 framework as unilateral actions would hurt European competitiveness and would lead to export of jobs and growth abroad. Many of these entities also underline the

importance of ensuring competitively priced energy in the EU. In part due to the fact that the EU represents a decreasing part of global emissions and energy consumption, several *Member States* note that it is crucial to secure comparable international commitments on reducing emissions.

NGOs, part of the academia and many *non-energy intensive companies* emphasize that the 2020 framework, with clear commitments, led to green growth and job creation in Europe. *NGOs* point out that the renewable energy sector has been resilient to the recession. Some *non-energy intensive companies* also argue that progress was made in international commitments that would not have occurred without European leadership.

GHG target and the ETS

There is an overall consensus among stakeholders that the ETS should remain the central instrument of the 2030 framework, as it is market driven and the cost-efficient way to lower emissions, although a number of stakeholders have emphasized the limits of the current design of the ETS. The ETS is seen as a technology neutral EU instrument that should give a credible signal for reducing emissions.

Many stakeholders note that the ETS has had difficulties in giving a strong and clear price signal. In line with this view, several *think tanks* argue that GHG reductions have been mostly driven by the economic crisis and RES support schemes. *NGOs* insist that the 2020 framework should have been more ambitious for both the ETS and the non-ETS sectors. They, together with many *trade unions*, call for the cancellation of international credits under the ETS and the Effort Sharing Decision (governing the non-ETS sectors) to instead focus on domestic action. Even with a robust ETS, *companies* and *organisations in the renewables sector* note that additional support will be needed to get pre-commercial technologies to the market.

On the other hand, *industrial organizations and energy intensive industries* argue that the ETS is functioning properly and the current low prices are the result of lower demand resulting from the economic crisis, the growth in RES and use of international offsets. *Utilities* stress that while the ETS has not been flexible in responding to changing circumstances, it did create a liquid market for carbon.

Renewable Energy

Several stakeholders note that the large deployment of RES has been costly and, in some cases, has led to market distortions. Many stakeholders also bring up that insufficient interconnections and grid reinforcement hindered RES integration.

The *energy intensive representatives*, *power sector representatives*, some *utilities* and part of *academia*, argue that the RES support schemes have distorted the energy market and led to issues with integrating the variable renewables in the market. In their opinion, a technology specific approach to RES is too costly as more cost-efficient technologies to reduce carbon emissions from the energy sector get displaced. In addition, many of these actors argue that RES policies undermine the effectiveness of the ETS by depressing the carbon prices.

From a different perspective, some *industrial organizations as well as some think tanks* acknowledge that Europe has become a leader in low-carbon technologies. *Renewable energy* and *non-energy intensive companies* and *NGOs* point that legally binding targets have been successful in bringing the costs of renewable technologies down and in overcoming administrative, economic and market barriers. They nonetheless recognize there has been overcompensation in many national support schemes and ask for this to be resolved through adapting the support schemes as technologies become more mature.

Energy Efficiency

As regards energy efficiency, a variety of stakeholders, including *industrial representatives* and *NGOs,* note that the 2020 framework did not manage to reduce energy consumption and GHG emissions in the building sector despite the large potential.

Several stakeholders, including *NGOs*, *green* and *non-intensive industries* and *trade unions* highlight the positive impact of energy efficiency in terms of security of supply, competitiveness and growth. These nonetheless point that its non-binding nature has reduced the chance to meet the energy savings target.

Some *Member States* note that the Energy Efficiency Directive[241] was established only in 2012 and that progress made will be assessed during the 2014 revision. From their perspective, it would be therefore be premature to set new targets before that date, a view shared by some *utilities* as well. Several *Member States* point out that there are some good policies related to energy efficiency such as a wider use of EU-wide performance standards that could help unlock energy efficiency potential.

Industrial organizations and *energy intensive companies* stress that what they consider an overlap between ETS and some energy efficiency policies is costly for industries and should be removed. For non-ETS sectors, they propose a bottom up approach in determining potential energy efficiency commitments.

Fragmentation and overlapping policies

General business organizations and *energy intensive companies* as well as *utilities* note that what they consider being overlapping targets for energy efficiency, RES and GHG has distorted the effectiveness of the policies, put additional administrative burden on businesses and increased costs. A large part of these stakeholders note that a single approach for the climate framework based on a single target is needed.

NGOs typically argue that there is a certain lack of coherence due to overlooking the interactions between the different policies; however they note that a three-target approach is good as they complement each other and ensure broader progress in the energy sector. Some *non-energy intensive companies* add that a proper impact assessment of interactions between overlapping policies could make them more coherent.

Many *industrial stakeholders* also note that national policies on RES support and energy efficiency measures need to be harmonized. *Renewable energy companies* support convergence of RES support schemes but argue that Member States should retain some control to adapt the instruments based on national circumstances. *Industrial stakeholders* warn that national initiatives such as the introduction of national carbon tax could further distort market signals and hinder integration. On the other hand, *Member States* stress that it would be crucial for them to retain the flexibility of achieving their reduction targets outside the ETS in order to better adapt their policies to national circumstances.

7.5.4. Targets for 2030

Which targets for 2030 would be most effective in driving the objectives of climate and energy policy? At what level should they apply (EU, Member States, or sectoral), and to what extent should they be legally binding?

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241 Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.

With few exceptions, there is a consensus that a GHG emission reduction target should be set within the 2030 framework. As far as other targets are concerned positions voiced by stakeholders followed two main lines of thought. Some stakeholders ask for a revised approach to 2030, in particular with regards to target-setting for RES and energy efficiency. On the other hand, others stress the importance of setting clear targets in all areas of the long term framework in order to ensure a stable investment environment in the energy sector, foster competitiveness in low carbon industries and keep the lead in the international negotiations.

Box 4: Main positions on targets among Member States having responded to the consultation[242]

All Member States that participated in the consultation are in favour of a *GHG reduction target for 2030*. Some Member States make such support conditional to a thorough analysis of impacts. Denmark, France, the United Kingdom and Spain are favourable to a binding target of 40%; Poland argues that the decision to adopt an objective for 2030 should be taken no earlier than in 2015; the Czech Republic would accept a more ambitious objective only in the case of a global agreement; Romania considers a 2030 target should be seen in the context of real climate action by third countries; Lithuania makes such support conditional to a thorough analysis of impacts and states that such a target should consider efforts by other major economies; Finland and the United Kingdom propose a dual emissions' reduction target for 2030 in the context of global negotiations with the UK proposing a 50% target in case of satisfactory international agreement; Cyprus supports less binding targets; Malta agrees with a GHG target in line with the 2050 roadmap, but also notes that international negotiations outcome should be considered.

On Renewables, Denmark is in favour of a 2030 target; Lithuania supports an RES target, set following a thorough assessment of impacts on industry sectors and individual Member States; Austria is strongly in favour provided the system security and social dimension is taken into account; Finland calls for an indicative or moderately binding target; France calls for a renewables target to be fixed at a later stage based on a partial harmonisation of support schemes and reflection on how to integrate renewables in the system; Portugal is open to a target, subject to more use of cooperation mechanisms; Estonia is ready to support a renewable target if the EU-level action provides substantial added value, following a cost-benefit analysis; Romania advocates a renewables' target set by the Member States; Malta proposes a RES investment target tied to GDP per capita; the United Kingdom and the Czech Republic are explicitly against setting targets for renewables.

On *Energy Efficiency*, Denmark and Portugal are in favour of a 2030 target; Estonia is ready to support energy efficiency targets if the EU-level action provides substantial added value; Lithuania envisages a target for energy efficiency related to energy intensity subject to a thorough impact assessment; France is open to a European target as a complimentary addition and to be fixed at a later stage with a new definition of energy intensity; Finland is favourable to an indicative EU energy efficiency target; Romania would be open to an overall aspirational target; Malta does not explicitly address energy efficiency, but say that Member States should have flexibility to decide on the mix of how to reduce GHG emissions; Austria and Cyprus would prefer to postpone discussions on energy efficiency until after 2014; the United Kingdom and the Czech Republic are explicitly against a mandatory energy efficiency target.

Other targets: Portugal advocates an intermediate target as regards the physical implementation of an Internal Energy Market (target for minimum interconnections between Member States) whereas Spain is proposing a binding interconnection target (10%). Romania advocates that targets should pursue also the objectives of security of supply and competitiveness. Lithuania asks for appropriate

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242 These contributions can be found under "public authorities" on: http://ec.europa.eu/energy/consultations/20130702_green_paper_2030_en.htm.

EU indicators for energy infrastructures' development, research and experimental development.

Greenhouse Gas Target

Whereas *Member States* are divided on the target approach (as illustrated in Box 4.), there is a general agreement on the need to set a new EU-wide GHG emissions reduction target. Further discussions will be necessary in order to establish a common view among Member States on other targets for 2030.

NGOs specifically highlight the cost of non-action or delayed action and the positive contribution of a low-carbon energy transition to future sustainable economic growth. Therefore they are generally asking for a more ambitious GHG target. They mostly suggest an ambitious target for GHG reductions of 40-60% with some are proposing a target for 2030 of up to 80% GHG reductions compared to 1990.

An important share of *European business organisations* believes that Europe has to put cost-competitiveness, security of supply and climate objectives on a more equal footing. Whereas there is general consensus that the EU should set a 2030 emissions reduction target to incentivise investments in low-carbon and energy-efficient technologies, there is no agreement on the other targets As regards GHG, parts of European industry clearly advocate a 40% reduction target, whereas others just indicate that, when deciding on the most appropriate level of ambition, the EU should first discuss it with Member States and business stakeholders and take into account the outcome of the international negotiations to avoid the negative consequences of unilateral decisions.

Utilities and the *power sector* (in line with their respective *business organisations*) are generally favourable to a single economy-wide EU GHG emissions target in line with the 2050 Energy Roadmap[243]. In their perspective, a target of 40% reduction against 1990 levels is generally considered in line with the reductions needed to achieve an 80-95% reduction by 2050. They also note that the 2030 framework has to be decided as soon as possible to provide regulatory certainty. In the same perspective, *oil and gas* companies generally support a single GHG target, with gas companies mostly favoring an ambitious target of 40%.

An important share of *energy intensive industry* associations also support this vision and are mostly only favourable to a top-down climate target under the condition of the establishment of a substantial global agreement with comparable burdens for industry worldwide. An important part of the same industry fears that legally binding targets would prevent the EU from adjusting its policy to changing economic circumstances. Any agreement on GHG reduction targets for 2030 should be conditional on a global agreement. Part of the *energy intensive industry* is rather asking for a relative/flexible target for industry allowing for economic growth.

Non-energy intensive companies and *trade unions* advocate for an ambitious GHG target that would provide green stimulus to the growth in the EU. Both stakeholders' groups are generally positively inclined toward a 40% GHG emissions reduction target for 2030.

As far as citizens are concerned, views are very mixed, and although they tend to be divided on the need for further targets, there seems to be a general agreement on at least a new GHG target.

Renewable Energy Target

[243] Communication "Energy Roadmap 2050" COM/2011/885

As mentioned in the previous Section, there is no consensus among respondents on whether RES and energy efficiency targets for 2030 should be established.

In addition to the *Member States'* positions provided in the previous Section, it can be noted that the *renewables industries, NGOs, local and regional authorities and trade unions* are mostly in favour of an ambitious and more comprehensive framework, irrespective of action in third countries. From their perspective the EU should continue a multiple and mutually supportive targets approach, which is seen as the most effective framework. Several *NGOs* and *RES representatives* argue that the RES target should be set at 45% for 2030.

Renewables associations and *non-energy intensive companies* are generally supportive of *three targets* with a strong level of ambition both concerning the renewable and the energy savings targets. In the same vein, *NGOs* generally ask the EU to agree on a set of ambitious, legally binding targets that could provide investment security for economic actors and reduce the costs of financing. European *trade unions*, while emphasising the importance of the social dimension of climate and energy policies, are generally in favour of a strong legal framework with binding quantitative targets for renewable energy, GHG emission reductions and energy efficiency, also stressing the importance of the workplace as a potential driver for energy efficiency.

Some *institutional investors* also emphasize the fact that an EU-wide approach and binding RES target would incentivise private sector investments in low carbon technologies.

On the other hand, many other stakeholders and in particular *industrial associations* believe that, due to their overlapping scope with the EU ETS, the EU targets for energy efficiency and RES should not be continued after 2020 or should be defined as second-level targets. Some *energy intensive industrial consumers* are in favour of a moderated combined RES-Carbon Capture and Storage target for 2030.

In the same vein, some *utilities* and the *power sector* generally advocate against renewable energy and energy efficiency targets and state they should not be considered on an equal footing with the GHG target. From their perspective, if developed, these dimensions should rather remain indicative and contribute to achieving the overall objectives of emission reduction, security of supply and competitiveness. Other *utilities* opine that legally binding RES and energy efficiency targets should be set as they have proven effective in promoting investments and enabled cost reductions through the scaling of RES.

Energy efficiency target

More specifically on the question of having an *energy efficiency target*, some companies fear that an absolute energy consumption cap would threaten growth perspectives. *Property owners* are also particularly sceptical and some of them advocate that the 2030 framework should include EU-wide benchmarks rather than binding targets in order to leave significant flexibility to Member States for an adaptation to the national context. A wide group of stakeholders, including also some *Member States*, propose that the energy efficiency target should be related to energy intensity rather than absolute energy consumption.

Conversely, a majority of European *NGOs and non-energy intensive industries* claim that the setting of an ambitious, binding 2030 EU target for energy savings would send a clear signal to investors and lower perceived risks, thereby reducing the costs of financing, while providing flexibility to Member States for the development of specific measures. *NGOs* propose targets between 30% and 50%.

Other targets

During the consultation a number of proposals on possible alternative targets emerged. Most of the proposals revolve around the objectives of competitiveness, security of supply and physical infrastructure.

A *number of industry associations* are also asking for an introduction of sub-sectoral targets that will also be illustrated in Section 7.5.4 which discusses the question *' Are targets for sub-sectors such as transport, agriculture, industry appropriate and, if so, which ones? For example, is a renewables target necessary for transport, given the targets for CO2 reductions for passenger cars and light commercial vehicles?'.*

At what level should the targets apply?

Stakeholder views on this question are varied and mostly relate to the target or set of targets proposed. There is consensus around the question of defining a GHG target at the EU level, broken down into ETS and national non ETS targets (for a discussion on extending the scope of the ETS, see first subsection in Section 7.5.5). As regards to the other two targets, positions are very differentiated. Stakeholders that are in favour of RES and energy efficiency targets are generally open to a dual level approach, with EU and national targets, recognizing the importance of assuring a higher level of flexibility to Member States; while those not in favour of such targets generally do not indicate how they consider that such targets should be met, were they to form part of the 2030 framework.

The *RES industry* is generally in favour of EU level RES targets to be broken down at national level as under the current framework. From their perspective a sole EU target with an EU wide harmonised support mechanism, would limit Member States' flexibility to meet their targets and would lead to the concentration of RES in the most mature markets creating unbalanced costs and public acceptance issues in these countries. Part of the same industry suggests that EU RES target should be made binding upon effort sharing calculation taking into account RES penetration levels and specific economic conditions.

Some other stakeholders also stress that RES and energy efficiency targets should be broken down at national level, based on indicative targets. Others argue for a more Europeanised approach to meeting such targets that would be less distortive to competition and market integration. Some further suggest that Member States should prepare specific programs to increase their share of RES and efforts on energy efficiency. From a different perspective, some stakeholders, *NGOs* in particular, propose the introduction of administrative penalties or economic sanctions for underachievement of targets.

Local and regional authorities are calling for measures to be adopted at the most appropriate level of government. From their perspective EU energy policy should incentivise and support local sustainable energy production and distribution. Therefore a number of them also claim the adoption of certain sub sectoral targets to be implemented at the local level.

Have there been inconsistences in the current 2020 targets and if so how can the coherence of potential 2030 targets be better ensured?

The stakeholders in general agree that the three targets for GHG, RES and energy efficiency have interacted, but have diverging views on whether this is problematic or not.

Some of the *Member States* note that the effectiveness of the 2020 framework is undermined due to the interactions between the three targets. While some *Member States* propose to set a single target, others call for further analysis and better coordination on how to make the targets more coherent (see Box 4 above). Several *Member States* note that a national impact assessment is needed to better evaluate the interaction and consequences of potential 2030 targets at their specific country level. Some *Member States*, in line with some *industrial*

organizations, also think that the climate and energy policies should be better coordinated with the EU industrial policy.

Industrial organizations, energy intensive industries, *utilities* and *the power sector* generally stress that overlapping targets undermined the EU ETS price signals. They point out that RES support schemes have promoted costly technologies and a more market-based approach is needed. According to *energy intensive companies,* the overlapping Energy Efficiency Directive and ETS for energy intensive industries will lead to additional burdens and higher costs, and they propose that the Energy Efficiency Directive exempts the ETS sectors.

In a different perspective, *renewable companies*, *non-energy intensive equipment manufacturers* and *local authorities* state that the three targets are positively reinforcing each other. They note that the EU ETS has not been undermined by the RES target, but instead by the economic slowdown, decreased demand for allowances and widespread use of international credits. *RES companies* and some *NGOs* then note that the major inconsistency has been that the GHG target for 2020 was set too low and the assessment of the interactions should be considered when deciding on the 2030 framework. Many of these entities also underline that a GHG target alone and the ETS currently provide no useful incentive for either RES development or energy efficiency improvements.

Academia also concludes that the three headline targets design can be better developed, and point out the need to better examine the potential interactions while others propose that a single, ambitious GHG target is needed that would provide a clear and credible signal.

Are targets for sub-sectors such as transport, agriculture, industry appropriate and, if so, which ones? For example, is a renewables target necessary for transport, given the targets for CO2 reductions for passenger cars and light commercial vehicles?

Many stakeholders note that emissions reductions in sub-sectors such as transport and buildings should contribute to the decarbonisation efforts with the aid of various policies. Several *Member States*, in line with some *utilities*, *industrial organizations* and *NGOs* see a benefit of further developing efficiency standards for buildings, EU-wide efficiency standards for appliances and vehicle CO2 efficiency standards. *NGOs* also point that F-gas regulations are appropriate.

Nonetheless, *Member States* generally ask to preserve a certain degree of flexibility at national level to ensure the most cost-efficient decarbonisation path. Some of them do not favour specific sectoral targets within the non-ETS sectors and, if these should be introduced, they ask for careful consideration in setting them. Within a framework of three targets, *NGOs* and representatives of the *RES industry* agree that sub-sector targets are not necessary so as to preserve flexibility at Member State level.

Utilities, *energy intensive companies* and *general business organizations* note that sectoral policies are needed to address the non-ETS sector, but do not generally favour binding targets for specific sectors. Some *utilities* note that indicative targets could be set for the heating, transport and building sectors, while *energy intensive companies* argue that if targets are to be set, this needs to be done through a bottom-up approach.

From another perspective, some *non-energy intensive companies* think that binding GHG targets could be beneficial to tap the potential for non-ETS sectors. This view is supported by *financial sector representatives* that argue that binding targets would be useful to provide certainty and guide investments.

Transport Sector

Many stakeholders note that even if there is no binding target for the transport sector, other EU policies need to contribute to emissions reductions.

Several utilities and *energy intensive companies* suggest extending the ETS to cover the transport sector. If this is not technically feasible, some suggest a sub-sector target or a carbon tax for the transport sector. *Utilities* and *energy intensive companies* also generally note that within the transport sector, the focus should be on promoting electrification of the sector, promotion of behavioural changes and continued use of CO2 standards for cars. *Gas companies* add that fuel substitution in heavy duty vehicles and maritime shipping should be addressed. Several *Member States* also note that electrification of transport should be pursued.

NGOs believe that the specific transport RES target has led to the unsustainable use of biofuels. Therefore they call for transport policy that would focus on efficiency improvements through shift in demand and vehicle efficiency. They ask for new standards within the Fuel Quality Directive[244] to ensure reduction in greenhouse intensity of fuels as well as for tightened CO2 standards for cars.

Few *non-energy intensive companies* agree that the debate on indirect land use change related to biofuels needs to be resolved but they see a benefit in having a binding target for the transport sector. Several support 2nd and 3rd generation of biofuels that do not compete with food and have proven lifecycle benefits. The *agriculture sector* also calls for the continuation of a transport sector renewable target that would provide needed certainty for continued investments.

Transport sector representatives generally note that technology and mode neutral policies are needed to lower emissions and not one mode should be favoured over another.

Finally, *RES companies* generally prefer an overall RES target, though they note that Member States might put indicative targets in their National Renewable Energy Action Plans.

Buildings

Many stakeholders agree that improving the energy performance of buildings needs to contribute to emission reductions with various suggestions on the policy framework to support this.

Several *utilities* suggest that EU-wide performance standards are needed, or alternatively, a few note that tax on performance could be introduced. *Energy intensive companies* and *gas companies* suggest that buildings should have higher performance standards and financing support at EU level could be provided. They could be supplemented with stricter standards on energy efficiency of appliances. *NGOs* agree that building emission reductions could be addressed through building renovation policies.

Non-energy intensive companies and *building sector representatives* note that a binding energy efficiency target for buildings might be needed to boost activity and create jobs. On the contrary, *property owners* bring up that they might not be able to afford renovations and a lot of buildings will not comply with overly strict regulations.

Agriculture

244 Directive 2009/30/EC amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC

Most stakeholders do not address the agriculture sector even though a few note difficulties in calculating carbon flows and ascribing performance of reductions from land use, land use change, forestry and other stores of carbon. Some *NGOs* welcome specific agriculture policies such as sustainable programs to enable non-ETS emission reductions.

Representatives of the *agriculture sector* say that an indicative non-binding ambition could help to realize the potential of multiple land-based RES to mitigate climate change and diversify supply. They typically note that a binding target of emissions in the agriculture sector is unfeasible.

How can targets reflect better the economic viability and the changing degree of maturity of technologies in the 2030 framework?

There is a general consensus from a wide range of stakeholders and Member States alike, that future policy goals should give greater consideration to future technological development.

Some *Member States* have underlined that setting only the emissions reduction target would leave them with the necessary flexibility to react to changing technologies. From their perspective they should have the freedom to shape the low-carbon energy mix.

A large number of respondents focused their replies on the integration of RES in the new framework. Many stakeholders opine that renewable electricity support schemes should be progressively limited to non-mature technologies and, when still needed, those schemes should avoid market distortions and promote fair competition with other RES and conventional energy sources in a framework which addresses existing market failures comprehensively.

Renewable industry representatives generally consider that targets should not be confused with support mechanisms. Although they agree that there is a need to adapt support mechanisms, they point out that renewable energy technologies used today are already becoming cost-competitive with conventional power generation in many parts of Europe. More technologies would be competitive before 2020, if given adequate support in the meantime. Some stakeholders have asked for the introduction of sub-targets for technologies under development to increase R&D and advance deployment of such technologies. Others condemn sudden changes or retro-active cuts and favour the promotion of flexible support mechanisms, which would respond to cost reductions and market evolutions in order to avoid overcompensation.

In the same line of thought, *NGOs* also recognize that some support mechanisms should be adjusted and propose that the rules for such adjustable support mechanism are clearly defined in advance.

Some *industry representatives* are suggesting the introduction of an EU-wide goal for immature or more precisely promising non-competitive technologies, whereas others are in favour of interim milestones. This would allow for an evaluation of the accuracy of the support schemes in place and, if needed, timely revisions in order to accelerate or decelerate the speed of deployment of certain technologies. Some *regional and local* organizations are also underlining that technologies need to be adapted to their environment, such as rural, mountainous or isolated areas.

Energy intensive industries generally fear that such targets as proposed above could lead to increases in energy costs. They are suggesting that targets should include a measure of the economic cost and the impact of these technologies.

How should progress be assessed for other aspects of EU energy policy, such as security of supply, which may not be captured by the headline targets?

From the consultation it clearly emerges that the dimension of *competitiveness* and *security of supply* would have to be better integrated in the new framework. Several *Member States* are stressing the need to monitor and eventually define clear indicators to support the competitiveness of the EU and the security of energy supplies.

Security of Supply

As regards *security of supply*, part of industry is stressing that progress in physical market integration, security and reliability of energy supply are crucial and thus propose the introduction of *infrastructure* and/or *energy independence targets*. Some utilities in particular are highlighting that a number of gas power stations are being mothballed. Therefore a wide range of instruments are generally suggested, such as *benchmarks towards a minimum capacity of energy storage*, *minimum compulsory interconnection exchange capacity targets* or a new *target for cross-border transmission infrastructure development*.

The introduction of indicators for import independence (gas and oil) and short-term electricity balancing for variable generation have also been proposed. The *industrial consumers* are generally asking to refocus EU and national policies so as to incorporate competitive prices and security of supply. Measures proposed range from EU rating tools or monitoring systems on generation adequacy and security of supply, energy prices and the costs and impacts of climate and energy policy to the *introduction of an EU-wide security of supply minimum target* in terms of indigenous fuel use (in %). Some *Member States* also ask for the introduction of intermediate target for minimum interconnections between Member States or a binding interconnection target whereas others ask for appropriate EU indicators for energy infrastructure developments, research and experimental development (see Box 4 above).

On the other side of the spectrum, *NGOs* and part of the *renewables industry* are generally suggesting that security of supply can be provided by a continuation of the three headline targets for 2020. In particular energy efficiency and RES targets would contribute to lower dependence on fossil fuel imports and increase security of supply. Some of them propose the introduction of an annual comprehensive *EC progress report* as a tool to monitor trends, identify the most effective measures and provide much needed background information for EU decision-makers.

Some local and regional authorities propose to assess the progress of EU energy policy by measuring the energy autonomy of different levels of administration.

Competitiveness

Several proposals were made to introduce indicators to assess *energy competitiveness*, mostly by European *business associations* and *energy intensive companies.* EU rating tools or monitoring systems on energy prices and the costs and impacts of climate and energy policy were proposed by *industrial consumers*. In this vein, a target for addressing the energy price differential between the EU and major competitors was proposed by some *business representatives*. It is suggested that this new target should be based upon the analysis of multiple energy prices (gas, electricity, solid fuels and oil) and the comparison with major competitors – especially the USA.

Many contributions of the *energy intensive* industry also propose to couple an intensity-based GHG target (relative to economic activity rather than absolute target) with *industrial targets* to be expressed as industry's share of GDP.

7.5.5. Instruments

Are changes necessary to other policy instruments and how they interact with one another, including between the EU and national levels?

There is an overall agreement that the ETS provides a single regulatory framework for the sectors covered by it and it should remain the central instrument for the 2030 climate framework. It is seen as cost-effective, compatible with the internal energy market and technology neutral. There are nonetheless diverging views among stakeholders on whether the ETS has to be reformed, what changes are necessary and what additional policies should supplement it.

EU ETS Reform

The majority of *Member States* support the ETS as the major instrument to achieve the EU climate and energy policy goals. Whereas some *Member States* argue that the ETS should be reformed to increase credibility, others note that it functions as expected and thus are opposed to reforming it.

General business organizations and *many energy intensive companies* believe that no measure is necessary for strengthening the EU ETS, as this would, from their perspective, undermine its long-term market nature. Some *energy intensive companies* further argue that current absolute cap on emissions would hamper European growth. Hence, from their perspective the ETS should be reformed to protect competitiveness by removing the absolute cap on emissions.

From a different perspective, *utilities, gas companies, academia* and *NGOs* typically request that the ETS is reformed in a timely manner so that it can drive investments in low carbon technologies and the needed infrastructure. They, together with *non-energy intensive companies*, generally support the temporary backloading of allowances and note that structural changes are also needed.

Utilities and gas companies, non-energy intensive companies and RES companies mostly favour introducing a flexible supply mechanism, that adjusts the supply of the EU ETS based on changing circumstances such as experienced in the recent economic slowdown. *Academia* agrees that a supply mechanism should be introduced with clearly defined rules of when an intervention would occur. Some *general business organizations* say that if a supply mechanism is to be introduced, it needs to be done after a very thorough impact assessment.

Another favoured reform is increasing the linear reduction factor. *Non-energy intensive* companies call for increasing the linear reduction factor. *Some utilities and academia* agree that it needs to be adjusted before the end of Phase 3 of the EU ETS. From another perspective, *energy intensive companies* note that the ETS linear reduction factor cannot be changed before a comparable and ambitious international agreement.

Less mentioned by the stakeholders is the introduction of a carbon price floor. Still, a few *utilities* and *think tanks* and some *RES companies* suggest that a price floor for carbon allowances should be introduced to decrease the volatility of the price and give certainty for investors. This view is not supported by *general business organizations* that request that the ETS remains a market-driven mechanism.

There are diverging views on whether or not international credits are to remain as part of the ETS. Typically *general business organizations* and *energy intensive companies* argue that international credits should remain part of the EU ETS as they would allow flexible and cost-efficient solutions and would help to prevent the risk of carbon leakage. On the other side, typically *NGOs* and *trade unions* call for limiting and eliminating international credits. According to *NGOs*, international credits led to dubious environmental impacts in developing countries and prevented domestic action and had a negative impact on the carbon price. *Trade unions* add that international credits should be removed both from the ETS and the Effort Sharing Decision to incentivize emission reductions in the EU.

Extend the ETS

Extending the scope of the ETS is mostly seen by the actors as ensuring more sectors contribute to the decarbonisation as opposed to a reform related to the surplus of allowances on the market. Some *utilities, several gas companies and energy intensive companies* point out that the ETS should be extended to cover buildings and the transport sector if it is technically feasible as they note that all sectors should contribute to the low carbon transition. On the other side, a few *NGOs* are sceptical with extending the ETS as in their view the instrument has not yet proven to be effective in reducing emissions. They argue in favour of a binding target for the non-ETS sector that could be supplemented with national and EU-wide carbon tax.

RES support schemes

On renewable energy support mechanisms, there is a general consensus that these should be designed and implemented in a more cost-efficient way in order to avoid over-subsidisation and market distortions. Yet, there are diverging views on the necessary changes.

Several *Member States* support the thesis that RES subsidies should be more coherent and include stronger elements of cooperation between Member States, and welcome the forthcoming guidance from the European Commission on RES support mechanisms.

Typically *energy intensive companies, utilities and the power sector, and general business organizations* call for adoption of technology neutral policy for the transition to the low carbon economy. Support provided should be limited, technology neutral, harmonized at the EU level and temporary. Several *utilities* bring up that further RES support schemes are not cost-efficient and additional support such as priority dispatching is distorting the market. They note that generous RES subsidies might lead to RES technology penetration beyond the infrastructure adaptation rate. Hence, they call for progressive phase-out of RES subsidies and removing non-economic support.

From a different perspective, *non-energy intensive companies*, *RES companies* and *NGOs* argue that market distortions should be eliminated, including removing subsidies for fossil fuels and nuclear energy.

Renewable, non-energy intensive companies and NGOs acknowledge that RES support schemes should be adapted to the technology maturity of the various technologies, but note that continuing demand pull for RES is still needed. RES companies add that flexibility should be introduced in the support schemes to reflect their maturity and prevent retroactive changes in the support mechanisms that were observed in some Member States. They also request better coordination across the EU on support mechanisms.

NGOs also bring up the issue that only sustainable bioenergy should be counted towards the RES targets to avoid unsustainable use of land to meet targets. Some *Member States* also suggest that the EU should play a role in determining the sustainability of bio energy, while others point out that this would lead to additional administrative burdens.

Energy efficiency

For a discussion on energy efficiency related policies, see Section 7.5.5 that discusses the question *'Which measures could be envisaged to make further energy savings most cost-effectively?'*.

GHG reductions in the non-ETS sectors

Many stakeholders underline that the non-ETS sectors must continue to contribute to the decarbonisation efforts. Most *Member States* argue that they should retain flexibility in

addressing the non-ETS policies as they can adapt them to national circumstances. A the same time many stakeholders such as some *Member States, utilities, NGOs, energy intensive companies* and *think tanks* point out that EU wide standards for buildings and product performance standards such as efficiency standards for cars, vans and lorries and eco-design for appliances should be continued for sectors outside the ETS.

NGOs argue that the Effort Sharing Decision should be strengthened, including a transposition placing duties on the national authorities. They note the Effort Sharing Decision was not strong enough and international credits undermined domestic action. They call for the setting of an ambitious legally binding target for the Effort Sharing Decision and the provision of financing for Member States less able to act.

Some *utilities* suggest that for sectors outside the ETS, command and control policies would work best while a few add that a carbon tax might be introduced at EU level with a price signal coherent with the ETS price signal. *NGOs* generally agree with some adding that carbon tax can be introduced for the ETS sector as well.

State Aid

Several *energy intensive companies* and *general business organizations* note that state aid rules need to be amended to add competitiveness protection provision. On the other side, they note that compensation for the risk of carbon leakage due to indirect costs (CO2 costs passed through to electricity prices) should not be through state aid as it would depend on Member State ability to pay. Instead, free allowance allocation should be used as it is market based and would harmonize support at EU level. Some *utilities* and *think tanks* underline that harmonized state aid can be the mechanism to compensate for indirect costs.

How should specific measures at the EU and national level best be defined to optimise cost-efficiency of meeting climate and energy objectives?

NGOs, *renewable energy organizations* and many *non-energy intensive representatives* argue that a longer term legal framework is required to achieving a cost-efficient decarbonisation path. *RES companies* in particular note that a long term commitment is needed to target specific technologies and retroactive changes to the support schemes should be avoided as these increase artificially the cost of capital.

Many stakeholders note the risk of market fragmentation due to incoherence between national policies. Industrial stakeholders call for better coordination and harmonization of national policies. Many see the harmonization of RES support mechanism, or at least the convergence, as an important step to more cost-efficient policies. *General business organizations* note the risk of market fragmentation if national policies such as a national carbon price tax are introduced. They also note that better coordination needs to be achieved between energy policies. They ask for establishing mandatory consultation procedures for energy policy decisions that might affect other Member States.

From a different perspective, *Member States* advocate for retaining control over their energy policies. They stress that they need flexibility in order to achieve the targets in the most cost-effective way and certain policies should remain under national authority. Nonetheless, some *Member States* note it as important to continue harmonization of policies and achieve the internal energy market in order to have a cost-effective policy. Hence the EU can play a role to ensure consistency of policies.

How can fragmentation of the internal energy market best be avoided particularly in relation to the need to encourage and mobilise investment?

There is a broad agreement between all stakeholder groups that the *completion of the internal market* for energy is a key strategy for minimising the cost of energy and securing supply. In this vein, the consistent implementation of the *Third Energy Package* across Member States is seen as a priority. The vast majority of stakeholders are aware that its completion from a regulatory perspective but also through a *higher rate of interconnections***,** including smarter infrastructures, will be an important step.

Some major *business associations* are calling for a better coordination of national policies and cooperation to ensure the proper functioning of the future interconnected energy market. From their perspective, non-harmonized instruments with purely a national design such as RES-E promotion schemes and the current design of capacity mechanisms will not help to realise the internal energy market.

Utilities and *the power sector* insist on the importance of the right legislative environment that can deliver a transparent, liquid and well-functioning single European market in gas and power, such as the gas target model[245,] the security of supply regulation, and the regulation on wholesale Energy Market Integrity and Transparency (REMIT). *Transmission System Operators* underline that cooperation mechanisms and demand-response measures could represent other important instruments to cost-effectively deliver the goals of the 2030 framework. Furthermore, they stress that distribution networks must be better linked across borders and relevant infrastructure projects need to be coordinated between all countries affected. Joint planning of networks, in particular of interconnections, could play an important role to ensure the most cost-efficient and coherent solutions for infrastructure networks.

Several stakeholders are also asking the Commission to come forward with a reflection on the existing energy *market design* which, as it currently stands, makes it difficult to integrate a further increase of electricity from RES. *Renewables associations* are generally asking for the development of cross-border grid infrastructure and for the EU to harmonise market design conditions (e.g. via harmonised network codes, integrated intraday, balancing markets but also via the development of storage and demand-response measures), increased flexibility from power generation capacity and improved cooperation mechanisms.

To attract *long-term investors* (e.g. insurance companies, pension funds), there is a general consensus that a strong and stable EU policy is needed. Transparency on market rules, tax exemptions, support grants and simplified administrative procedures are seen as some of many possible tools to enhance private investments. More efforts are also required to increase regulatory stability (permit granting) and public acceptance. Hence, the adopted changes at national level to facilitate and speed up investments need to be fully implemented (Energy Infrastructure Package).

Part of the progressive community in favour of an energy savings binding 2030 target underlines that this will encourage Member States to improve implementation of the EU *acquis* for energy efficiency, thereby contributing to the harmonisation of the regulatory environment.

Capacity mechanisms

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245 Related to gas, a vision for a gas target model was presented by CEER at the end of the year 2011 and endorsed by the Madrid Forum in its 21st meeting in March 2012. The target model, proposed by the energy regulators is based on hub-to-hub trading through the establishment of a number of well-functioning market areas and trading regions, which would be closely linked through cross-border interconnections, with market based allocation mechanisms and an efficient use of capacity through appropriate congestion management measures.

As regards *capacity mechanisms,* an important part of stakeholders, including *citizens*, *NGOs* and *industry* voice a sceptical view and are asking Member States to limit further fragmentation of the energy market and the EU to strive for European solutions in the least discriminatory and distortive manner. Some are suggesting that violations of the EU rules on competition, state aid and the internal market must be sanctioned. However the *power sector* generally consider such instruments as fundamental to ensure the construction of the necessary capacity based on the long term needs of the electricity system.

Which measures could be envisaged to make further energy savings most cost-effectively?

Renewables associations and *organisations representing companies offering solutions to energy efficiency improvements* generally advocate long term targets for both RES and energy efficiency as the best tools to stabilise the market and provide the sector with certainty, thereby facilitating the achievement of both 2020 targets and long term ambitions. From their perspective, having binding targets for energy savings would be the most effective way to foster investments and decrease costs. The effective implementation of the Energy Efficiency Directive[246] would be of a paramount importance.

In line with these views, several *NGOs* are also insisting that additional public funding should be allocated to R&D in energy efficiency, in order to ensure the widest range of technologies is available to deliver long-term energy savings in the energy sector and the wider economy. They note that lack of financing and split incentives are barriers for energy efficiency improvements. Horizon 2020[247]and the SET plan[248]are expected to contribute significantly to the achievement of energy and climate targets.

On the contrary, other *industry representatives* generally believe that energy efficiency should be achieved by voluntary initiatives, rather than by mandatory requirements which would lead to new administrative burdens.

Some industrial stakeholders also underlined that the most cost-efficient way of making further energy savings would be to improve the energy efficiency of existing buildings by way of thermal renovation. In this respect, they note the European Commission should ensure that both the recast Energy Performance of Buildings Directive[249]and the new Energy Efficiency Directive are properly implemented by the Member States. Some *industrial stakeholders* also note that the lack of access to financing needs to be addressed. *Property owners* fear that some existing buildings in Europe may not be able to meet EU-imposed high energy efficiency standards and this could result in many older properties needing to be demolished.

Several stakeholders, such as, but not limited to, *consumer associations* and *Distribution System Operators (DSO)*, have also highlighted the importance of raising *citizen and consumer awareness,* for instance by introducing energy performance labels for household appliances. Transparency of costs for consumers at all levels is most likely to drive energy saving measures. When promoting the construction of *smart grids*, consumer flexibilities

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246 Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC.

247 http://ec.europa.eu/research/horizon2020/index_en.cfm

248 The SET-Plan establishes an energy technology policy for Europe. It's a strategic plan to accelerate the development and deployment of cost-effective low carbon technologies. The plan comprises measures relating to planning, implementation, resources and international cooperation in the field of energy technology. http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm

249 Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings.

should be used to optimise the grid load. Real time monitoring and flexibilities provide new business opportunities for energy service companies in promoting energy efficiency.

Electrification of heating, cooling and transport are also perceived by some stakeholders as efficient tools to ensure cost-efficient energy savings. Finally, *trade unions* generally stress the importance of the workplace as a potential driver for energy efficiency and together with *non-energy intensive companies*, ask the promotion of dedicated environmental trainings.

How can EU research and innovation policies best support the achievement of the 2030 framework?

Research and innovation support is broadly recognized as key in achieving the future objectives of the 2030 framework and there is a strong overall agreement on the need for EU-level coordinated research initiatives. Some stakeholders note that national support schemes for R&D need to be better coordinated. Many stakeholders also recognize the importance of private sector participation in innovation and call for a clear and stable regulatory framework that would facilitate their participation.

From the consultation it emerges that the different stakeholders generally consider that Horizon 2020 and the SET Plan will play an instrumental role to support the EU innovation agenda. Several stakeholders suggest that structural and cohesion funds should be utilized.

Several *Member States* propose that high potential technologies should be prioritized within Horizon 2020. *Utilities* note that research priorities should be better aligned with the energy agenda, while *general business organizations* and *energy intensive companies* argue that funding should be in line with the ambition levels of the climate agenda.

Utilities suggest that Member States need to increase their cooperation on high cost industrial technologies such as Carbon Capture and Storage (CCS) and infrastructure projects. Several *utilities* argue that R&D should support the full value chain of all types of fuels, including conventional and unconventional fuels, promising renewable technologies, smart grids, infrastructure projects and energy storage. From a different perspective, *NGOs* call for less focus on nuclear technologies and some point out that no further support should be provided to CCS as it increases dependence on fossil fuels.

Energy intensive companies, utilities and general business organizations argue that projects should be supported through the demonstration phase. Deployment support should be limited and these funds should instead be used for R&D on lowering costs of promising technologies. In the same line of thought, oil and gas companies note that support to pre-commercial technologies should be provided, but commercial deployment should be incentivized through the ETS and GHG intensity goals. *Energy intensive industries* generally request that a focus also be given to R&D for industrial processes themselves and not only for specific energy technologies. *Oil and gas companies* note that the SET plan should be technology neutral and open to all promising technologies.

Non-energy intensive companies on the other hand argue that support should not only be focused on R&D and demonstration but also on deployment. *RES companies* and *NGOs* are of the same opinion, noting that demand pull and supply push are needed to commercialize technologies. *Non-energy intensive companies* generally call for further funding on RES, gas turbines, CCS, demand response, energy storage, and smart grids. *NGOs* ask for increased focus on RES and energy efficiency. *RES companies* request that the SET Plan is extended to cover all RES technologies.

Some local authorities and *trade unions* bring up that the Intelligent Energy-Europe[250]should reinforced within Horizon 2020 and help fill the gap between R&D and wide market uptake of innovation. Local authorities also point that Horizon 2020 should include non-technical innovations such as capacity building and new financing instruments.

Many stakeholders approve NER 300[251]type instruments that could help with innovation on the demonstration phase of various technologies. *Energy intensive companies* bring up that NER 300 type support should be provided to industrial processes as well. *General business organizations* and *some utilities* call for continued support of CCS technologies under the NER 300. NGOs also call for NER 300 for projects with EU-wide importance. *RES companies* approve of the NER 300 so far with focus on innovative RES technologies such as offshore wind. Some *non-energy intensive companies* suggest the creation of a fund for clean energy that allocated funds after a competitive process such as the NER 300.

Some *stakeholders* urge cooperation within the SET Plan between academics, policy makers and the industry.

7.5.6. Competitiveness and security of supply

Which elements of the framework for climate and energy policies could be strengthened to better promote job creation, growth and competitiveness?

NGOs and most of the *renewable and non-energy intensive industrial associations, trade unions* and *companies* are stressing that renewables and energy efficiency offer specific advantages in terms of job creation, competitiveness and innovation. Europe's competitiveness and its capacity to create jobs in the climate and energy sector, depends on its ability to drive innovation in sectors of the future. Therefore stable and ambitious long-term market and legislative frameworks are key for competitiveness, jobs and growth, whereas from their perspective a greenhouse gas-only approach would not be sufficient to make the huge job potential in renewable energy a reality. The development of RES and energy efficiency would also reduce import dependency, easing pressure on national budgets and trade deficits while freeing up financial resources for investment within the EU. In the same line, some *sectoral associations* are also insisting that Energy efficiency of buildings and in particular renovation of existing buildings as well as the EU's technological leadership in heating and cooling systems must be strengthened to better promote local job creation and growth. Others underline that other low carbon technologies, such as nuclear and CCS, could promote competitiveness and that their potential contribution should be recognised.

On the other side of the spectrum, *European industrial consumers* and *trade unions* stress the need for competitive energy prices and costs, security of supply and climate policies that do not endanger industrial competitiveness. Some of these also argue that ambitious climate and renewables objectives in particular could endanger EU price competitiveness of energy (for this aspect, see Section 7.5.6 below discussing question *'What are the specific drivers in observed trends in energy costs and to what extent can the EU influence them?'*).

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[250] Intelligent Energy – Europe (IEE) offers a helping hand to organisations willing to improve energy sustainability. Launched in 2003 by the European Commission, the programme is part of a broad push to create an energy-intelligent future for us all. It supports EU energy efficiency and renewable energy policies, with a view to reaching the EU 2020 targets (20% cut in GHG emissions, 20% improvement in energy efficiency and 20% of renewables in EU energy consumption).

[251] NER 300 is one of the world's largest funding programmes for innovative low-carbon energy demonstration projects. The programme is conceived as a catalyst for the demonstration of environmentally safe CCS and innovative RES technologies on a commercial scale within the European Union. Funding comes from the auctioning of allowances in the ETS.

There is wide concern among stakeholders from Central and Eastern European Countries, in particular *Member States* and *citizens*, about the impact of European climate and energy policy on European competitiveness. A wide number of stakeholders underline that, if compared to the USA, the energy price differential is increasing, causing a competitive disadvantage for energy-intensive industries in the EU. As a result, this would jeopardise growth and employment in Europe.

European industry associations and *energy intensive companies* also fear that a "green economy" dependent on subsidies, or on regulatory taxes on consumers or industry, is unlikely to be economically sustainable. *Trade unions* stress that training and education of our workforce are also necessary to promote competitiveness and the modernisation of our energy systems. As already discussed, *European companies* generally see the modernisation of European energy infrastructure and the completion of the single market as important steps to increase security of supply and enhance competitiveness.

For issues relating to carbon leakage and the design of climate policy to prevent it, see question below.

What evidence is there for carbon leakage under the current framework and can this be quantified? How could this problem be addressed in the 2030 framework?

Whereas there is no consensus among stakeholders on the existence of carbon leakage, the consultation registered a concern from a large number of *Member States*, *industries and organizations* on this issue.

Member States recognize that carbon leakage will be an increasingly important issue within the 2030 framework, and call for a framework which ensures European competitiveness. The vast majority supports, if no international agreement is reached, the continuation of free allowance allocation to industries that would be most affected, while ensuring that the carbon leakage rules remain cost-effective.

The *energy intensive industry and general business organizations* highlight how competitive pressures have been increasing on EU industry mainly due to development in emerging economies and recent shale gas exploitation in the US. They note that European industry needs enhanced protection mechanisms. They state that allowance revenues should be utilized to compensate the affected industries for cost increases in order to avoid carbon leakage or to support low carbon technology investments. *General business organizations* call for compensation for indirect pass-through costs of increased electricity prices, and ask for harmonization of the compensation across Member States, suggesting the development of an EU-wide instrument to replace the national state aid mechanisms, as currently governed by state aid guidelines. A few *industrial stakeholders* also propose to consider a border carbon tax for imports to create a level playing field.

Utilities generally note that there is limited evidence for carbon leakage at this stage. They ask for careful re-examination of businesses which are at risk of carbon leakage. In case there is no international agreement, they agree that free allowances should be used to compensate businesses. *Trade unions* note that the carbon leakage list needs to be reviewed but energy intensive industries should be preserved in the EU.

From a different perspective, according to *NGOs, RES organizations, non-energy intensive companies and part of academia* there is little evidence for carbon leakage at this stage. From this perspective, NGOs stress that free allowances are discouraging investments in low carbon technologies. *RES organizations, academia and non-energy intensive companies generally* note that other market factors, such as labour costs have a more significant impact on investment decisions. They also argue that most climate policy costs are passed to final

consumers. In that context, free allocation should be reduced to better reflect the lower carbon costs that are currently on the market.

What are the specific drivers in observed trends in energy costs and to what extent can the EU influence them?

Although the reasons for the current high energy costs in the EU are diverse and complex, there is an overall agreement that *fossil fuels price increases* have been one of the main drivers of energy price increases in the EU. From this perspective, stakeholders stress that the European Union has little margin for manoeuvre to influence world trends in energy costs.

In addition, taxes, tariffs and levies and the lack of competition due to a fragmented internal energy market are commonly considered as other important drivers having an impact on high energy prices. The completion of the *internal energy market* – including increased cooperation and coordination between Member States – is therefore seen by a majority of stakeholders as an important step to mitigate the rise of energy costs in Europe.

A wide segment of the *industrial community* and in particular *energy intensive associations* and companies are underlining that the increase of the relative price of energy in comparison to the USA results mainly from the shale gas revolution. The same stakeholders are generally also blaming the expansion of renewable energy and the related subsidies for the rising energy costs. From their perspective, the diversification of gas sources - both through new suppliers and routes as well as through the increased use of European conventional and *unconventional resources* – would be particularly important to reduce this differential. These stakeholders are calling for *external EU energy policies* to play an important role in fostering relations with major energy suppliers, to further diversify energy sources and to promote competition, and as such to have a positive impact on energy costs. The persistence of *regulated prices* in some Member States is another issue generally raised by several industrial associations as having an impact on competition and energy prices.

In contrast, a vast majority of *NGOs* and the *renewable industry* believe that RES could make the European Union much more resilient to international energy prices fluctuations whereas renewable schemes would have limited impacts on average retail electricity bills. These stakeholders underline that several renewable technologies, such as wind and solar, could be exploited at very low marginal costs. From their perspective, the completion of the internal energy market and related infrastructure development would enable much more efficient operation of the power system and cost-effective integration of renewables (thereby reducing the need for back-up, storage etc.) and decrease overall energy system costs.

Partially in line with this view, *institutional investors* and a vast majority of *utilities* and the *power sector* criticise the oligopolistic nature of electricity and gas markets in many Member States and the corresponding insufficient levels of competition. There is also concern about the rising need for costly substitutions of old energy infrastructures as well as the increasing cost of capital.

A number of *citizen* and *consumer associations* agree with this last concern and stress that the investments for the expansion and modernisation of the energy infrastructure have an impact on prices for consumers. From their perspective attention should also be given to the protection of final consumers in order for them to have access to affordable and efficient energy commodities.

Several *NGOs*, *trade unions* and part of the *industrial sector* focus on the importance of *energy savings policies* to contain the cost impact of energy use, which would also decrease import dependence and the fossil fuel import bill. Policies that reduce energy demand would

also reduce pressure on international fossil fuel prices, thereby having a positive effect on European fossil fuel prices.

Finally, stakeholders from different backgrounds and *academia* in particular, ask for more research and innovation to reduce overall cost and ease the penetration of new technologies.

Relatively few stakeholders have indicated that currently the EU ETS carbon price is an important factor contributing to the increase of energy costs, whereas a high number of *industrial stakeholders* are concerned how the ETS would impact prices in the long term.

How should uncertainty about efforts and the level of commitments that other developed countries and economically important developing nations will make in the on-going international negotiations be taken into account?

There is universal recognition that the EU needs to engage the international community and reach an agreement consistent with the internationally agreed target to limit atmospheric warming to below 2°C, while protecting the EU competitiveness. Yet, there are diverging views on how to solve the political uncertainty linked to international negotiations within the 2030 framework.

For the views of different Member States, see Box 4.

Energy intensive companies support the idea that the efforts and level of commitments cannot be taken unilaterally. *General business organizations* oppose setting targets before an international agreement, noting that only no-regrets options can be implemented in the meantime. If targets are to be set beforehand, *energy intensive companies* agree that they should incorporate a level of flexibility to allow for adjustments based on the outcome of international negotiations. These mechanisms need to be clearly defined. Some *citizens* are also concerned about European competitiveness and oppose unilateral EU action.

On the other side, many *utilities* argue that the EU should take action as quickly as possible to trigger long-term investments, while *non-energy intensive companies* also note that this would allow the EU to retain its competitive advantage. These suggest that the EU should establish dual targets – one unilateral and one more ambitious in case an international agreement is reached in 2015, but both of these targets should be decided upon as soon as possible to provide visibility to the economic actors.

In the same political line, *NGOs* call for action irrespective of actions from third countries since conditional commitments by the EU did not achieve the necessary results. They point out that other countries, such as China and the United States, are already making commitments and the EU needs to act to keep its early mover advantage in renewables and energy efficiency technologies. *Trade unions and some citizens* are also in favour of an early and clear commitment to reduce costs of decarbonisation and ensure job creation.

How to increase regulatory certainty for business while building in flexibility to adapt to changing circumstances (e.g. progress in international climate negotiations and changes in energy markets)?

There is a general consensus that regulatory certainty can be increased by creating a stable long-term legal framework. Answers generally provided focus once again on the trade–off between binding and flexible policies.

An important part of the *business* and *investment community* underlines that the European Commission should communicate a clear policy framework. In this respect, targets can help clarify what stakeholders are expected to deliver as long as those are commonly agreed, credible in terms of delivery and adapted to national circumstances. *NGOs* insist on stronger political line, stressing the importance of an explicit political commitment regardless of

climate action in third countries whereas a number of *Member States* argue that the future framework should also take into account national specificities and to changing economic and political circumstances.

In order to increase certainty for investors, *renewable industry* insists on the need for a clear framework with a close monitoring system. Disruptive and retroactive policy changes have to be avoided. Regarding climate policies, an automatic downward adjustment mechanism is often proposed to increase regulatory certainty while adapting to changing circumstances.

Industrial consumers insist that planning and investment security are crucial with regard to the needed investments in the EU energy system. The new framework should therefore offer to the industry the required certainty and flexibility while avoiding short term intervention. The legislator should take greater account of the reality of the market and promote regulatory simplification and transparency while political intervention should be limited. The backloading proposal and recent proposal on biofuels (ILUC) are seen by part of the European industry as causing uncertainty.

Finally, *Utilities,* while also condemning short-term selective measures intervening in the market, are generally insisting that existing EU legislation should be duly implemented in all Member States. Government and national authorities are playing an important role to ensure a common level playing field while more coordination could reduce negative effects of national policies through cross-border impacts.

How can the EU increase the innovation capacity of manufacturing industry? Is there a role for the revenues from the auctioning of allowances?

Action to improve the innovation capacity of the manufacturing industry is welcomed by the participating stakeholders. Overall most stakeholders welcome the use of NER 300 type instruments at the EU level, calling for continuation of the program as discussed in Section 7.5.5 discussing question *'How can EU research and innovation policies best support the achievement of the 2030 framework?'*.

Industrial organizations and *energy-intensive industries* request that funding should be provided in proportion of the ambition level of the climate policy. *Energy intensive companies* note the importance to support not only new technologies but also process innovation. They note that some sectors would require break through innovations to lower emissions such a glass and cement hence sufficient support should be provided. They welcome the SPIRE partnership[252] to deliver solutions for energy and resource efficiency for the industry. Some representatives of the *energy intensive industry* note that auction revenues should be used exclusively as protection against carbon leakage or as incentives for the industries to develop low-carbon technologies.

Several *Member States* argue that the allowance revenues should remain a national competence but overall agree that at least partially these should be used to support low carbon transition of the industry.

Industries that provide solutions to the sustainability challenge generally request that 100% of the allowance revenues should be spent to support low-carbon technologies, up from the 50% that currently Member States are obliged to spend on climate mitigation and adaptation. *NGOs* state for example that allowance revenues should not only be used to support manufacturing industry innovation but also contribute to leveraging private investments under

[252] Sustainable Process Industry through Resource and Energy Efficiency (SPIRE) is a public-private partnership to be launched as part of the Horizon2020 framework programme.

the SET Plan and the Green Fund within the UN to support developing countries. *Trade unions* request that part of the allowance revenues be channelled to training and re-qualification for workers in the transition to the low carbon economy.

Many stakeholders, including some *Member States*, highlight the importance of mobilizing private investments to increase innovation. Some *NGOs* propose the creation of industrial fund to support innovation.

How can the EU best exploit the development of indigenous conventional and unconventional energy sources within the EU to contribute to reduced energy prices and import dependency?

Once again, on the definition and development of indigenous energy sources the consultation replies show that two general *diverging* outlooks exist in Europe.

Whereas *Member States* and *citizens* are generally divided, a significant share of the *industry,* the *energy intensive* industry and the *power sector* believes that Europe has to diversify its energy supplies and be more positive towards the development of alternative energy sources such as shale gas. Unconventional energy sources are seen by part of the industry as a possible means of keeping the price of EU energy competitive. In this respect, they are calling for the EU to adopt a clear and stable regulatory framework that could facilitate the safe exploitation of these resources.

At the same time several NGOs and the *renewable industry* advocate that energy savings and renewable energy are the EU's only significant and long-term indigenous energy solutions. From their perspective, RES are the only indigenous sources in which the EU has a competitive advantage.

Moreover, several *climate NGOs*, *local authorities*, *citizens* but also a minority of *companies* have some doubts on the potential for European shale gas exploitation to contribute to reduced import dependency, as shale gas reserves within the EU are not comparable to those of the U.S. Hydraulic fracturing methods are associated with a range of environmental impacts and some of them claim that the carbon “footprint” of shale gas may be significantly greater than for conventional gas. In line with these positions, some *citizens and NGOs* are also concerned about the potential implications for health and the environment.

How can the EU best improve security of energy supply internally by ensuring the full and effective functioning of the internal energy market (e.g. through the development of necessary interconnections), and externally by diversifying energy supply routes?

Views are split on which sources can guarantee greater security and should therefore be given priority, often related to stakeholders' sectoral interests. Some argue that RES bring instability to internal security of supply due to their intermittency and tend to argue for a diverse portfolio of energy sources and suppliers as the best way to ensure security of supply. Others argue that, along with the necessary grid infrastructure developments, a focus on RES and energy efficiency will ensure a diversified portfolio of technologies, hence offering the best potential for sustainable energy independence in the long run.

Industry widely supports the timely completion of the internal energy market, the development of cross-border interconnections and better coordination between national policies. Some stakeholders go further, for example arguing for the removal of all remaining price controls. Externally, the diversification of energy suppliers and routes is seen as crucial.

European grid operators primarily argue for greater coordination between the national-level security of supply policies of Member States, as well as for the effective implementation of existing arrangements, such as for example the Ten Year Network Development

Plan[253].Similar to the above, the completion of the pan-European electricity system is seen as key.

Among *Member States* there is a broad agreement on the importance of completing the internal energy market and developing the necessary infrastructure. There is no consensus on whether renewable energy sources should and can be a major factor ensuring security of supply, with a widespread concern over the potential instability that renewables could bring to the network unless the necessary interconnecting infrastructure is in place.

Civil society and in particular *NGOs* also broadly recognise the need for greater grid interconnections across Europe. Along with the *renewable industry* they tend to support the increase of energy efficiency and use of indigenous RES as the best way to improve security of supply. They equally support the establishment of cross-border markets for day-ahead and intra-day trading, as well as a greater flexibility of the system. Furthermore, they advocate targeted support for electricity storage, increased decentralisation of power generation and demand-side response measures as areas with great potential that have so far largely remained untapped. Those respondents addressing external supply diversification are typically in favour of continued efforts in this regard.

7.5.7. Capacity and distributional aspects

How should the new framework ensure an equitable distribution of effort among Member States? What concrete steps can be taken to reflect their different abilities to implement climate and energy measures?

Overall stakeholders argue that it is important to consider several factors when deciding on the distribution of effort among Member States. As regards GHG emissions, it is generally acknowledged that the ETS has provisions to allow for the fair distribution of efforts, so the focus should be on how to share the efforts for the Effort Sharing Decision.

Member States mostly agree that the distribution of efforts should be decided based on national specificities and potential to incorporate certain technologies, including financial capabilities. Some *Member States as well as some NGOs* note that financing could be provided through EU-wide instruments. Several *Member States* note that it would be important also to consider past efforts to lower emissions. In order to define the optimal division, several *Member States* and *general business organizations* suggest that a thorough impact assessment per Member State should be performed to evaluate the different starting points, potentials and financial capabilities.

NGOs note that the highest potential countries also often have the least ability to act, hence the effort sharing should take into account ability to pay and low marginal abatement costs. In the same line of thought, *utilities* cite a mix between financial and socio-economic capabilities that need to be considered. A few *utilities* propose to distribute the efforts based on the share of absolute emissions expected in 2030.

Some *energy intensive companies* suggest that for the non-ETS sector, a bottom up analysis could be done and cost-effective abatement potential across Member States should be implemented. *Oil and gas companies* note that negotiations should be carried out by Member States on how to distribute the efforts. Some of these request transparency in the distribution

[253] The 3rd Energy Package mandated ENTSO-E to publish a biannual, non-binding, Ten-Year Network Development Plan (TYNDP). The TYNDP is designed to increase information and transparency regarding the investments in electricity transmission systems which are required on a pan-European basis and to support decision-making processes at regional and European level.

of efforts. Some *non-energy intensive companies* suggest distribution based on natural resource endowments. *Renewable energy companies* note that the national targets should allow for cooperation mechanisms such as statistical transfers, joint projects and joint support for achieving related to the RES target. *Trade unions* argue that capacity for action should be considered including geographical differences and wealth.

Some local authorities note that within the non-ETS, efforts should be based on the GDP of the Member States but also consideration should be given to potential for renewable resources and energy efficiency.

For distributional aspects relating to a potential RES target for 2030, see question below.

What mechanisms can be envisaged to promote cooperation and a fair effort sharing between Member States whilst seeking the most cost-effective delivery of new climate and energy objectives?

The majority of *Member States* are addressing this issue supporting the use of the ETS auctioning revenues. Member States formulated also some opinion on suitable mechanisms for effort sharing. Some propose the introduction of flexibility measures for GHG emission reduction in different sectors and the preparation of regional plans based on economic development levels or energy market volumes. Others note that trans-border collaboration projects should be better supported, e.g. as regards renewables development but also in view of developing large scale capital intensive technologies such the CCS. Member States' climate change and energy efficiency plans could also be combined into regions or sub-groups.

While the *manufacturing industry* and in particular *the energy intensive industries* mainly focus on the ETS as a suitable mechanism, the *renewable industry* and a majority of *NGOs*, but also major players in the *gas industry* tend to discuss the need for an increased use of cooperation mechanisms in other fields, such as those proposed within the Renewable Energy Directive[254]in the form of statistical transfers, joint projects and joint support mechanisms. It was noted that progress with interconnections would encourage cooperation. Furthermore, these groups argued for a target-sharing based on efforts by all Member States and the consideration of national GDP as well as studies on RES and energy efficiency potentials to help ensure a fair distribution of efforts. Some *NGOs* specifically voiced the need for a reform of the Effort Sharing Decision, as the current flexibilities provided too little pressure on Member States to reduce emissions within their own borders.

Finally, *trade unions* generally stated the need for a reinforced Effort Sharing Decision as an integral part of efforts until 2030. In addition, a reinforcement of the Renewables and Energy Efficiency Directives should be envisaged as well as new binding national objectives.

Are new financing instruments or arrangements required to support the new 2030 framework?

Stakeholders agree that the EU should facilitate climate- and energy-related investments. While some stakeholder request innovative financial instruments, others note that the existing ones are sufficient. There is an overall agreement that it is key to leverage private investments.

Several stakeholders note that financing for less capable Member States should be provided. *NGOs* note the need to address investments in areas that have less financial capabilities such as Central and Eastern Europe. Several *Member States* acknowledge a gap in the cost of

[254] Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

capital and support that this issue should be addressed through EU-instruments. Some TSOs suggest increasing the risk tolerance of the European Investment Bank (EIB) to provide financing to riskier markets or through grouping projects in different Member States together to ensure sufficient funding. Some *trade unions* note that a regional development funds could be created under the European Investment Fund.

Many stakeholders argue for the need to use public funds to leverage private investments. Several stakeholders such as *RES companies, utilities* and *general business organizations* note that pension funds and institutional investors funds will be needed so investments from these need to be facilitated. *General business organizations* point out that an increased access to venture capital and private equity funds is needed. EIB could help with improving access to capital and leveraging private funds.

On infrastructure, according to *financial investors*, government backed investment banks could aid with the substantial investments. Some *general business organizations* argue that joint planning for networks is essential to make them cost efficient. They together some TSOs propose that project bonds could be used for infrastructure across borders. *NGOs and some industrial representatives* note that the Connecting Europe Facility is crucial to support cross border infrastructure projects. Finally, several stakeholders propose that community funds could be used for Projects of Common Interest, as well as for energy efficiency projects.

Energy intensive industries have diverging views – some say that new financing instruments are needed while others point out the focus should be on adjusting and improving the existing ones. They bring up that these should support manufacturing industry through demonstration and deployment and process improvements in energy intensive sectors. Some point to cooperation programs with EIB, the European Bank for Reconstruction and Development and the World Bank to help them for high capital cost projects.

RES companies note that innovative instruments are needed to support RES investments, citing for example offshore wind. They point that EIB could provide loans and guarantees. They also argue that the EIB should stop financing fossil fuel projects.

NGOs generally say that innovative financial instruments are needed to achieve the reduction potential under the Effort Sharing Decision. Some suggest that the EIB introduces an NER-300 type instrument for the Effort Sharing Decision. For energy efficiency, they propose aggregating investments to make them more attractive to investors. They also support, together with *non-energy intensive companies*, the development of risk-sharing facilities, equity, loans and project bonds.

Local authorities request for better information on how to combine various sources of funding.

7.6. Existing free allocation procedures in the EU ETS

The volume of free allocation is in principle fixed, based on historic production numbers and benchmarking rules, with significant reductions in the amount of free allocation foreseen after 2020 for those sectors deemed exposed to carbon leakage that now still receive full free allocation.

But rules exist for addressing closures, expansions and new entrants that clearly do result in an impact on allocation when production changes. Commission Decision 2011/278/EU foresees adaptations of the amount of free allocation for industrial installations in case of significant capacity changes (reductions or increases), as well as in case of partial or full cessation (closure). A sub-installation has a significant capacity change if 'one or more physical changes led to an increase/decrease in capacity of at least 10%' or to 'an increase/decrease in allocation to the sub-installation of more than 50 000 allowances per year and the difference represents more than 5% of the amount of allowances calculated irrespective of the physical change.' In such case, the amount of free allocation is adapted to reflect the new capacity of the installation. In case of partial cessation of operations, an installation is considered to have partially ceased operations if: "…one of its sub-installations has reduced its annual activity level in a given calendar year by at least 50% compared to the [initial] activity level..." and if this sub-installation contributes "…to at least to 30% of the installation's final annual amount of emission allowances allocated free of charge OR - to more than 50 000 allowances [per year]...". If the activity level of the sub-installation is reduced by 50% to 75%, it receives 50% of the initially allocated allowances; if it decreases by 75% to 90%, it receives 25% and if it decreases beyond 90%, no free allocation is given. An operation is deemed to have ceased operations when any of several substantial conditions are met (expiration or withdrawal of GHG permit, operation of installation is technically impossible, the installation is not operating and it is technically impossible to resume operations or it cannot be established that the installation will resume operations'. For more details, see Commission Decision 2011/278/EU and the Guidance Document[255].

[255] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32011D0278:EN:NOT 7 http://ec.europa.eu/clima/policies/ets/cap/allocation/docs/gd7_new_entrants_and_closures_en.pdf

7.7. Challenges relates to skills and training

Key employment challenges that can be identified for implementing climate and energy policy are the pressure on systems of skills formation to provide learners with portable skills, signposting and support services to foster labour mobility and transfer of existing skills to different sectors, locations and workplaces. This is especially relevant in the context of enabling the smooth reallocation of workers towards growth sectors. Other challenges include the increasing need for new industrial alliances and governance structures; the uneven geographical distribution of jobs and training offers; the increasing costs of technical training offers and the increasing need for environmental awareness across all occupations[256.]

Targeted policy can address these challenges and play an important role in helping to anticipate and manage the impacts of low carbon transition on jobs and skills. This should be seen in the context of the wider labour market, which is in a constant transition due to technological progress and other economic factors[257.]

The analysis shows that policies that improve the general adaptive capacity of the labour markets while also providing adequate social protection for workers are most effective in assisting the restructuring of the economy and smooth job transitions due to climate and energy policies[258.] For those workers at risk of redundancy, active support to facilitate the search for alternative employment and maintain attachment to the labour market for workers and jobseekers is important. Particular focus on individual needs, and especially those associated with vulnerable groups, merit specific attention.

Low levels of labour mobility in Europe – between sectors, occupations and geographical areas – could lead to unemployment and unfilled vacancies, especially in the short term. An improvement of basic skills and hence mobility between jobs could play an important role in facilitating the transition to a low-carbon economy[259]. When considering the skills aspect, priority should be given to improving science, technology, engineering and maths (STEM) skills at all levels, as well as the broad range of technical and managerial skills[260]. In the majority of cases, extensive reskilling is not required, rather the upgrading of certain skills through structured training.

Given their role in skills formation and development, and in supporting individuals' transition to the labour market, the effectiveness of vocational education and training (VET) systems and employment services is therefore likely to play a key role. In particular, greater coherence and coordination between education, training, employment and low carbon policy will be needed to engender a job-rich, low-carbon transition[261.] Improving dialogue between policy makers and industry to allow businesses to anticipate changes in future skills requirements could also help for a smoother low-carbon transition[262].

There is a clear role for a broader range of social policies to play as well, especially in supporting workers that can be negatively affected due to the restructuring.

There is a range of financial tools that can support jobs promotion in the low-carbon economy, both at EU and Member State levels. In the context of the 20% climate

256 Cedefop, 2013
257 Eurofound, 2012
258 OECD 2011 study, p.10 & Employment effects of selected scenarios from the Energy Roadmap 2050, p. 61
259 Employment effects of selected scenarios from the Energy Roadmap 2050, Executive summary
260 Employment study ENER, p. 61; OECD, 2011; Cedefop, 2010
261 Cedefop, 2013
262 Eurofound study, 2012

mainstreaming objective for the 2014-2020 Multiannual Financial Framework, the Structural Funds are expected to contribute significantly to creating and safeguarding jobs across the economy.

The European Social Fund (ESF) especially can play a crucial role in supporting the labour force transition towards low carbon skills, jobs and working methods, with a view to safeguarding, transforming and creating jobs. Evidence from the 2007-2013 financial period shows that the ESF has been successful in supporting the low-carbon transition by promoting lifelong learning and enhancing access to employment[263.] For instance by facilitating access to employment for job-seekers and inactive people[264,] promoting self-employment, entrepreneurship and business creation[265], supporting the adaptation of workers, enterprises and entrepreneurs to change[266,] enhancing equal access to lifelong learning, upgrading the skills and competences of the workforce and increasing the labour market relevance of education and training systems[267] and capacity building for stakeholders delivering employment, education and social policies[268.]

Also the European Globalisation Adjustment Fund which provides one-off, time-limited individual support geared to helping workers who have suffered redundancy as a result of globalisation can be a tool to support employees who have lost their jobs due to changing global trade patterns in climate related sectors.

[263] Ecorys, 2013 and Metis, 2012
[264] Skills for sustainable energy and new technology (UK)
[265] Skills for climate change (UK)
[266] Clear about carbon (UK)
[267] ECO+ (BE), EmpleaVerde Green Jobs (ES)
[268] Green Ways to Work (UK)

7.8. Extension of the scope of the EU ETS to other sectors

This Annex reflects on the feasibility and impacts of further extending the scope of the EU ETS to include all energy related emissions, thus including for instance road transport and the heating of buildings.

The EU ETS at present includes typically large emitters such as power plants, as well as aviation which is a sector where the amount of operators is relatively limited. Expanding the scope of the ETS to include all energy related emissions, is an option in the further development of the European carbon market recognised by the Carbon Market Report, but still would require addressing a number of administrative challenges. For instance, the large number of end consumers in the energy sector, would make it difficult to regulate them directly through the ETS. An upstream approach would be administratively less complex[269]. Such an approach could address fuel suppliers, tax warehouse keepers or excise duty points, but would need to take into account different practices in different Member States, which would make implementation in the short term challenging. Also, further analysis is required in order to consider if and how any such measures would result in complementary incentives to existing taxation and excise schemes, including the ongoing discussions related to the proposed review of the Energy Taxation Directive; as well as the interaction with already existing measures addressing CO2 emissions and energy consumption in sectors such as transport and the housing segment.

An efficient outcome of a potentially enlarged scope would require existing market barriers and imperfections to be addressed, such as lack of information, split incentives, financing constraints and low price elasticity of demand, reasons which explain why the ETS in itself cannot be the only driver for change in these sectors. A price incentive through the ETS could therefore only be further considered if it would be part of a package of complementary policies, which would require further development of ambitious energy efficiency, renewables and other energy policies. For these reasons, the EU has developed measures such as the Energy Performance of Buildings Directive, the Eco-design and Labelling Directives, CO_2&cars and vans regulations and other transport measures, and the Energy Efficiency Directive. These types of regulatory approaches, as well as policies for R&D and innovation will need to be maintained to overcome such barriers. Without these complementary policies, the lower price elasticity of energy demand could lead to unnecessarily high carbon prices if these sectors would be included in the ETS. This complexity of regulatory approach and the need to avoid any elements of double regulation would have to be carefully analysed in any future more detailed assessments in this regard.

Without prejudice to such future dedicated assessments, if the scope of the ETS would be extended to emissions related to fossil fuel combustion in the residential, services and remaining transport sectors (road, rail and inland navigation) then the projections resulting in 40% GHG reduction in 2030 as discussed in Section 5.1 show ETS reductions of around 37% compared to 2005 emissions (see Table 43). This target could be achieved by keeping the linear factor at the existing level of 1.74%, but applying it also to all additional sectors included in the ETS.

[269] Other ETS systems developed include small scale sources. California's cap-and-trade programme will in the future include transport fuels through fuel distributors. The Australian emissions trading system has foreseen to include suppliers of natural gas for heating houses and buildings

Table 43: Reductions in 2030 in the ETS, depending on sectoral coverage

2030 reduction vs 2005 for different scenarios	ETS emissions present scope	Sectors to which scope expansion applies	Total emissions ETS after scope expansion
GHG -40%	-43%	-28%	-37%
GHG -40% + EE	-38%	-36%	-37%
GHG 40% + RES 30% + EE	-40%	-36%	-38%

To what extent the inclusion of new sectors would affect scarcity, and thus price formation, will depend on the overall cap under an enlarged scope, but an extension of the scope in itself will not result in a rapid change in the surplus, but rather like the change of linear factor for the existing sectors, lead to a more gradual decrease of the surplus.

If an extension of the ETS would be considered appropriate after a future more detailed assessment, it would have to be decided in a second step if auctioning or free allocation would be the suitable approach, while considering the possible impacts of windfall profits and costs for end consumers. For illustrative purposes, Table 44 provides an indication of the potential impact on revenues from the ETS.

Table 44: 2030 ETS auction revenue, depending on sectoral coverage of ETS and degree of auctioning

2030 auctioning revenue (billion €)*	Applied to the power sector and aviation	Applied to the power sector and aviation + extension of scope
Scenario GHG -40%	26	72
Scenario GHG -40% + EE	16	38
Scenario GHG 40% + RES 30% + EE	8	19
*estimates based on PRIMES-GAINS emission estimates per sector, covering only outgoing flights		

Any potential proposal in this regard would necessitate more detailed assessment of all the relevant impacts.