COUNCIL OF THE EUROPEAN UNION

Brussels, 7 June 2012

11052/12
ADD 1

ENER 276
ENV 499
POLGEN 107

COVER NOTE

from:	Secretary-General of the European Commission, signed by Mr Jordi AYET PUIGARNAU, Director
date of receipt:	7 June 2012
to:	Mr Uwe CORSEPIUS, Secretary-General of the Council of the European Union
No Cion doc.:	SWD(2012) 149 final
Subject:	Commission Staff Working Paper - Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Renewable Energy : a major player in the European energy market

Delegations will find attached Commission document SWD(2012) 149 final.

Encl.: SWD(2012) 149 final

EUROPEAN COMMISSION

Brussels, 6.6.2012
SWD(2012) 149 final

COMMISSION STAFF WORKING PAPER

IMPACT ASSESSMENT

Accompanying the document

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Renewable energy: a major player in the European energy market

{COM(2012) 271 final}
{SWD(2012) 163 final}
{SWD(2012) 164 final}

COMMISSION STAFF WORKING PAPER

IMPACT ASSESSMENT

Accompanying the document

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Renewable energy: a major player in the European energy market

TABLE OF CONTENTS

1. SECTION 1: PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

Identification: Lead DG: DG ENER. Agenda planning/WP reference: 2012/ENER/001

1.1. Organisation and timing

The Impact Assessment (IA) work started in autumn 2011. An Impact Assessment Steering Group (IASG) was established in November 2011 and met 3 times until February 2012 to discuss the various sections of the IA, including: problem definition, objectives, policy options, assessment of impacts and comparison of options. The IASG included the following DGs: AGRI, BUDG, CLIMA, COMP, ECFIN, EMPL, ENTR, ENV, INFSO, JRC, MARE, MARKT, MOVE, REGIO, RTD, SANCO, SG, and TAXUD.

1.2. Consultation and expertise

On 6 December 2011, the Directorate General for Energy launched a public consultation on the 2012 Renewable Energy Strategy. The public consultation was based on an online questionnaire with 10 sections and 33 questions, some requiring comments and others in the form of multiple choices. The public consultation was open until 7 February 2012. Some 400 contributions were received. Most contributions were received from industry (including utilities and other energy suppliers, technology providers and energy consumers), followed by individuals; NGOs (including consumers and environmental groups but also think tanks, trade and research associations); and public authorities (both from the state and regional/local level). Given the participation from a broad spectrum of organisations as well as citizens, this public consultation offers insights into a large range of stakeholder opinions. All Commission's minimum consultation standards were met. The results of the public consultation are summarised below (see Annex 1).

A) *General policy approach:* A clear majority of stakeholders expressed support for a post-2020 renewable energy target, with most participants in favour of mandatory target. In particular, renewable energy technology manufactures, renewables project developers and environmental NGOs vastly support mandatory targets. A number of utilities are not in favour of renewable energy targets although mostly of voluntary/indicative nature. Only 14% of respondents considered specific mandatory targets unnecessary.

B) *Financial incentives:* There was wide support for making support schemes more market oriented, but most respondents considered that national control over support schemes should nevertheless be maintained. Public authorities were considerably more sceptical than both industry and NGOs about the need to establish common EU benchmarks for support levels. The need for financial incentives beyond 2020 was seen in a differentiated way, with most respondents considering that support should be phased out for mature technologies.

C) *Administrative procedures:* Stakeholders identified the length and complexity of administrative procedures relating to authorisation, certification and licensing as a key obstacle to further growth of renewables. Only very few respondents (8%) considered that the requirements contained in the RES directive are sufficient to address all administrative barriers. Most participants either called for more direct intervention into national procedures or even for more harmonisation or mutual recognition in this field.

D) *Grid integration of electricity from renewable energy sources:* Respondents considered that obstacles for grid connection of renewables were likely to persist after 2020. Grid connection rules (39% of respondents), followed by balancing and cost-sharing rules (both 29%) were identified as key issues. The curtailment regime was regarded as less problematic

(23%). A minority anticipated that all obstacles related to grid access for renewables would be removed in a post-2020 perspective (19%). The need to increase flexibility to enable electricity systems to cope with a higher share of variable renewable supply was confirmed. The most favoured options were demand-side management, infrastructure development (both 45%) and an increased level of storage (40%). Capacity payments for new back-up generation received less support (only 21%).

E) *Market integration:* Exposing renewable generation to balancing risk or introducing direct marketing of electricity from renewable sources were mentioned as ways to improve renewables market integration. A shift towards feed-in premiums also scores high amongst stakeholder views, although some respondents also argued in favour of the introduction of quota systems. Respondents also saw a need to move away from today's market model based on short-run marginal cost pricing (only 8% considered this future-proof). Most respondents considered it necessary to move towards reflecting full costs (33%) or towards energy service markets where revenues would be earned from more than just selling electricity (25%).

F) *Renewables in Heating and Cooling:* In this section costs or lack of financial support were most often cited as main obstacles for stronger renewables penetration (43% of all respondents). Other obstacles that received a lot of attention were lack of awareness or unfavourable building regulations. On the most promising pathways for heating and cooling, solar thermal received the most support among the respondents (44%), clearly ahead of biomass which was named similarly often as geothermal (both by around 33%). Electrification on the basis of a higher share of renewables in electricity production received somewhat less support (24%).

G) *Renewables in Transport:* For this sector the respondents saw the costs of a further deployment as the most challenging problem (39%). This goes along with a lack of the necessary infrastructure and the need to set standards more quickly. A big concern among the respondents was whether sustainably produced biofuels can be supplied on a big scale and also to public acceptance linked to sustainability concerns such as indirect land-use change. As a way forward, a high number of respondents proposed to increase the share of RES via electrification. Regarding transport sectors most respondents cited road transport for passengers (46%) and rail transport (44%) as promising for stronger renewables penetration; prospects for air and water transport were considered less favourable.

H) *Sustainability:* Asked about the need for additional sustainability criteria in the period post-2020, a clear majority of respondents confirmed that in their view sustainability criteria should in the future be applied to both all biomass and fossil fuels (51%). Besides, around 19% considered that additional criteria would be necessary to ensure only the best performing biomass was promoted.

I) *Regional and international dimensions:* Here a slight majority of respondents considered that current rules for cooperation between Member States were not sufficient or had to be supplemented to become operational (41% over 34% who considered the current arrangements sufficient). More detailed guidance on the use of the flexibility mechanisms was frequently requested from the Commission. Cooperation between the EU and third countries on the development of renewables was seen positively, with a clear majority of respondents favouring further promotion of such cooperation (58% over 30% who favoured focusing exclusively on EU domestic resources). More respondents favoured an approach based on agreements between the EU and third countries rather than bilateral agreements to be concluded by Member States (45% over 19%).

J) *Technology development:* Concerning the key challenges for the technologies currently covered by European Industrial Initiatives (wind, solar and bio-energy in the area of renewable energy) most respondent identified technology performance and cost-competitiveness as most important (46% of respondents), ahead of issues linked to system integration (39%) and industrial manufacturing and supply chain issues (20%). When asked about technologies other than those covered by today's industrial initiatives that had the potential for industrial scale application in a post-2020 perspective, the fields most often mentioned were storage technologies, ocean energies such as wave and tidal and various forms of geothermal energy.

In addition to the public consultation, the Directorate General for Energy met numerous stakeholders individually and received many reports on the topic of renewable energy policy post-2012. Furthermore, on 24 February 2012 a public conference was held in Brussels in order to present the first outcomes of the public consultation and further discuss with a wide range of stakeholders the following key themes: ‘grid and market integration of renewable energy’, ‘regional and international cooperation’, ‘sustainable growth of renewable energies in transport and heating and cooling’, and ‘technology innovation and development’. The conference featured intervention from distinguished speakers representing a wide range of stakeholders, including from industry, NGOs, the Council and the European Parliament.

1.3. Opinion of the IAB

The first draft Impact Assessment (IA) report was presented to the Impact Assessment Board (IAB) on 28 March 2012. The IAB asked to further strengthen and improve the IA document by i) better explaining the policy context and the problem definition; ii) strengthening description of policy options; iii) improving the assessment of impacts; and finally iv) including more specific on the results of the stakeholder consultation.

The revised IA report addresses the IAB comments in the following way: section 1.3 includes a summary of the public consultation results; section 2.1 further explains the rationale for bringing forward the present communication, and clarifies the linkages and the coherence of this initiative with other EU policies; section 2.2 describes in more detail the specific challenges affecting future renewable energy growth in the EU, including investors' uncertainty and the cost-effectiveness and market integration of support schemes. The objectives of this initiative were further refined. In addition, a table summarising how the various policy options relate to the underlying drivers and further information on stakeholder view were included in section 4. Section 5 includes a more structured and detailed qualitative analysis of the economic, environmental and social impacts, which is complemented where appropriate by related quantitative analysis from the Energy Roadmap 2050 modelling and from relevant literature. Furthermore, policy coherence was further discussed in section 6. Finally, more information on the results of the public consultation and on the Primes model was added in the Annexes.

2. SECTION 2: PROBLEM DEFINITION

2.1. Context

The EU renewable energy policy started with the adoption of the European Commission's 1997 White Paper[1] which laid down a Community strategy and action plan for doubling the share of renewable energy in the EU's gross internal energy consumption from 6% to 12% by 2010. This has been driven by the need to address key challenges affecting the EU energy sector, including: deteriorating security and diversity of energy supplies, weak competitiveness, and energy-related GHG emissions (see Box 1).

Box 1: Key challenges for the EU energy sector

- *Deteriorating security of energy supply.* The EU is increasingly competing with other importing countries and regions for energy supplies, given that its own domestic energy production is on the decline. With more than half of the energy consumed in the EU coming from third countries, the EU is already the world's largest energy importer. Today, the EU imports more than 80% of the oil and more than 60% of the gas it consumes. If the current trends continue, import levels could reach more than 70% of the EU overall energy needs by 2030.
- *Low diversity of energy supply.* The EU's geographical location puts it in close proximity of a number of energy-producing regions as well as at the intersection of important supply routes. Countries in the EU's neighbourhood already account for the majority of EU's imports in oil and gas. Russia, Norway and Algeria represent together 85% of the EU natural gas imports and almost 50% of the crude oil imports. This reliance on a limited number of fuels and technologies and suppliers generates supply and price risks, price rises and price volatility. Countering such trends, the increased growth of renewable energy significantly increases the diversity of fuels and suppliers, generally with a strong indigenous component.
- *Weak competitiveness*. The combination of soaring energy consumption in emerging economies and the gradual depletion of fossil fuel supplies are inevitably pushing up energy prices. Already today oil prices exceed €90 per barrel despite the financial and economic crisis. Market volatility and medium and long term price risks increase costs and uncertainty for European industry, which can be mitigated through indigenous, more stably priced renewable energy sources.
- *Climate change from excessive greenhouse gas emissions*. Whereas the EU as a whole has seen its GHG emissions decrease over the last 2 decades[2], they are not in line with the reduction pathway required to achieve the EU and international goal of limiting global mean temperature increase below 2°C and avoid dangerous climate change. Despite reduction in carbon intensity, the energy sector remains the single largest source of EU GHG emissions. Attaining the 2°C objective will require a dramatic reduction in the GHG emissions of the energy system, which means reducing energy consumption and increasing significantly the use of renewables and other low-carbon energy sources. Renewable energy could reduce exposure to

[1] COM (97) 599 final
[2] Excluding emissions from LULUCF (Land Use, Land Use Change and Forestry)

climate change risks, and so provide climate adaptation benefits as well as climate change mitigation.

The White Paper was followed in 2001 by the "Renewable Electricity Directive"[3] and in 2003 by the "Biofuels Directive"[4] which set respectively national indicative targets such that the EU would reach a share of renewable energy in electricity generation of 21% by 2010[5] and a share of renewable energy replacing petrol and diesel in transport of 5.75% by 2010. As the Commission noted in earlier reports[6], the 2010 targets have not been met. This inadequate rate of progress, and the need to foster a more balanced renewable energy development in all Member States and technologies, was among the reasons that prompted a change in policy approach marked by the adoption of the Renewable Energy Directive (hereafter: the RES Directive) [7], as a key component of the 2008 Climate and Energy package.

The RES Directive covers energy consumption as a whole, including the heating and cooling sectors. For the first time, it lays down legally binding rather than indicative national targets such that the EU achieves a 20% share of renewable energy by 2020. It also contains a much-reinforced set of provisions to facilitate the development of renewable energy, such as a legal requirement for the Member States to prepare National Renewable Energy Action Plans (NREAPs) – ie detailed roadmaps to reach the RES targets, reform planning regimes, and develop electricity grids.

This comprehensive and binding regulatory framework is proving catalytic in driving forward renewable energy growth in line with the ambitious targets that the EU has set itself. As shown in Figure 1, MS project that renewable energy will grow at a faster pace in the years up to 2020 than in the past (6% during 2010-2020 compared to 4.5% in 2000-2010). As a result, the overall share of renewable energy in the EU will exceed the 20% target in 2020.

Figure 1: Renewable energy share (% of total gross final energy consumption). Source: PRIMES 2011

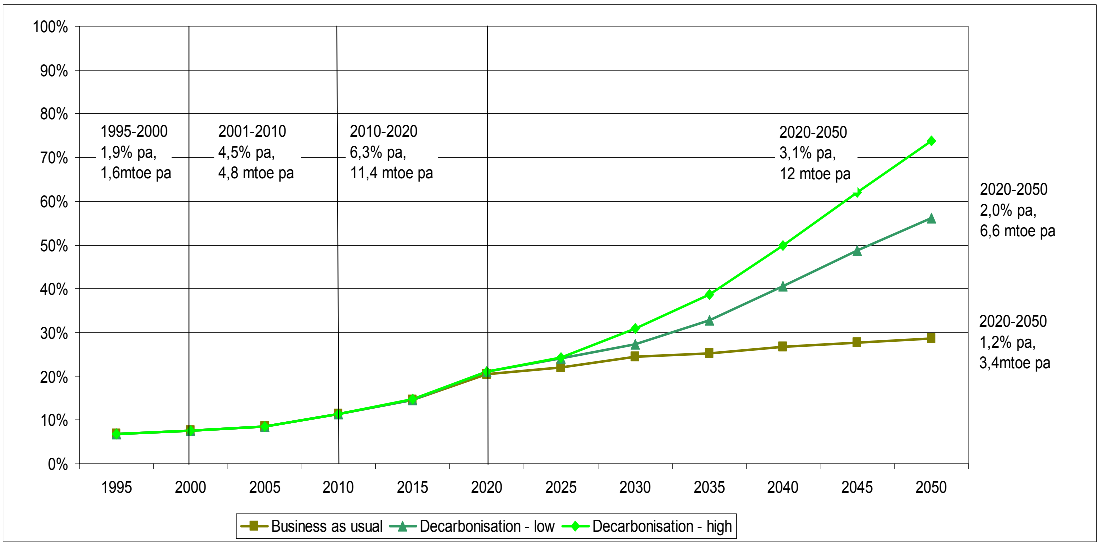
3 Directive 2001/77/EC of 27 September 2001 on the promotion of electricity produced from renewable energy sources

4 Directive 2003/30/EC of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels

5 The EU share of renewable energy in electricity generation included in the Annex of Directive 2001/77/EC is 22%, but following subsequent accessions has since then been amended to 21%.

6 Renewable Energy: Progressing towards the 2020 target, COM/2011/0031 final.

7 Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources



The RES Directive has created the world's most ambitious policy framework for renewable energy deployment up to 2020. But its is clear that this represents only an early step in what will be a long road towards decarbonization of the European energy sector. In order to keep climate change below 2°C, both the European Council and Parliament have already set the objective of reducing greenhouse gas emissions by 80-95% by 2050, compared to 1990 levels, in the context of necessary reductions by developed countries as a group[8].

In 2011, the Commission published a 'Roadmap for moving to a competitive low carbon economy in 2050' [9] which makes the economic case for decarbonisation and shows that the targeted 80-95% GHG emissions reduction by 2050 will have to be met largely domestically. Intermediate milestones for a cost-efficient pathway, e.g. 40% domestic reduction by 2030, and sectoral milestones expressed as ranges of GHG emissions reductions in 2030 and 2050 were put forward.

This initiative was followed by two sectoral roadmaps exploring the dynamics of decarbonisation within the transport and energy sectors and its interplay with other sectoral objectives. The 'Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system[10] aims to introduce profound changes in passenger and freight transport patterns, resulting in a competitive transport sector which allows increased mobility, cuts CO2 emissions to 60% below 1990 levels by 2050 and breaks the transport system's dependence on oil.

The Energy Roadmap 2050[11], published in December 2011, investigates possible pathways for a transition towards a low-carbon energy system. It identifies a higher penetration of renewable energy beyond 2020 as a major pre-requisite for a more sustainable and secure energy system. More specifically, it shows that renewables will supply the biggest share of

---

8 European Council, Brussels, 29/30 October 2009, Presidency conclusions. 15265/1/09. European Parliament resolution of 4 February 2009 on "2050: The future begins today – Recommendations for the EU's future integrated policy on climate change; resolution of 11 March 2009 on an EU strategy for a comprehensive climate change agreement in Copenhagen and the adequate provision of financing for climate change policy; resolution of 25 November 2009 on the EU strategy for the Copenhagen Conference on Climate Change (COP 15)

9 COM(2011)112, 8 March

10 COM(2011)144, 28 March

11 COM(2011) 885/2

EU final energy consumption in 2050[12]. Therefore, post-2020 renewables are set to play a central role in Europe's energy mix, moving from technology development to mass production and deployment, from small-scale to large-scale, from financial support to grid parity and competitiveness. This changing nature of renewables points to need for start reflecting on how to adjust policy in parallel to market development, build on using the full potential of the existing EU renewable legislation.

The Communication that this Impact Assessment accompanies is linked to initiatives to deliver on a resource Efficient Europe, one of the seven flagships of the Europe 2020 strategy[13]. It aims at further developing the analysis presented in the Energy Roadmap 2050, with particular attention to the challenges and the related policy solutions that are needed to enable a greater share of renewables in the EU energy mix, while prompting cost-effectiveness, a European approach, and greater market integration.

2.2. What is the problem?

Since the adoption of the RES Directive in 2009, the EU renewable energy sector has developed faster than foreseen. Many Member States have experienced rapid growth in the deployment of renewable energy technologies and as a result 18 Member States are currently ahead of their renewable energy trajectory as set out in the Directive. Driven by economies of scale and technology improvement, unit costs of different renewable technologies have decreased by up to 50%, This is particularly the case for solar PV. In view of the EU´s ambitions to significantly increase its share of renewable energy this development is to be welcomed.

During the same period, the EU has undergone a serious financial and economic crisis, which has put pressure onto business and communities across Europe, as well as causing huge stress on public finances. This has made national and international investors cautious about investing in capital intensive energy markets, and in particular in the policy-dependent renewable energy sector. The economic downturn has also contributed to low carbon prices, which in turn has weakened the incentive to invest in renewables.

The rapid fall in costs for renewable energy technologies and the boom in renewable energy installations, has in some cases lead to increased aggregate costs for electricity consumers (and in some cases taxpayers). At a time of economic austerity, such cost increases can be difficult to manage, and the risk of over compensation to energy producers has risen. In response to such events, Member States have increasingly reduced incentives and reformed support schemes for renewables to ensure cost-effectiveness and market integration. Again, this is to be welcomed. However, sometimes the manner in which such reforms have been undertaken has failed to follow European best practice, creating investor uncertainty across Europe.

Against this context, it is increasingly clear that the EU 2020 renewable energy target may not in itself be sufficient to promote the necessary long-term investments that will allow for further cost reduction and a greater share of renewabe energy post-2020. For instance, the testing facilities, cable production, factories and ships needed for building offshore wind power plants not only need time to be developed, but their investment profiles change

[12] RES share is projected to rise substantially in all scenarios analysed, achieving between 55% and 75% of total final energy consumption in 2050, up from today's level at around 10%. RES share in electricity consumption reaches even higher levels, with 64% in a high-efficiency scenario and 97% in a high-renewables scenario.

[13] COM(2011) 21, 26 January 2011.

significantly according to policy frameworks: payback periods to 2020 (8 years) change investment decisions, compared to payback periods of 18 years (to 2030). Clarity about the future direction of EU renewable energy policy is thus crucial in order to provide the renewables sector with predictability. Recognizing this issue, a number of MS have already set milestones for renewable energy share post-2020. For instance, in 2011 Germany adopted the goal of increase renewable power share to 50% by 2030, rising to 60% by 2040 and 80% by 2050[14], while in 2012 Denmark committed to covering 100% of its national energy supply with renewable by 2050[15].

The RES Directive requires the Commission to present a post-2020 Renewable Energy Roadmap only in 2018, taking into account technological development and the experience gained from the Directive implementation. In addition, it contains a requirement for the Commission to review certain specific provisions of the Directive (notably regarding the GHG savings thresholds for biofuels and bioliquids, the measures and the impact of biofuels and bioliquids and the so-called cooperation mechanisms) by 2014. However, considering the fast-evolving economic, technology and regulatory environment described above, the Commission senses a growing belief amongst stakeholders that planning for the post-2020 period requires consideration already today.

The Communication that this Impact Assessment accompanies looks at both the challenges and possible solutions in terms of energy market opening, support scheme reform, modified electricity market arrangements, optimised infrastructure management and sustainability that are required to facilitate the integration of renewable energy into the single market. It also sets the framework for determining what policy regime is necessary post-2020 to enable Europe's renewable energy production continues to grow to 2030 and beyond. All of this is meant to provide clear signals to Member States, investors, and citizens about the EU's long-term commitment to the promotion of cost-effective deployment of renewable energy.

2.3. Underlying drivers of the problem

The RES Directive is based on the rationale that a positive framework for renewable energy development is necessary due to a number of market and regulatory failures or imperfections. These include non-internalisation of negative externalities of conventional energy forms, the presence of subsidies for other energy forms, imperfect market structures, regulatory barriers, the status of many renewable technologies as "infant industries" together with significant inertia of the system, and barriers related to information and public perception. While some of these issues will be increasingly addressed by 2020 through on-going policy initiatives[16], the following six challenges need to be addressed in the coming years in order to facilitate a greater share of renewable energy the EU energy mix post-2020.

(1) Uncertainty of future policy framework

---

14 German Federal Ministry of Environment (2011), Germany's Energy Concept, www.bmu.de/english/transformation_of_the_energy_system/faq/doc/47589.php#1

15 Danish Ministry of Climate, Energy and Building (2012) Denmark Energy Agreement, 22 March 2012, www.kemin.dk/Documents/Presse/2012/Energiaftale/FAKTA%20UK%201.pdf

16 For example, policies include the ETS and the Large Combustion Plant Directive for the non-internalisation of negative externalities of conventional energy forms; the commitments to phase out coal subsidies and the Energy Taxation Directive for the presence of subsidies for other energy forms; the competition policy and the Third Package unbundling for imperfect market structures; the Third Package again and the RES Directive priority connection requirements for regulatory barriers; and the RES Directive for information and public perception.

The RES Directive established a clear, stable and robust regulatory framework, notably based on legally binding national targets for renewable energy by 2020, which has created the required conditions for a period of major growth and investment in the sector in Europe. Whilst the framework is still relatively young, current analysis suggests that it has been successful in promoting MS action to remove barriers to and support the development of renewable energy. The case is similar for carbon emissions, technology development such as carbon capture and storage, and energy efficiency measures. These are all issues which require strong and continued government intervention for significant development to occur.

As currently framed, however, the EU renewable energy policy framework effectively ends in 2020, a mere eight years away. Post-2020, there are no renewables objectives and no decarbonisation targets other than a decreasing EU Emission Trading Scheme (ETS) cap by a linear factor of 1.74% per year and a political, rather than legal, EU Council objective to achieve 80-95% greenhouse gas reductions by 2050 if other developed countries take similar action. Carbon pricing can provide an incentive for deployment of the more mature renewable energy technologies across Europe. In particular a strengthened ETS is a necessary condition for promoting renewables post-2020 but it may not be sufficient, particularly for speeding up the commercialization of innovative renewable energy technologies. The uncertainty about renewable energy market volumes post-2020 and the related support schemes may therefore lead to commercialization problems for new capital intensive renewables technologies where investments are marked by long lead times.

(2) Viability of financing incentives

Whilst multiple financial, institutional, structural, administrative and technological barriers hinder the development of renewable energy, financial incentives have often been used to overcome all such constraints. These have consisted of R&D support, investment aid and operating support. This multitude of different support schemes raise concerns from the perspective of the single market as it could undermine system efficiency for achieving EU objectives and raise costs[17]. In addition, a rise in expenditure (partly caused by a boom in installations resulting from falling photovoltaic per unit costs) is generating concerns on the cost-effectiveness and on their possible impacts on energy consumers[18].

The cooperation mechanisms established by the RES Directive address the need to improve the cost-effectiveness, convergence and market integration of national support schemes, with the view to increase the efficiency with which Europe develops its renewable energy resources[19]. However, further EU action may be necessary in the coming years, depending on the rate of technology cost reductions, policy and regulatory reform at national level and the scale of future renewable energy growth.

17 Investors are confronted with different criteria for and levels of support as well as administrative procedures and grid access conditions, all of which influence their production and site location decisions. See SEC (2011)131.

18 Operational financial incentives are typically supported by energy consumers through power and gas tariffs.

19 According to COM (2011)31 and SEC(2011)131, this will be done through: the facilitation of the development of cooperation mechanisms both between Member States and with third countries, the preparation of guidelines for more harmonised reform of national renewable energy support schemes, the promotion of reforms in the southern Mediterranean to facilitate the growth of renewable energy and the scope for third country cooperation post 2020, the continued work with financial institutions to improve European support for private investment in renewable energy projects, the increased use of innovative financial instruments as a device for achieving greater private sector leverage for European policy priorities and maximising the EU value added of financing in the energy sector.

(3) Consistency of market arrangements

Current power market arrangements were created in an electricity sector characterised by centralised conventional power plants running on gas and coal. Wholesale electricity prices tend to be based on short-run marginal costs (with significant legacy capital, average costs were low) and are largely driven by changes in fossil fuel prices. Most forms of renewable power generation, by contrast, have high upfront capital costs but low operational costs (with the exception of bioenergy). As the proportion of renewable generation within the electricity market increases, if wholesale power prices remain based on short run marginal costs, prices will fall and investments covered only by electricity sales revenues will struggle to cover costs. This might lead to concerns about the ability of investors to recover capital and fixed operating costs. In addition, current renewable electricity purchasing arrangements do not always allow for renewable generators to effectively respond to market price signals, thus creating inefficiencies in market operation.

In some Member States these challenges have led to calls for the introduction of 'capacity payments' (mechanisms to remunerate the provision of capacity in addition to the electricity sold) to help covering fixed costs. Other Member States and market participants have been more sceptical about the introduction of such payments and see them undermining price signals in the market. Against this background, the question arises on how to address capacity challenges in a way that does not lead to new distortions in the internal electricity market.

(4) Adequacy of energy infrastructure

Most of Europe's large-scale renewable energy is located at its periphery (including wind and wave power in the northern seas, biomass in the Northern/Eastern Europe and solar power around the Mediterranean), away from centres of consumption. Making best use of this potential will require greater volumes of electricity crossing national borders. Transmission expansion throughout Europe is a fundamental enabler for integrating power markets and is the most cost effective means to accommodate higher levels of diverse renewable energy in a secure and robust power system. In addition, the distribution grid also needs to become much smarter to deal with significant new forms of distributed generation such as solar PV and to facilitate increased demand response. With more decentralized generation, smart grids, new networks users (e.g. electric vehicles) and demand side management, there is also a greater need for more integrated view on transmission, distribution and storage.

The EU energy infrastructure policy, including the proposed regulation on trans-European energy infrastructure,[20] addresses the need to improve Europe's transmission and distribution networks to enable the growth of electricity from renewable energy sources as well as to facilitate the integration of the European single market by 2020[21]. However, stakeholders in the finance community are starting to raise concerns such investments will be difficult to realize in the current economic environment. Therefore further measures may be necessary, depending on the rate of infrastructure development, the coordination of network planning and the scale of future renewable energy growth.

---

20 COM(2011)658.

21 More specifically, transmission System Operators (TSOs) are required to co-operate to elaborate regional and European 10-year network development plans (TYNDP) for electricity and gas with a focus on cross-border interconnections, in the framework of the European Network of TSOs (ENTSO). The package also establishes an Agency for the Co-operation of Energy Regulators (ACER) that – among other tasks – will have to monitor the implementation of European TYNDPs. The third package finally sets the target, where possible, to equip at least 80% of consumers with smart meters by 2020 as a first step towards the implementation of smart grids.

(5) Uncertainty about innovative technologies

The 2050 Energy Roadmap highlighted how a continuous up-take of breakthrough renewable energy technologies[22] will be needed throughout the period to 2050 to achieve the transition to a sustainable and secure energy sector. However, bringing these new renewables to the commercial market-place is challenging and cannot be achieved by the market alone. Creating new technologies requires large and cutting-edge research infrastructures. Their up-scaling to commercial stage demands significant capital investments with risks that are too large for venture capital and too high for the traditional banking sector. All in all, higher public and private investment in R&D technological innovation are crucial in speeding up energy innovation.

The EU Strategic Energy Technology (SET) Plan addresses the main bottlenecks energy technologies are facing from the technology creation stage to the first-of-a-kind commercialisation and system integration stage through a better integration and coordination of research and innovation capacities and leverage of resources. Horizon 2020, the proposed framework programme for research and innovation for the period 2014-2020, will be key in catalysing these efforts. Reinforcing the capacity of the market to systematically promote the latest breakthrough innovations and their diffusion will be one of the central issues for the post-2020 horizon.

(6) Public acceptance and sustainability

Public acceptance of renewable energies is fundamental to further increasing their share in the overall energy supply[23]. Generally, renewable energy generation enjoys widespread public support because of its distributed nature and its global and local environmental and socio-economic benefits. However, a lack of such support for building large-scale renewable energy installations or related energy infrastructure (both at transmission and distribution level) is often causing a slowing down of their planning and permitting processes, potentially becoming a barrier to renewables growth.

While the RES Directive and the Fuel Quality Directive introduced the world's first mandatory sustainability criteria for biofuels and bioliquids, concerns have been raised about the need to further strengthen such scheme as bioenergy demand is set to be a significant component of the renewables increase post-2020. In this context, the Commission will soon report both on the issue of indirect land use change emissions and on the need for EU sustainability criteria for solid and gaseous biomass used in electricity and/or heating and cooling. The rationale for a specific renewables target in transports will also need to be looked closely at in the context of the post-2020 regime. Existing EU policy initiative, including the energy infrastructure package, will help in streamlining authorisation procedures for international energy interconnectors, but further measures may be needed, also to ensure public acceptance of the roll-out of smart-grid applications.

---

22 Such transition will require significant advances in renewable energy technologies such as deep off-shore wind resources, second generation bio-fuels, biomass gasification, thin film photovoltaic, ocean energy, direct steam generation concentrating solar plants and compressed air energy storage.

23 See: Heras-Saizarbitoria et al. (2011), Public acceptance of renewables and the media: an analysis of the Spanish PV solar experience, Renewable and Sustainable Energy Reviews, Vol. 15/ 9, Pg. 4685-4696; and, Zoellner et al. (2008), Public acceptance of renewable energies: Results from case studies in Germany, Energy Policy, Vol. 36/ 11, Pg. 4136–4141.

2.4. Business as usual developments

This chapter looks at how renewable energy share would develop post-2020, under a business-as-usual scenario (BAU) where no further EU policy actions is taken. The analysis builds considerably on the Current Policy Initiatives (CPI) scenario described in the Impact Assessment of the Roadmap Energy 2050. The CPI scenario reflects the continuation of current EU climate and energy policies (including the RES Directive, the latest Commission legislative proposals on energy efficiency, energy taxation and energy infrastructure) and also takes into account recent energy policy developments (higher energy import prices and effects of nuclear accident in Japan).

Therefore, the BAU scenario assumes the achievement of the overall GHG target, ETS cap and non-ETS national targets by 2020 but thereafter GHG reductions fall short of what is required to mitigate climate change with a view to reaching the 2 °C objective. Import dependency, in particular for gas, increases over the projection period and electricity prices and energy costs also rise. So despite efforts over recent years, the long term effects of our current and planned policies (including the RES Directive) are not sufficient to achieve the ambitious 2050 decarbonisation objective set by the Council, and to improve both security of supply and competitiveness. Below the main energy trends of the BAU scenario are described.

Energy developments

Under the BAU scenario, primary energy demand falls by 5% in 2020, and it continues slightly to decrease in 2030 (-5.8%) and in 2050 (-8.4%). Final energy consumption in 2020 is below that expected under earlier, 2007 projections, further decreasing significantly up to 2050 as more efficient technologies have by then reached market maturity and so reduced energy demand. The sectorial break-down of demand remains broadly stable with transport remaining the biggest single consumer accounting for 32% in 2050; the industrial share increases slightly while that of households declines a bit. Further energy savings are brought about mainly by energy efficiency measures for households and services sector and efficiency improvements in energy transformation in the short to medium term, leading to further declines in final energy demand which remains 4-6% below the BAU scenario.

Renewable energy share is raising very slowly post-2020 to reach only 25% in 2030 and just over 29% in 2050. The sector's growth declines from 6% per year in the current decade, to only by 1% per year between 2020-2050. This trend is due to the assumed phasing out of operational aid to mature renewable energy technologies. The share of renewables in transport also shows very slow growth, increasing from 10% in 2020 – as required by the RES directive – to a mere 13% by 2050. Similarly, the pace of electrification in the transport sector is projected to remain slow in the BAU scenario: electric propulsion in road transport does not make significant inroads by 2050.

Although consumption of fossil fuels decreases and an increasing share of energy is from renewable energy, the share of energy imports still rises, though only slightly (by 6% from 2005 to 2050). This is because the development of renewable energy is not fast enough to compensate for the drop in domestic supply of fossil fuels. Import dependency rises from 54%, reaching 58% in 2030 and flattening out to 2050 due to increased domestic renewable energy production.

Average electricity prices rise up to 2030 and stabilise thereafter. The price increase up to 2030 is due to three main elements: high fuel prices due to the world recovery after the economic crisis, ETS carbon prices and support to renewables. Post-2020, electricity prices remain stable because of the techno-economic improvements of various power generation technologies that limit the effects of higher input fuel prices and CO2 prices. Total costs of energy (including capital costs, energy purchases and direct efficiency investment costs) are rising fast over the projection period but are not equally distributed across sectors. Energy related expenditures in households rise strongly while the growth of energy related costs for services and industry is more moderate. Energy costs are rising faster than GDP and represent around 15.3% of GDP in 2030 (up from 10.5% in 2005) and 14.6% in 2050. The faster rate of growth relative to GDP reflects significant investments needs in energy production, transmission and distribution as well as demand based energy efficiency measures.

Environmental developments

Under the BAU scenario, greenhouse gas emissions fall by 26% in 2030 and 41% in 2050, achieving only half of the contribution necessary to limit climate change to 2°C[24]. The substitution of the use of fossil fuels would be partially achieved by greater use of biomass. Whilst current EU law sets sustainability criteria for the production of biofuels and bioliquids, emissions from indirect land use change are not taken into account in the current regime and the use of biomass in electricity and heating/cooling is not so far addressed at EU level. At the same time, national and EU measures promoting biomass sustainability such as forest management laws and processes and environmental policies (e.g. EU post-2020 biodiversity strategy) are in place across the Union but they do not apply to third countries, which are expected to contribute significantly to EU biomass supply post 2020. This is the situation reflected in the business as usual scenarios. The lack of a coherent EU sustainability scheme may lead to increased pressures on land use and biodiversity. This is even more likely when biomass imports are considered, where the issue can be even more sensitive in certain third countries where there is a lack of forest management policies or ineffective implementation.

Social developments

The vast majority of literature[25] indicates that renewable deployment is associated with net job creation. For fuel-free renewable energy technologies, the greatest number of jobs is generally concentrated in the installation, manufacturing, and administration phase, while for fuel-based technologies such as bioenergy, biomass feedstock production and distribution account for the largest share. While labour productivity evolves over time, studies have shown that renewables are currently more labour-intensive than fossil fuel technologies. Against this backdrop, under the business as usual scenario new job creation can be expected mainly in the period up to 2020 when the current renewable energy framework generates strong growth of the sector. Post-2020, as a consequence of the low growth rates in renewable energy markets, net job creation would be reduced significantly, especially if the EU would quickly loose its global technological lead on renewables.

2.5. EU's right to act

The EU's competence in the area of energy is set out in the Treaty on the Functioning of European Union, Article 192 (environment), Articles 114 (internal market) and Article 194

---

24 This includes also some energy-related non-CO2 emissions, e.g. methane emissions from coal mining and losses in gas distribution networks and F-Gas emissions related to air conditioning and refrigeration. While the former are estimated to decrease under current trends, the latter are projected to increase considerably. For a more detailed analysis of the overall GHG reduction efforts needed and of trends in non-CO2 emissions see the Impact Assessment of the Roadmap for moving to a competitive low carbon economy in 2050 (SEC(2011)288).

25 IRENA (International Renewable Energy Agency) (2012), Renewable Energy - Jobs Status, Prospects & Policies, www.irena.org/DocumentDownloads/Publications/RenewableEnergyJobs.pdf.

(energy)[26]. From an economic perspective, many energy system developments can be achieved on an EU-wide basis, encompassing both EU and Member State action while duly considering the respective competences. The European market can encourage the most cost-effective renewable energy production; facilitate the balancing of the electricity system and reduce the need for back-up capacity and energy storage. The large scale investments needed to harness a number of renewable energy sources (e.g. off-shore wind, second generation biofuels) are also more feasible and cost effective in EU-wide markets. Finally, the large R&D budgets needed for developing innovative renewable energy technologies can be mobilized and organized more-effectively at the European scale rather than at national level.

2.6. Who is affected?

The energy industry, including but not limited to the renewable energy sector, will be directly concerned as it will need to develop and deploy the needed renewable energy technologies in the coming years as well as integrate them into the single energy market. Consumers will be affected by overall energy expenditure (resulting from the combination of energy prices and amount of energy used) as well as by energy-related investments such as house renovation, new types of vehicles, more efficient appliances etc. Public authorities will also need to engage in discussions about the pros, cons and trade-offs of different policy options (higher and geographically concentrated renewable energy development will require additional energy infrastructure investments; supply of sustainable biomass will require enhance agriculture and forestry practices, etc.). Changes in the role of renewables within the EU energy mix will also have a direct influence on third country fuel suppliers.

3. SECTION 3: OBJECTIVES

3.1. General objectives

The general objective of this intervention is to ensure that EU renewable energy policy contributes significantly to: the security and diversity of energy supply, competitiveness, and environment and climate protection, but also supports economic growth, employment creation, regional development and innovation in the EU.

3.2. Specific objectives

More specifically, in order to achieve the general objectives, this initiative aims to: i) reduce uncertainty for investors and the business community, ii) improve viability and cost-effectiveness of financial incentives, iii) facilitate consistency with market arrangements, iv) provide adequate energy infrastructure, v) foster technology innovation and development, vi) and ensure wider public acceptance and address sustainability considerations.

3.3. Operational objectives

The operational objective is to give insight on how the EU renewable energy policy framework could develop beyond 2020, with the view to: a) inform market actors (technology providers, operators, investors) and other stakeholders (central governments, local authorities, NGOs and citizens) about the possible future policy orientations at the EU level for enabling higher penetration of renewables in the EU energy mix; b) show trade-offs among policy objectives as well as among different renewable energy development pathway; and, c) support

[26] Under Article 194 TFEU, Union policy on energy shall aim at: (a) ensure the functioning of the energy market; (b) ensure security of energy supply in the Union; (c) promote energy efficiency and energy saving and the development of new and renewable forms of energy; and (d) promote the interconnection of energy networks.

the policy debate on the need, ambition and timing of possible renewable energy milestones for the post 2020 period.

3.4. Consistency with other European policies

The Renewable Energy Strategy fits into the overall framework of decarbonisation as designed by the Europe 2020 flagship initiatives 'Resource Efficient Europe' and the Commission's Communications on 'Roadmap for moving to a competitive low carbon economy in 2050' and 'Energy Roadmap 2050'. The objectives of this intervention are coherent with the objectives of medium term strategy as defined in the Commission's Communications 'Europe 2020' and 'Energy 2020', the EU objective to reduce GHG emissions by 80 to 95% in 2050 compared to 1990, as well as with energy policy objectives as described in the Lisbon Treaty. This initiative seeks synergies and complementarities with a number of other EU policies and initiatives such as the EU Emission Trading Scheme, the Internal Energy Market development, the Common Agriculture Policy and the EU Sorest Strategy, the Bioeconomy Strategy and Action Plan and the Resource Efficiency Roadmap. It is clear that the evolution of the renewable energy policy must evolve in conjunction with energy market, energy efficiency and climate action policy discussions, with the view to maximize synergies and minimize possible overlaps.

4. SECTION 4: POLICY OPTIONS

Table 1 below summarise the policy options identified in this impact assessment and further described in this section. They respond to the problem definition described in section 2.2, addressing the six underlining drivers described in section 2.3 with a selected number of key policy measures which are grouped in coherent policy packages that are characterised by an increasing level of policy ambition and EU integration. Additional policy elements that are necessary to promote renewable energy post-2020 include, for instance: phase-out of support mechanisms or subsidies for conventional, non-renewable energy sources; better financing possibilities for renewable energies; public procurement obligations, etc. For keeping the assessment manageable, these measures have not been included in the studied options but they could be subject to future analysis.

Table 1: Key features of policy options

Policy options	**(1) Business as usual**	**(2) Decarbonisation with no renewables targets**	**(3) Post-2020 national renewables targets/ coordinated support**	**(4) Post-2020 EU renewable target/ harmonised measures**
Underlining drivers				
Policy uncertainty	No new RES/GHG targets	New GHG targets post-2020, no specific RES targets	Post-2020 national RES targets + new carbon and energy efficiency goals	Post-2020 EU-wide RES target + new carbon and energy efficiency goals
Support viability	Phase out of RES support	Phase out of national support schemes	Enhanced coordination and cooperation amongst MS	EU-wide harmonized support schemes
Market arrangements consistency	No new measures	Renewables fully exposed to market risks	Accelerated exposure to market risks	Common balancing and capacity markets
Infrastructure adequacy	No new measures	New measures, connections with 3rd countries	New measures, connections with 3rd countries	New measures, connections with 3rd countries
Innovative technologies uncertainty	No new measures	Enhanced R&D financing through carbon markets	Enhanced R&D financing through carbon markets	Enhanced R&D financing through carbon markets
Public acceptance/ sustainability	No new measures	Sustainability criteria applied to all bioenergy uses	Sustainability criteria applied to all bioenergy uses	Sustainability criteria applied to all bioenergy uses

4.1. Policy options

4.1.1. Option 1: Business as usual

As explored in 2.5., option 1 would imply **no new EU policy framework** promoting renewable energy after 2020, when the current EU renewable energy target of 20% ends. Renewable energy would continue to benefit from to the current greenhouse gas reduction framework for post-2020. This consists of the directive on the EU Emissions Trading System, which will continue to reduce the emissions cap for the ETS sectors by a linear factor 1.74% each year beyond 2020. The planned coordinated and partially EU-financed development of energy infrastructure, including power grids, should improve and will be able to keep pace with the projected low growth of renewable energy share.

The strong growth in renewable energy up to 2020 is expected to continue to bring down the cost of renewable energy technologies. As different technologies mature, **support can be phased out**, or at least renewable energy producers can be integrated into the market with reforms to support schemes that expose renewable energy production to market risks. Once the energy market for established renewable energy technologies is liberalised and competitive, only new renewable energy technologies that still clearly need support would not be exposed to full market risk. With no further renewable energy support or policy objective, the **development of international renewable energy sources** (e.g. in North Africa and in the European neighbourhood), currently facilitated by the renewable energy Directive's "cooperation mechanisms", would slow down for want of European incentives.

Concerning the **sustainability of renewable energy**, in most instances, the environmental impact of energy related activities, including renewable energy, are addressed through horizontal measures. At EU level these include requirements for strategic environmental assessments, environmental impact assessments, compliance with EU biodiversity and environmental legislation as a whole. This strong European environmental framework is usually capable of addressing the public's concerns regarding sustainability. However, with the expected increase in biofuel generation due to the current 10% renewable energy in transport target by 2020, dedicated sustainability criteria have been introduced for biofuel and bioliquids under the RES Directive, Fuel Quality Directive (FQD) and are also applicable under the EU ETS. Under this option, given that the current sustainability scheme for biofuels is closely linked to the enforcement of the EU renewable energy target for transports, it is unclear how it would apply to biofuels used post-2020. Their impact depends on the future evolution of the targets of the FQD, which could be considered as remaining at current level for the purposes of this business as usual scenario. In addition, it assumed that solid and gaseous biomass would remain exempted from sustainability standards.

This option would not be in line with the views expressed by a clear majority of stakeholders which support some form of dedicated target for renewable energy post-2020. Only 14% of respondents considered such a target unnecessary. Among those favouring renewable energy targets, a clear majority supported mandatory over indicative targets (39% over 14%).

4.1.2. Option 2: Decarbonisation without renewable energy targets post-2020

Option 2 would imply **strengthened GHG reduction targets** and/or policies fully compatible with the long-term decarbonisation goal of reducing EU GHG emissions by 80% to 95% by 2050 compared to 1990, e.g. along milestones as outlined in the Low Carbon Economy Roadmap. For the ETS sectors, this could imply reductions compared to 2005 by around 45% by 2030 and around 90% in 2050, which is beyond the current ETS linear reduction factor of 1.74% that would lead to just over 70% reduction in 2050. For non-ETS sectors, this could imply additional policies and measures which lead to GHG emission reductions compared to 2005 by around 30% in 2030 and around 70% in 2050, going well beyond current non-ETS policies. Also GHG emissions from Land Use, Land Use Change and Forestry (LULUCF) would be appropriately covered by the policy framework.

Under this option, no specific post-2020 renewable energy objectives would be set. However, this option would include binding **EU measures addressing the non-cost barriers to investments** in renewable energy. These measures could be developed for the specific conditions in the electricity, heating and cooling sectors, reflecting on grid access and authorisation regimes for new entrants, both for electricity and gas. They would also include a strengthening of existing provisions contained in the 2009 RES Directive, aimed at fostering the use of renewable energy in new and renovated buildings, at developing low carbon district heating networks, and introducing standardised product certification regimes.

As with option 1, the absence of a post-2020 renewable energy specific target would end or reduce **operational incentives for renewable energy**, thus no further EU policy action aimed at promoting more cost-effective and integrated national support schemes would be needed[27]. Concerning infrastructure, further growth in renewable energy production, particularly if it is concentrated in few regions with the most cost-effective resources, could require **supplementary measures on energy infrastructure** beyond current policy initiatives[28]. Such measures would depend on the location of renewable energy growth and subsequent impact on electricity or other infrastructure. It would also depend on expectations regarding imports of renewable energy from neighbouring countries. For instance, greater efforts in developing appropriate energy infrastructure are needed in order to allow for imports from North Africa post-2020.

Additional policy elements of this option would include **enhanced EU R&D and demonstration support** for low carbon energy technologies, building on a philosophy exemplified in the NER 300 programme using a part of ETS auctioning revenues for such purposes[29], and the Horizon 2020 research and innovation framework programme approach and **EU-wide binding sustainability criteria** in line with GHG emission reduction objectives for all biomass for energy purposes, which effectively exclude adverse GHG emission effects including effects via indirect land use change, whether it used in electricity, heating or transport. It should be noted, however, that the implementation of such criteria on those energy users that would be neither covered by the EU ETS, by the Fuel Quality Directive nor the future LULUCF policy framework could raise some administrative challenges, given that currently compliance is closely linked to financial incentives and target achievement.

---

27 This option assumes that there will be no need to introduce explicit capacity payments on energy only markets to ensure system adequacy. This is because the wide spread application of smart technologies and appliances will enable consumers to adjust their consumptions when needed. Consumers will be offered appropriate supply schemes which mirror short term energy prices on wholesale markets and as such provide them with sufficient incentives to reduce or increase off-take instantaneously. This will make investment in generation capacities obsolete which would otherwise be only needed to serve periods of extreme peak demands.

28 Additional measures could consist of regulatory, organisational or financial nature (e.g. regarding planning authorisation regimes, European grid development coordination and EU funding for projects of common interest).

29 Recommendations would be developed at EU level to allocate parts of revenues generated from allowances auctioning towards support to research and innovation activities, in particular financing first-of-a-kind commercial demonstration projects.

As stated above, a large majority of stakeholders support a dedicated renewable energy target for 2030. However, it should be noted that a number of stakeholders support a strengthened GHG reduction regime as the main tool for promoting low-carbon energy source, including renewables. Other aspects of this option which are clearly in line with the majority view of stakeholders include the need for additional measures to address the non-cost barriers to renewables and the application of EU-wide sustainability criteria to all biomass uses.

4.1.3. Option 3: Binding national renewable energy targets post-2020 and coordinated support

Option 3 would imply a continuation of the current energy and climate policy approach embodied in the Europe 2020 Strategy, by maintaining the three interlinked and mutually reinforcing EU targets on GHG emissions, renewable energy and energy efficiency. This would therefore imply setting EU and national **renewable energy targets** for 2030, consistent with the long-term EU climate objectives as outlined in option 2 but in addition ensuring specific growth in renewable energy to address security and diversity of supply goals, innovative technology deployment and competitive industrial development.

This option would also include a **more active convergence of national support schemes** for renewable energy, building on and further strengthening the cooperation mechanisms laid down in the RES Directive. As described in section 3, there is an ongoing debate on the viability of financial support for renewables, both in terms of the levels of incentives and the scheme design, and on their impacts on energy consumers. Financial incentives are increasingly being revised downwards in several Member States to reflect falling costs due to economies of scale and technology development. To the extent that support will be necessary for non-mature and innovative renewable energy technologies, further EU action will be needed to ensure that stronger growth of renewable energy occurs in a cost-effective fashion. This could take the form of EU guidelines on financial support, common cost methodologies, as well as further operationalization of the cooperation mechanisms established by the RES directive, including enhanced cooperation with neighbouring countries.

As in option 2, this option would also imply additional measures **on energy infrastructure** and **enhanced EU R&D support** for renewable energy technologies and, aligned to the further expected demand rise, **EU-wide binding sustainability criteria** in line with GHG emission reduction objectives for all biomass for energy purposes, which effectively exclude adverse GHG emission effects including effects via indirect land use change..

To a large extent, this option reflects the majority view, expressed in the public consultation. As explained above, stakeholders largely support the introduction of post-2020 renewable energy targets, while they believe that support schemes management should remain under MS control. At the same time, many consider as necessary the on-going reform of national support schemes through introduction of market elements, tariff down-ward revision and ultimately phasing out support for mature technologies.

4.1.4. Option 4: EU renewable energy target and harmonised measures

Besides strengthened administrative/planning regimes (cf. infrastructure package) as in option 3, option 4 would imply the establishment of a **EU-wide renewable energy target backed-up by a harmonised support scheme** for renewable energy (if and where support is still necessary) and harmonised electricity system management. A strong European approach to renewable energy development implies that full and **open trading of renewable energy** occurs across all member States. Combined with the ongoing developments of integrating renewable energy producers into the European market, this option implies that all producers face market prices, that any distortions resulting from national approaches are removed, and that the target is achieved in the theoretically most cost-effective manner. An example is this is given by the current technology neutral Swedish-Norwegian tradable certificate regime. Under such approach a joint support scheme based on a technology neutral premium or green certificate regime, all participating Member States would pay the same premium for a MWh of electricity from renewable energy sources, thus equalising costs across the EU. Such a scheme could be established based on joint support schemes.

An additional element for such a policy option would be the extension of such a harmonised regime to the **production of renewable energy in neighbouring countries**. Then, irrespective of the trade in electricity, the green energy could be purchased via a certificate trading scheme. The inclusion of 3rd countries within the same EU framework would be intended to facilitate the growth of renewable energy even beyond the EU's borders, in a cost effective manner. As with option 3, **infrastructure needs** beyond the current 2020 infrastructure package would depend on the expected or intended renewable energy targets and the extent to which the broader (beyond EU) cost effective development of renewables modified the EU energy mix and location.

This policy option also assumes a **common EU approach to market arrangements**. It is clearly the intention of the EU to ensure the completion of the internal market well before 2020[30] and to harmonise a number of network codes, framework guidelines and other grid management practices. The extent and success of this harmonisation, the infrastructure needs associated with the energy mix expected to be generated by an EU-wide approach to renewable energy development, and the convergence of support schemes for renewable energy all have implications for electricity market arrangements. As in option 2, this option would also see an enhanced **EU R&D support for renewable** energy technologies and **EU-wide binding sustainability criteria** in line with GHG emission reduction objectives for all biomass for energy purposes, which effectively exclude adverse GHG emission effects including effects via indirect land use change.

The full EU harmonisation of support schemes envisaged in this option is supported by a number of stakeholders, mainly energy traders and utilities. Overall, the majority of respondents to the public consultation (54%) believe that national control over support schemes should continue. A EU requirement to open support schemes to producers from third countries as envisaged under this option would be particularly controversial (supported by only 11%).

5. SECTION 5: ANALYSIS OF IMPACTS

This chapter analyses - proportionally to the nature of the document proposed[31] - the economic, environmental and social impacts of the four policy options discussed in chapter 4. The analysis is mainly qualitative but, where possible, it is complemented by quantitative data drawn from the Primes modelling carried out for the Energy Roadmap (see Annex 2 for more details). More specifically, it is assumed that the four policy options considered in this document broadly correspond to 4 scenarios analysed in the Roadmap Impact Assessment. Accordingly, option 1 (business as usual) is to a large extent reflected in the Energy Roadmap

---

30 European Council Conclusions, 4/2/11, note "The EU needs a fully functioning, interconnected and integrated internal energy market. Legislation on the internal energy market must therefore be speedily and fully implemented by Member States …. The internal market should be completed by 2014"

31 In-depth impact assessments examining the impacts of specific policy measures would be carried out for any follow up legislative proposal.

reference scenario (CPI); option 2 'Decarbonisation without renewable energy targets post-2020' is reflected by the 'Diversified supply technologies (DST)' scenario where renewable growth is driven only by carbon prices; option 3 'Post-2020 renewable energy targets' and option 4 'EU-wide renewable target and full trading' are reflected in the range of renewable energy shares modelled in the 'Energy efficiency' scenario and in the 'High Renewables' scenario of the Roadmap. For further information regarding the assumptions used in the Energy Roadmap please see Annex 2.

5.1. Economic impacts

The overall economic impact of renewable energy policy is the outcome of multiples interlinked and counterbalancing mechanisms. First, the deployment of renewables creates **economic activity** in the renewable energy sectors. For instance, in Germany investments in renewable energy facilities have increased significantly between 2005 and 2010, respectively from 10.3 to 26.6 billion euros. Over the same time, total demand for facilities and components (including exports), operation and maintenance as well as biomass fuels grew from 13.7 billion to 35.5 billion euros[32]. Activities in non-energy sectors of the economy can also benefit from renewable energy growth, through the supply of intermediate inputs or manufacturing equipment (e.g. steel industry producing wind turbines or shipping sector for seagoing vessels) which will contribute to increase the aggregate final demand. By defining the market volumes for renewables, **options 3 and 4** could lead to greater direct or indirect economic activity related to renewables than **option 2**.

Second, increased consumption of indigenous renewable energy reduces the demand for conventional energy, including fossil fuel imports, thus increasing **energy security**. For instance, the Energy Roadmap shows that the combined effect of significant penetration of renewables and increased energy efficiency will be able to reduce the expenditure for fossil fuel imports and thereby the total external fuel bill of the EU. Compared to the business as usual scenario, the EU economy could save in 2050 between 518 and 550 billion euros (08). By promoting strong action to develop renewables and energy efficiency, **options 3 and 4** would lead to relatively greater reduction in expenditure on fossil fuel imports that **option 2**.

It should be recalled that other aspects of security of energy supply, such as fuel and supplier diversity, are not captured in the simple indicator of import dependency. Current analysis is difficult to use to quantify the scope and benefits of a more secure and diverse energy supply. However, it would appear that a short-term cost minimising decarbonisation approach as contained in **option 2** should encourage carbon emissions, but does not offer incentives regarding the diversity or sources of a given energy mix. It therefore does not reflect any of the external cost of security and diversity of energy supply and thus stimulate relatively less any such benefits. In all cases, EU security of supply would increase as a result of an increased use of renewable energies: even in the case of goods and technologies imported from third countries, energy generation actually takes places in the EU. However, in a broader sense, EU security of supply also strongly depends on the domestic sourcing of renewable energy inputs and on the mastery of associated technologies. Hence, EU security of supply would benefit from framework conditions allowing for a competitive, EU-based renewable energy industry to maintain its position as a world leader in the long run.

32 BMU (2011), Renewable energy sources in figures: national and international developments, http://www.bmu.de/english/renewable_energy/downloads/doc/5996.php

Third, renewable energy deployment promotes **energy innovation,** which is key for ensuring the development of sufficient different technologies enabling the long-term cost-effective decarbonisation of the energy sector. Energy innovation is also important in economic terms, as it create competitive advantages on international markets with associated growth and export opportunities – fact that it is often not quantified in macro-economic studies about the costs/benefits of renewable energy[33]. **Options 3-4** involve significant improvement in efficiency and cost parameters of the new technologies due to greater economies of scale and faster learning curves compared to the BAU scenario. The strengthening of the carbon price under **option 2** could reduce the relative cost of new technology options, while ETS revenues could partly address funding for innovative companies and projects that fall into the 'commercialization gap'.

However technology development or innovation driven only by carbon prices focuses narrowly on lowest cost, near-to-market technologies at the expense of a broader range of technologies which could be competitive in the medium term. In other words, **option 2** is likely to maximize short-term CO_2 reductions and minimize short-term costs, creating innovation incentives for existing technologies, but not addressing longer-term technology development and innovation, to the detriment of renewable energy technologies that are still some distance away from being competitive, such as wave and tidal energy or second/third generation biofuels[34]. In this respect, the cost-minimization focus of **option 2** (and option 4 to the extent it is technology neutral within the renewables sector) would appear less directed at spurring innovation than **option 3**.

Lead-market research suggests that early investment in the renewables sector allows a given economy to capitalize on **growing global markets**, with positive impacts on domestic growth. For instance, historically the EU has been a major exporter of renewable energy technology and expertise. However, as renewable energy industries develop internationally it is not clear that this advantage would be maintained automatically. As the European sector evolves, greater specialisation and development of expertise could result, together with greater trade. There are implications both for the renewable technology and fuel providers, as both grow and become exposed to greater international competition. All in all, renewable energy export opportunities will strongly depend on the elimination of trade barriers in and free access to key emerging renewable energy markets such as in China, India, and Brazil.

On the other hand, renewable energy expansion can also **displace investment** (and employment) in the conventional energy sector with the associated negative sectorial impacts. In addition, the cost of financial support for renewables can result in higher energy prices, which may impact on energy users' bills and affect the competitiveness of energy-intensive industries. This repercussion can lead to the so-called **'budget effect'** whereby additional costs of renewables somehow constrain the budget available for the purchase of non-energy goods or services, leading to economic contraction. The Roadmap modelling shows that average prices of electricity are expected rising compared to 2005 **under all options**, including the BAU scenario. It also shows that due to renewables and energy efficiency promotion, energy intensive industries may face particularly high energy costs for their highly energy consuming production processes.

This said, an important aspect to be considered in this discussion is the 'price effect' of renewable electricity, which can help to reduce the average power cost by affecting the

---

33 Lehr et al (2008), Renewable Energy and Employment in Germany, Energy Policy 36, pg 108-117.

34 Centre for European Policy Studies (2011), The EU Emissions Trading System and Climate Policy towards 2050: real incentives to reduce emissions and drive innovation?

wholesale price. Typically, supply is made up of various power technologies: wind, hydro, nuclear, combined heat and power plants, coal and natural gas plants. In a power market, the supply curve (the 'merit-order' curve) and goes from the least to the most expensive units, reflecting marginal variable costs (mostly fuel costs). Because renewable electricity has low variable costs it is first on the merit order curve and the size of the remaining demand to be purchased on the spot market is reduced. Under the "merit order" principle, plants with the lowest costs are used first to meet demand, with more costly plants being brought on line later if needed. The most expensive conventional power plants are therefore no longer needed to meet demand. If the price is set by cheaper plants rather than by the most expensive conventional plants, then the average cost of electricity decreases, and this is called the 'merit-order effect'.

A few empirical analyses have attempted to estimate this merit□order effect. For example, Sensfuss et al (2008) [35] calculate that the volume of the merit□order effect would have been EUR 5 billion in 2006 in Germany if the entire electricity demand of a single hour was purchased at the corresponding spot market price. Meanwhile, the cost of incentives for renewables in that same year totalled EUR 5.6 billion. The same authors estimate the value of the kilowatt hour produced by renewables (*i.e.* the costs avoided by substitution of electricity from other sources) at around EUR 2.5 billion, leaving EUR 3.1 billion as the true extra cost of RE support incentives. Of these, 0.6 billion are directly paid by final consumers, while the remainder EUR2.5 billion are basically paid by utilities through a decrease of their infra□marginal rents due to the merit□order effect. In this way, the merit□order effect transfers wealth from utilities to deregulated customers. In reality, not all electricity is sold on the spot market in Germany, and bilateral contracts mitigate this result. Furthermore, the lower price paid by deregulated customers does not represent a lower cost for producing electricity. The overall cost of wind kilowatt hours remains higher than some competitors, even if the gap has considerably narrowed in the last decade. Utilities may ultimately find ways to pass part of these costs to customers.

A more recent study on wind power in Ireland provides even more striking results. Clifford et al (2011)[36], using a detailed model of the all□Island Single Electricity Market, show that the wind generation expected in 2011 will reduce Ireland's wholesale market cost of electricity by around EUR 74 million. This is approximately equivalent to the sum of the Public Service Obligation (financing the feed□in tariff for wind) cost, estimated as EUR 50 million, and the increased "constraint" (or balancing) costs incurred due to wind in 2011. The reduction of Ireland's dependence on fossil fuels and the CO2 emission cuts cost nothing in this case, despite the persistence of the support scheme which ensures recovery of the long□term costs of electricity generation from the wind even when the market prices are low.

A quantitative assessment of the **macroeconomic impacts** of a supportive renewable energy policy framework (**option 3 and 4**), was performed by a peer-reviewed study by Ragwitz et al (2009) for the European Commission[37]**.** Using an input-output model (Multireg) to assess the effect of developments in the RES sector on other economic sectors, and two macro-economic models (Nemesis and Astra), they found that achieving the EU 20% renewable energy target

---

35 Sensfuss et al. (2008), The merit-order effect: a detailed analysis of the price effect of renewable electricity generation on spot market prices in Germany. Energy Policy 36/ 8, pg. 3076–3084.

36 Clifford et al (2011), Impacts of Wind Generation on Wholesale Electricity Costs in 2011, SEAI/EirGrid, Ireland

37 Ragwitz et al (2009), EmployRES: the impact of renewable energy policy on economic growth and employment in the EU, Fraunhofer ISI et al. Report for the European Commission. http://ec.europa.eu/energy/renewables/studies/doc/renewables/2009_employ_res_report.pdf.

will lead to a net GDP increase of 0.23-0.25% in comparison with a scenario where all renewables support policies were abandoned. A continuation of a EU-wide specific renewable energy framework post-2020 (assuming a 30% renewables share) would result in a net GDP growth by 0.36-0.40% by 2030 in case of moderate development of renewables technologies exports, which could increase to 0.44% in case of more optimistic export assumptions. According to this research, the increase in GDP is most strongly influenced by both the renewable energy investments and the improved trade balance.

These findings were echoed in a recent study by Balzejczak et al (2011)[38] for the German Institute of Economic Research, assessing both economic-wide and sectoral impacts of renewable energy expansion in Germany. Using an econometric model that evaluates the net economic outcomes by taking account of various inter-related economic mechanisms, they found that the expansion of renewable energy in Germany by 2030 has a positive net effect on economic activity, particularly thanks to increased investment activity.

An additional indicator of economic impacts is represented by the **total energy system costs**, which consist in costs for the entire energy system including capital cost (for energy using equipment, appliances, and vehicles), fuel and electricity costs, and direct efficiency investment cost (house insulation, control system, energy management, etc.). They exclude disutility costs and auction payments. Reporting data from the Roadmap modelling, Table 2 shows that system costs of **all options** are basically similar up to 2030. The ratio of energy system costs to GDP is similar across all options scenarios.

It should be noted that significant differences among the identified options occur only after 2030, reflecting mainly increased investments in transport equipment as the major transition to electric and plug in hybrids vehicles is projected after 2030. Additional system cost difference are also linked to significant expansion of renewables- based power generation capacity post-2030, which is likely to necessitate additional DC lines mainly to transport wind electricity from the North Sea to the centre of Europe and grid reinforcement in the Mediterranean countries to exploit their solar PV potentials, as well overall more storage facilities. Furthermore, increased uptake of energy efficiency and energy saving technologies and practices brings additional costs, although it will help minimize the risk of possible negative impacts of raising energy costs on businesses and households.

Using the Green-X model, Resch (2010)[39] has analysed in more detail the costs of the financing elements of **option 3 compared to option 4**. In a harmonised technology neutral support framework, where producers of renewable energy are rewarded through the sale of green certificates across a European market, intuitively costs are reduced, since renewable energy sources are exploited where they are most optimal. However, the analysis finds that several factors raise the average annual support costs of this option by 12% (€43.2bn compared with €70.3bn).

In particular, when the certificate price is set by the last (most expensive) unit of renewable energy, all the renewable energy receives that price, irrespective of their cost. Thus all but the most expensive technologies receive over compensation. In other words, there is a risk that

---

[38] Blazejczak, 2011, Economic effects of renewable energy expansion: a model-based analysis for Germany, Discussion Paper, German Institute for Economic Research, www.diw.de/discussionpapers.

[39] Resch et al (2010), Quo(ta) vadis, Europe? A comparative assessment of two recent studies on the future development of renewable electricity support in Europe, Report for the RE SHAPING project, www.reshaping-res-policy.eu/downloads/Quo(ta)-vadis-Europe_RE-Shaping-report.pdf. See also background analysis carried out in the framework for "Beyond 2020" project: www.res-policy-beyond2020.eu.

windfall profits are paid to all producers with costs lower than the final price-setting technology. Empirical analysis[40] of renewable energy support schemes has found that an extra risk premium is paid to producers for greater exposure to market and price risk. Finally, the extra infrastructure expenditure resulting from greater concentration of production (e.g. wind production in the north and solar production in the south, needing transport to consumption centres) also raises costs.

As discussed in the IA of the Energy Roadmap 2050, the increased bioenergy utilization might have impacts on prices for biomass from agriculture and forest-based industries either directly through increased demand for energy use, or through increased demand for land and thus higher land prices. As most of the biomass used for energy has competing uses (food and feed, renewable raw materials), food prices and input costs of other biomass-using industries are likely to increase.

In conclusion, **options 2-4** are likely to lead to positive economic impacts, as they will promote (to a varying degree) significant investments in the renewable energy technologies with that have the potential to generate new industries and jobs. In addition, they will help lowering expenditure on imported fuels which may also protect the EU economy against external energy price shocks, although **options 3-4** may result in high import savings than **option 2**. Meanwhile, financial incentives for renewables under **options 3-4** may increase costs for consumers (with option 4 having relatively higher costs), although this is likely to be partially compensated by the merit order effect that reduces wholesale electricity prices. On the contrary, **option 1** has higher fuel costs which do not generate much economic growth, meanwhile it will require fewer public and private investments in developing and deploying renewable energy technologies.

5.2. Environmental impacts

An increased share of renewable energy in the EU final consumption has the potential to reduce significantly greenhouse emissions. As discussed in the Impact Assessment to the Energy Roadmap 2050, **all policy options** explored but the BAU scenario achieve 80% GHG reduction and close to 85% energy related CO2 reductions in 2050 compared to 1990, as well as equal cumulative emissions over the projection period. In 2030, energy-related CO2 emissions are between 38-41% lower, and total GHG emissions reductions are lower by 40-42%. Local air pollution is also expected to decrease significantly, as this often goes hand in hand with GHG emissions. However, in some cases (where small unregulated biomass plants increase significantly), particulate matter (PM) and gaseous emissions could rise, causing local air pollution, although this risk can be mitigated by emission standards for small boilers as well as increased use of efficient and modern district heating. Overall, air quality effects can be expected to remain positive[41].

All options are likely to affect directly the local biodiversity due to the construction of energy infrastructure, particularly overhead power lines. Some short-term disturbances to animals and destruction of plants and habitats may occur during construction work, and some permanent displacements of animals and destruction of habitats might take place due to underground cables and electricity pylons. Further, overhead electricity lines might make it necessary to keep open vegetation in corridors in wooded areas and cause habitat

---

[40] Ragwitz et al (2011), Financing renewable energy in the European energy market, Report by Ecofys for the EC. http://ec.europa.eu/energy/renewables/studies/doc/renewables/2011_financing_renewable.pdf

[41] For a detailed analysis see SEC (2011)288, section 5.2.14.

fragmentation to animal and plant species and disturbances to birds. These impacts will vary depending on the project, but are considered to be rather limited outside wooded areas for electricity line projects, as, due to the size of electricity pylons only small areas are affected, and underground impacts of cables are expected to be less important due to the limited existence of wildlife in those areas. Under all options all environmental laws must be complied with. **Option 2 and 4** may have higher impacts, in so far they are likely to prioritize deployment of renewable energy projects in the best sites which are often far from consumption centres. This will require additional high-voltage transmission lines, including interconnectors with neighbouring countries.

However, all in all, if the infrastructure development follows well established environmental rules (including Strategic Environmental Assessment and Environmental Impact Assessment), these potentially negative consequences can be limited. Therefore, the pathways as such do not necessarily lead to biodiversity problems, as this will depend on implementation, but it is important to engage all stakeholders, including local communities, at an early stage of the planning, which must be carried out in a strategic manner.

Higher share of renewable energy in post-2020 period would imply an increase in bioenergy consumption and an obvious rise in demand for biomass feedstock. . The Impact Assessment to the Energy Roadmap 2050 gives an indication of the biomass supply needed to achieve the decarbonisation target by 2030, ranging from 214 to 236 Mtoe depending on the level of renewable energy share. Whilst today biowaste and residues from forestry and agriculture have an important untapped potential, it is likely that up to until 2020 most of these bioenergy streams will be utilized (either locally or for exports). Therefore it is expected that beyond-2020 additional biomass production would be mainly based on dedicated energy crops, a fact that will require additional amounts of agricultural land.

Several studies have tried to estimate the potentially available amount of biomass in Europe and worldwide for 2030 and beyond. For instance, the European Environment Agency (EEA) estimated the amount of potentially available biomass in 2030 in the range of 12±2 exajoules, depending on the strictness of application of environmental criteria[42]. Based on peer-reviewed data, the 2011 IPCC Report on Renewable Energy[43] mentions a plausible global potential in the range of 100-300 exajoules, depending on the assumptions regarding the realisation of new production methods. This range corresponds to approximately 2500-7000 Mtoe by 2050. A conservative approach would therefore take the lower end of this range to assess the potentially available supply of sustainable biomass. Given the many new initiatives and technologies required to realise the 2050 potential, it can be assumed that about 100-200 exjajoules (or about 2500-5000 Mtoe) could be realistically available by 2030 on the world market. Considering the development of renewable energy and bio-economy based policies in other countries, it can be assumed that a fourth of the global potential is likely to be available for the European market, equal to a potential of about 625-1250 Mtoe by 2030. While this indicates that it is possible to increase the use of sustainable biomass to meet energy and other uses, the concrete realization will require significant and long-term investment in the agriculture and forestry sectors over the coming years, with the objective of increasing productivity in a sustainable manner.

42 EEA (2006), How much bioenergy can Europe produce without harming the environment? European Environment Agency, Copenhagen, EEA report no. 7/2006

43 IPCC (2011), IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, prepared by Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press.

It should be recalled that land use impacts of increased biomass use will depend on number of assumptions and uncertainties. One main source of uncertainty is the underlying assumption regarding the amount of unused agricultural land available for the cultivation of bioenergy crops, and to what extent natural grasslands contribute to this potential. In particular, assumptions regarding future agricultural productivity and future consumption of animal products have a great impact on the results. Furthermore, the uncertainty in the amounts of available waste and residue resources from agriculture strongly depends on the still uncertain future demand from other uses such as animal feed, renewable raw material and fertilizers. The same can be said for forestry biomass feedstock that has multiple uses, i.e. material, fibre and energy production[44]. Another source of uncertainty is represented by the potential to further improve crop yields for all uses (food, feed, energy and renewable raw materials), as the amount of available agricultural land depends on the yields which can be achieved. Finally, an important factor is the application of sustainability criteria, aimed to exclude biomass for energy purposes on the market that is produced under environmentally harmful conditions.

The limited availability of sustainable biomass resource may also require a prioritisation of its application. Biomass should be used primarily in those sectors where there are no other renewable energy alternatives. These include, for instance, biofuels for heavy trucks, shipping and aviation, but also high temperature bioheat for industry. Outside the energy sector, the use of biomass as bulk chemical is the only option for the production of renewable raw materials. A post-2020 renewable energy strategy should therefore focus on stimulating these prioritised biomass applications and short term decision should be ideally in line with these long-term considerations.

CO2 emissions related to land use, land use change and forestry (LULUCF) due to increased bioenergy use have been also discussed in the Impact Assessment accompanying the Low carbon roadmap[45]. In this respect, the Commission has recently tabled a proposal for monitor LULUCF emissions in the EU. Those taking place in third countries will need to be addressed in the framework of the global climate change negotiations.

Given the above, by increasing the use of bioenergy and the demand for biomass raw material, **options 3 and 4** (and option 2 to a minor extent) will result in higher risks of significant direct and indirect land use impacts. But these could be reduced by applying robust sustainability criteria for all bioenergy uses, building on (and further strengthening) the mandatory criteria currently applying to biofuels and bioliquids. In addition, policy measures are needed to facilitate significant improvements in agriculture and forestry productivity and land-use efficiency in general, as well as to promote internationally action to reduce deforestation and forest degradation (REDD)[46]. On the contrary, under **option 1** it is likely that a growing demand of biomass for energy could lead to increased risks of a non-sustainable supply and overexploitation of natural resources in absence of sustainability rules for all biomass for energy uses, including solid and gaseous biomass.

Options 2-4 include a possible 6-7% increase in hydropower, which could have impacts in terms of depletion of **freshwater resources**, from changes in river morphology, combined with higher fertilizer inputs resulting from the increased cultivation of dedicated energy crops.

---

44 For on-going EC research on current and future demand and supplies for wood resources, see: http://ec.europa.eu/enterprise/newsroom/cf/itemlongdetail.cfm?item_id=5328

45 SEC(2011)288, sections 5.1.4, 5.2.7 and 5.2.10

46 This said, it should be also recalled that biomass production can also have positive land use and biodiversity effects. For instance, when the cultivation of perennial crops takes place on degraded land it may have positive local impacts on net greenhouse gas emissions and biodiversity.

In a context of increasing water stress due to demographic, socio-economic pressures and climate change[47], if not addressed these impacts could exacerbate already existing water shortages and jeopardize the recovery of good status of surface and groundwater availability. It is expected, however, that these risks are minimized under all options by the effective implementation of existing EU and national freshwater management policies such as Water Framework Directive.

With its effects on e.g. water and air temperatures, precipitation, sea level, as well as occurrence of floods and storms, climate change has the potential to influence energy generation. Nuclear and fossil power plants' operations are sensitive to temperature (i.e. mainly impacts on efficiency) and precipitation (i.e. mainly impacts on cooling water supply) changes. Moreover, precipitation changes may show increasing or decreasing trends, depending on the geographical area and the season, leading to considerable changes in discharge regimes for hydro-generation. Other renewable sources of energy, such as wind or solar power, may also be affected by a changing climate, and there are potentially important impacts on bioenergy (production)[48]. Overall **options 2-4**, combined with effective adaptation measures, have the potential to improve the climate resilience of the EU energy system. In particular, decentralisation of electricity generation plays an important role in decreasing overall network and system vulnerability to climate related natural (and other) disasters.

5.3. Social impacts

The transition to higher shares of renewables will imply significant new opportunities for new and better jobs directly or indirectly related to the growing renewable energy sector. Studies on **gross employment impacts** of renewable energy policy have been conducted for several countries and renewable energy technologies, including Germany[49], the UK[50], the EU[51] and the US[52] and they all show positive figures. For instance, by the end of 2010, the EU renewable energy industry employed over 1.1 million people, with the solid biomass sector being the top employer with more than 273,000 jobs, followed by the PV and wind power sectors with respectively over 268,000 and 253,000 jobs[53]. More sophisticated studies go beyond gross employment impacts to calculate **net job impacts**. This research usually require sophisticated approaches to model complex economic and sectoral inter-linkages, accounting for a reduction in demand for conventional generation, the effects of government expenditures on renewables in the economy, and electricity price impacts. In general, these comprehensive analyses show that net employment impacts are sensitive to assumptions regarding future energy prices, strategies for addressing greenhouse gas (GHG) emissions reductions, and the capacity to export technology.

---

47 See the ClimWatAdapt project and on-going work for the preparation of the 2012 Blueprint to safeguard Europe's waters (http://ec.europa.eu/environment/water/blueprint/index_en.htm)

48 See e.g. Rademaekers, K. et al. (2011): Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to effects of climate change, Final report (http://ec.europa.eu/energy/nuclear/studies/doc/2011_03_eur24769-en.pdf), and ongoing work under the ClimateCost FP7 project (http://www.climatecost.cc) and under the "Support to the EU Adaptation Strategy" DG CLIMA contract.

49 BUA (2011), Renewable Energy Sources in Figures - national and international development.

50 Esteban et al (2011) Job retention in the British offshore sector through greening of the North Sea energy industry, Energy Policy, 39/ 3, Pg. 1543-1551

51 Ragwitz et al. 2009

52 Wei et al (2010), Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US? Energy Policy, 38/2, pg. 919–931.

53 EurObserv'ER (2012), The State of Renewable Energies in Europe, www.eurobserve-er.org

In their study for the European Commission, Ragwitz et al. (2011) have assessed both gross and net employment impacts of the EU renewable energy policy. They calculated that the total gross employment in the EU renewables sector could amount to 2.8 million people in 2020 and could increase to 3.4 million people by 2030, assuming an extension of the EU renewable energy framework post-2020 and with optimistic export expectations. A strong development in knowledge-intensive renewable energy technologies such as offshore wind power, ocean energy, solar PV and thermal electricity is responsible for roughly half of the estimated gross employment increase. The study also shows that about two thirds of the jobs created in the renewable energy sector are based on small and medium-sized enterprises (SME). Compared to gross employment, the net employment effects are smaller yet positive. Even considering the negative impacts on replaced investments in conventional energy technologies as well as the dampening effect of the higher costs of renewable energies compared to conventional ones, a strong renewable energy policy framework would result in up to 656,000 net jobs in 2030, depending on the export potential assumptions.

Other sectoral studies, such as the PV Employment Study[54], have come to similar findings. Under a scenario with 35 GW of annual new installed PV capacity in the EU-27, the net positive employment effects would amount to 162,000 jobs by 2030. While today the major source of employment stems from the PV manufacturing, this study suggest that in the future most jobs will be created in the operation and management (O&M) of PV systems and in servicing activities. The creation of indirect jobs will also be considerably high, accounting for 39% of the total employment creation. Lehr et al (2011) provide more recent net employment estimates for Germany. They use scenario calculations based on a combination of an econometric input-output model, an ecological model and a model for international linkages. According to this study, net employment effects in 2030 are positive throughout all scenario analysed. The largest job gains occur in a scenario with high fossil fuel prices and strong exports of renewable energy technologies and components.

The above research suggests that in order to maintain a positive employment balance in the future, it is crucial to uphold and improve the competitive position of European manufactures of renewable energy technology, by ensuring both sustained domestic demand and also access to foreign markets. Consequently, by actively promoting innovative renewable energy technologies, **option 3** may have higher employment benefits that **option 2**, which thorough its cost-based approach is likely to incentivise only mature technologies. To the extent that **option 3** would imply smoothing of renewable investment over time, it could also provide more stable employment for workers, helping to avoid periods of serious labour shortages for employers[55]. In addition, by providing financial and other incentives it can offer the needed key tool to establish domestic manufacturing facilities and encourage demand for local components, thus helping to establish domestic manufacturing capacity with potential for access to export markets. **Option 4**, where a share of renewable energy will be developed in third countries, may have lower (although still sizable) employment benefits.

On the other hand, deployment of renewable energy will imply **restructuring within the energy sector** and certain jobs will be lost. Given that the most polluting industries account for a relatively small share of total employment, the adjustment pressures will be concentrated on a small portion of the total workforce. The top emitting industries in the EU have some common characteristics in terms of employment, such as high share of older workers and low mobility, both within their sector and outside it, which may increase the costs of adjustment.

---

54 EPIA (2011), PV Employment Study, www.pvemployment.org

55 ILO/EU (2011), Skills and Occupational Needs in Renewable Energy http://www.ilo.org/skills/pubs/WCMS_166823/lang--en/index.htm

For instance, the share of workers in electricity (NACE 40) that move to another sector of occupation is less than 2 % and the job-to-job separation rate is around 4 %. Equivalent figures for agriculture and hotels and restaurants surpass 4 % and 16 % respectively. In contrast to that, two electricity sectors (NACE 40 and 23) occupy more highly skilled workers than the average economy and especially as other top polluting industries. One of the reasons is implementation of various innovations in environmental technologies in recent years (renewable energy, energy efficiency, fuel efficiency and biotechnology) [56]. In addition, it should be noted that a wide range of skills are required in the renewable energy sector. In order to achieve deployment targets and maximise job benefits, it is necessary to facilitate and increase education and training. A large-scale shift to renewable energy will require some skills similar to those needed in the conventional energy workforce and other skills that are specific to certain renewable technologies.

In their study employment and economic impacts of renewable energy expansion in Germany, Balzejczak et al (2011) found that employment benefits are more likely to be maximised where there are active labour market interventions to support acquisition of necessary skills. If labour markets are rigid and additional works cannot be easily mobilized from the pool of unemployed people, this can impact net employment effects. This result highlights the importance of labour market policies as a supplement to renewable energy expansion, for instance, in the form of measures to increase labour market participation. This study also indicates that renewable energy deployment triggers sectoral restructuring, as renewables growth results in a re-allocation of economic resources. In particular, fixed and human capital is being invested in renewable technologies instead than in conventional energy. This underlines the need for labour market policies, in particular for additional qualification measures.

Affordability of energy services is another indicator for assessing social impacts of renewable energy policies, particularly on households. According to the Roadmap modeling, all policy options show significant fuel savings compared to BAU scenario but also higher costs for stationary energy uses, due to highly efficient appliances and building insulation. **Options 3 and 4** (that imply ambitious energy efficiency measures) may result in higher costs for energy services by 2030 compared to options 1 and 2. Therefore, policy measures will be needed to minimize possible affordability challenges for vulnerable consumers that may not be able to afford the necessary upfront investment to obtain later savings.

6. SECTION 6: COMPARING THE OPTIONS

This section provides an assessment of how the analysed policy options will contribute to the realisation of the policy objectives, as set in Section 3, in light of the following evaluation criteria:

- **Effectiveness:** the extent to which policy options analysed achieve the general and specific policy objectives of this intervention;
- **Efficiency:** the extent to which the specific objectives can be achieved at least cost;
- **Coherence:** the extent to which the identified policy options are likely to limit trade-offs across the economic, social, and environmental domains and the relevant EU policies.

[56] EU Employment and Social Situation, Quarterly Review (2011) http://ec.europa.eu/social/main.jsp?langId=en&catId=89&newsId=1157&furtherNews=yes.

6.1. Effectiveness

To recall, the specific objectives of this intervention include: a) reduce investors uncertainty, b) improve viability of financing incentives, c) facilitate consistency with market arrangements, c) provide adequacy of energy infrastructure, e) promote technology innovation, f) and ensure sustainability and public acceptance.

Concerning **investors' uncertainty**, option 1 would not help addressing it, as it does not provide clear policy framework post-2020. Currently only a general, horizontal framework exists for the EU ETS. By building on and further strengthening the existing EU ETS regime, option 2 would help creating a long-term framework for investment decisions into renewable and other low carbon energy solutions provided that it delivers the right market signals to investors through appropriate carbon prices. Renewable energy-specific targets and measures as contained in options 3 and 4 would provide investors and the business community with a higher degree of visibility on the future market volumes for renewable energy technologies. In addition, it would again maintain a sense of continuity with the existing policy and regulatory framework which realizes in a number of interlinked policy instruments (ETS, RES targets, energy efficiency measures, SET Plan and R&D programmes etc.) to maximise the chances of policy success.

Under option 1, the ongoing reforms and cost reductions regarding renewable energy support schemes should result in significant improvements in their overall **viability and consistency with the internal market**, and considerable phasing out of support. Option 1 also presupposes the internal market will be completed shortly and that national approaches to market arrangements and capacity needs are similarly compatible with the internal market. Under option 2, support schemes for renewable energy would also decline rapidly, since decarbonisation would be driven by carbon prices alone. Under option 3, while Member States would continue using support schemes for those renewable energy technologies that are not competitive, a more active convergence would be pursued at EU level such that the schemes would be time limited, share a common framework and be consistent with market principles. In option 4, a single EU-wide support scheme would be applied for the target framework, which would have the potential to reduce tendencies towards distortion of competition and achieving EU targets with the minimum amount of aid, in compliance with State aid principles. However, as noted above, this could risk raising support scheme costs and undermining their viability, however it would normally be a clear means of fully integrating renewable energy into the internal market[57]. On the other hand, a greater role for cheaper renewable energy sources in neighbouring countries such as in North Africa and the Balkans would potentially also keep cost of RES support lower.

Concerning the development of **adequate energy infrastructure**, the policy options assessed broadly rely on the implementation of the current infrastructure package providing a clearer, stronger European framework for planning, coordinating and developing energy infrastructure as well as better national and European instruments for financing the infrastructure. Thus under the BAU scenario, no further measures are envisaged post 2020. Under options 2-4, partly depending on the stringency of either the GHG savings or renewable energy targets (or both), further efforts and harmonisation of infrastructure planning may be needed, with the view to ensuring even greater coherence and cooperation in the development of European infrastructure as well as extension of European infrastructure to create greater connectivity

[57] For all options it remains the case that support schemes constituting State aid are subject to State aid control which aims to ensure that the objectives is achieved with well-targeted aid which is limited to the minimum and does not unduly distort competition.

with neighbouring countries, and so facilitate greater regional renewable energy cooperation and development. Significant infrastructure action may be needed to allow green power imports from 3rd countries.

Under policy options 1, 2 and 3 it is expected that **electricity market arrangements** evolve in a manner consistent with the internal market and with the development of a liquid trading market, open to all undertakings capable of providing flexibility in managing both supply and demand. This is a condition for a level playing field and competitive energy market in which renewable energy producers are expected to compete. Under option 4, this tendency would be reinforced as necessary, to ensure a harmonised European approach that was compatible and consistent with internal market objectives.

Technology specific policies include both R&D support, which would be enhanced under options 2, 3 and 4; and "market pull" policies that would bring new technologies into the market for mass deployment. Option 2 is technologically wholly neutral and thus its "market pull" is limited to current, cost effective technologies. Option 4, whilst creating instruments to promote renewable energy in general, would again, focus on the most cost effective renewable energy technologies and not expressly drive technology innovation. Option 3 would facilitate Member States applying more technology specific initiatives and so spur "market pull" innovation (as opposed to solely R&D).

Sustainability concerns are not adequately addressed under option 1, but would be effectively addressed under options 2, 3 and 4: there is no expectation that any significant further development of renewable energy could occur without further measures to ensure the sustainability of biomass production and use. The effects on biomass use and the implications for the further development of the sustainability framework need further analysis which will occur prior to any post 2020 renewable energy policy framework decisions. Regarding the acceptability of infrastructure/generation plant, public acceptance concerns would be addressed in accordance with the provisions of the RES Directive, the infrastructure package and existing environmental legislation.

6.2. Efficiency

Overall system costs should be minimised, for achieving the multiple objectives in a satisfactory manner, rather than one objective in isolation. The present analysis indicates broadly similar levels of system costs for options 2, 3 and 4[58]. By establishing a single GHG reduction target and using the EU ETS and other GHG-related measures in non-ETS sectors, option 2 has an intuitive appeal in particular because it would allow the market the flexibility to choose the most cost-effective technologies and other cost effective means of achieving the goal of decarbonisation. This in turn should help reducing the overall cost of the policy, as well as lowering the administrative burden associated with managing multiple targets. However, since it does not ensure other policy objectives are met (however imprecise they may be), it does not necessarily ensure the effective achievement of key components of EU energy policy, including energy security and diversity and the promotion of innovative energy technologies in a competitive renewable energy industry.

This said, the extent to which the instruments created under option 2 could contribute to energy policy objectives (technological innovation and a competitive energy sector) requires more detailed analysis. Option 3 is effective to meet GHG and renewable energy objectives

[58] It should be noted that the 2050 Roadmap analysis shows that whilst the differences in policy option trends are relatively minor to 2030, differences appear beyond 2030 (higher costs associated with greater technology innovation and diversity of technologies).

but could still incur higher costs if progress is slow to remove inconsistencies between national schemes. The analysis shows that option 4 is also less efficient that theoretically expected.

6.3. Coherence

When assessing the coherence of policy options it is important to recall the findings of the impact assessment to the Climate and Energy package, which analysed the role that different instruments (the EU ETS, national GHG reduction targets, energy efficiency measures, a new framework for carbon capture and storage and the RES Directive) play in achieving multiple objectives. It acknowledged that strong and stable carbon price signal *should* drive a range of emissions reduction measures in a well operating energy market. However, price signals may not be reaching all players (in particular households) and may not provide the required long-term incentives for product energy efficiency and technology development. As a result, the need was found for other, more direct methods – i.e. renewables and energy efficiency specific regimes – to ensure that efforts were made in all sectors such that long-term energy sustainability can occur at an affordable cost.

Notwithstanding the above, the BAU trends established by the current regulatory framework (including energy market liberalisation, reform of electricity market arrangements and renewable energy support schemes, R&D initiatives and ETS pricing) are further enhancing policy coherence, however without specific measures to achieve post-2020 energy related objectives. While option 2 chiefly focus on emissions reductions and does not address specifically other energy policy objectives, a strengthened EU emission trading scheme as key pillar of option 2 would appear to be coherent with the existing energy policy framework, drawing on the benefits of an internal market and respecting subsidiarity on energy technology supply choices. For other climate-related policies, the extent of the coherence with the development of the internal energy market depends very much on post-2020 policy design. Option 3 and 4 could continue the policy approach initiated with the 2008 Climate and Energy Package, while providing further assurance that the multiple energy policy objectives would be equally pursued and all sectors would contribute effectively to the long-term decarbonisation effort at an affordable cost. This said, building on the experience of the recent years, more detailed analysis of policy instrument interactions is appropriate for assessing related aspects of coherence but this is beyond the scope of this assessment and will be conducted in the context of future specific policy proposals.

6.4. Overall summary

The above comparative analysis of the impacts of the four policy options assessed can be summarised as follows:

- *Business as usual.* This option would not address the current investors' uncertainty about the EU renewable energy policy post-2020. As this scenario assumes a phase out of incentives for renewables, issues of cost-effectiveness and market integration of support schemes will be addressed by the end of the decade. Similarly, energy infrastructure development would continue as currently planned, which would be sufficient to integrate the expected low growth in renewables. Finally this option does nothing to enhance growth, employment creation and energy technology innovation and to ensure sustainability and public acceptance issues.

- *Decarbonisation without renewable energy targets post-2020.* This option would facilitate more visibility regarding renewable energy market developments post-2020, assuming that policy tools addressing ETS and non-ETS sectors would be able to provide effective market signals in favour of renewable energies, through appropriate carbon pricing. By applying a European market integrated approach, it could help improving support schemes cost-effectiveness, facilitate market integration and provide sufficient infrastructure. The technology-neutral nature of the policy instruments included in this option could also have a weaker impact on energy technology innovation compared to other options that include specific energy technology measures. This option would effectively help minimizing sustainability and public acceptance issues.

- *Binding renewable energy targets post-2020 and coordinated support*. Depending on the ambition of targets, it could help provide investors' and the business community with greater certainty on future market volumes for renewable energy technologies. It would also promote –in a predictable way– further cost-effectiveness and convergence of national support schemes and foster greater research and development of innovative technologies. This option would also effectively help minimizing sustainability and public acceptance issues, by promoting a more balanced and regionally equilibrated deployment of renewables, including for auto-consumption.

- *EU renewable energy target and harmonised measures*. This option would also positively address both post-2020 policy uncertainties, while promoting reinforced internal market integration. It would provide technology neutral support combined with market exposure to producers and it is likely to promote more concentrated and distant centralised renewable energy generation, rather than distributed generation nearer centres of consumption. As a result, this option could risks raising support scheme and infrastructure costs, as well as public acceptance issues. As in option 3, potential risks of unwanted side effects of bioenergy uses would be minimized by a strengthen sustainability framework.

Table 4: Comparison of analysed options against the baseline

Criteria	Options	1: No new EU action	2: GHG targets/ no RES target	3: post 2020 national RES targets	4: EU RES target and harmonised measures
Effectiveness	Policy certainty	=	+	++	++
	Support viability	=	++	+	+
	Infrastructure adequacy	=	++	++	+
	Internal market	=	++	+	++
	Technology innovation	=	+	++	+
	Sust./public acceptance	=	+	+	+
Efficiency	System costs	=	=	=	=
Coherence	with other EU policies	=	+	+	+

Legend = equivalent; + improvement; - deterioration.

7. SECTION 7: MONITORING AND EVALUATION

This impact assessment has highlighted that there are major expectations of the *current* policy framework delivering improvements that will help ensure EU energy and climate goals are achieved. Key elements are the timely, complete, and effective implementation of the renewable energy Directive, and energy market liberalisation and the adoption of the energy efficiency Directive, the infrastructure package, and the EU ETS and other sectoral climate legislation. Progress on these elements will be closely monitored to ensure that the EU stays on track to achieve its 2020 climate and energy objectives and so is capable of building on that framework to achieve its medium to long term goals.

Core indicators for meeting the objectives of this initiative include:

Indicator	**Relevance**
Share of renewable energy sources in EU final energy consumption	Renewable energy development
Reduction of GHG gas emissions in the EU	GHG emissions reductions
Level of ETS carbon prices	Effectiveness of carbon markets
Origin of biofuels and bioliquids consumed in the EU and	Sustainability
Biofuels impacts on land use, food availability and biomass prices	Sustainability
The amount of MS financial support for RES	Efficiency, cost minimising
The use of the cooperation mechanisms laid down in the RES Directive	Efficiency, cost minimising
The production costs of various RES technologies	Efficiency, cost minimising
The economic availability of sustainable biomass	Renewable energy development
The rate of market coupling	Efficiency, market integration

Reporting and monitoring systems for the above mentioned indicators are available at EU level. More specifically, under the renewable energy Directive Member States are required to submit regular progress reports, including amongst other information on sectoral and overall share of renewable energy, the functioning of support schemes and other measure to promote energy from renewables, the development in the availability and use of biomass resources for energy purposes, the estimated net GHG emissions related to renewable energy use. Additional EU legislation has already established reporting requirements related to GHG emissions and carbon prices.

Annex 1: Results of the public consultation

1 Introduction

The Commission is preparing a Renewable Energy Strategy to be adopted in the second quarter of 2012. This will complement a Communication on the Internal Energy Market also planned for this year which will also help inform the evolution of the EU's wider energy policies following on from the Energy 2050 Roadmap.

The main purpose of the Communication on renewable energy will be to examine the conditions that might be necessary for a further development of renewable energy in a medium term perspective – i.e. until 2030. This will cover the three pillars of energy policy (sustainability, security of supply and competitiveness) and be consistent with the long-term decarbonisation scenarios presented in the 2050 Roadmap which all point to a substantially increased share of renewable energy sources. There is a need to ensure a cost-effective development of renewable energy potential, as well as to ensure that their further expansion happens in line with the requirements for system stability (electricity) and is consistent with other Union policies, notably climate mitigation, the internal market, international cooperation, technology development and protection of the environment, including biodiversity.

On 6 December 2011, as part of the process of preparation of the Renewable Energy Strategy the Directorate General for Energy launched a public consultation. The public consultation was based on an online questionnaire which contained numerous questions subdivided under the following chapters:

(1) General policy approach

(2) Financial support

(3) Administrative procedures

(4) Grid integration of electricity from renewable energy sources

(5) Market integration

(6) Renewables in Heating and Cooling

(7) Renewables in transport

(8) Sustainability

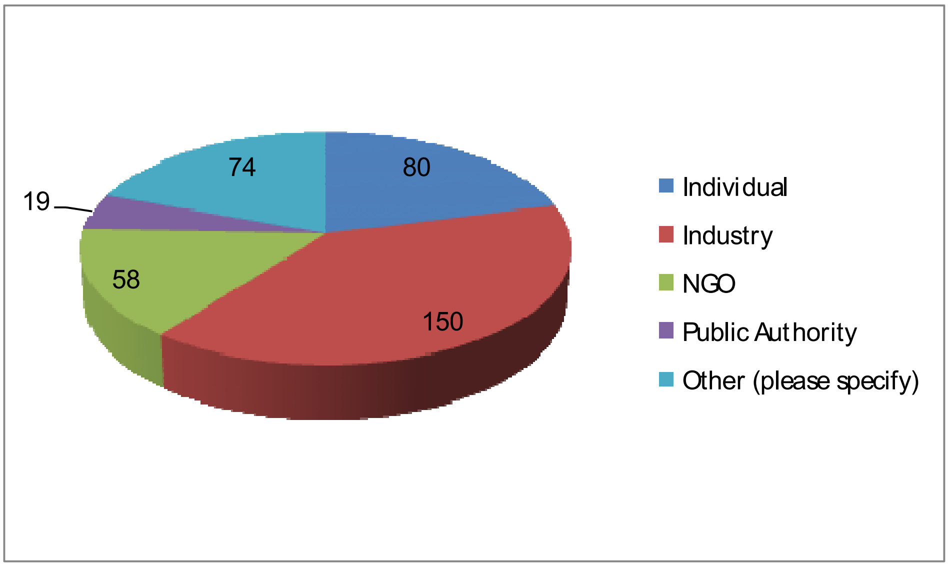
(9) Regional and international dimensions

(10) Technology development

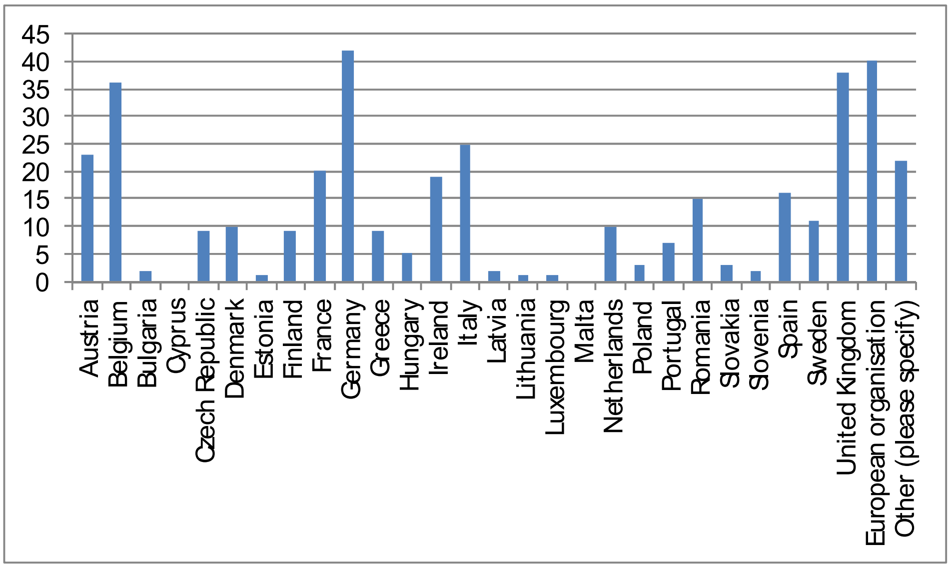
The public consultation was open until 7 February 2012. More than 400 contributions were received. Most contributions were received from industry, followed by individuals, NGOs and public authorities. Member States as such did not participate in the public consultation. The individual contributions have been published on the public consultation webpage[59].

Participation in the consultation came from a broad spectrum of organisations as well as citizens:

[59] Address to be added.



Likewise participation followed a fairly broad geographical spread, with all Member States except from Malta and Cyprus being represented:



In conclusion, this public consultation therefore offers insights into a large range of stakeholder opinions.

2. General policy approach

This section inquired about the attitude of participants towards the general policy approach to be adopted for the post-2020 framework. The first question asked whether they saw a role for new targets for renewable energy sources post-2020. A clear majority of stakeholders expressed support for some form of dedicated target for renewable energy post-2020. Only 14% of respondents considered this unnecessary. The relatively highest shares of opponents of new targets are in the categories of NGOs, individuals and others, whereas only a very small percentage of industry participants (9%) and none of the participating public authorities considered targets unnecessary. Among those favouring targets, a clear majority supported mandatory over indicative targets (39% over 14%). Likewise relatively few participants favoured an approach based exclusively on sectoral targets (only 10%).

There was also a question in this section about which other policy elements would be necessary to promote renewable energies post 2020. With multiple answers possible, two elements were clearly singled out as most important: enhanced focus on R&D as well as enhanced facilitation policies such as faster and easier permitting, improved grid access and availability of more sites (both options supported by around 60% of respondents). Among the options given public procurement obligations were seen as relatively least important.

3 Financial Support

Replies on the need for financial support post-2020 showed that respondents see a need for a more differentiated approach in that time frame. A majority considered that support should be available for selected technologies (57%) whereas only 13% favoured phasing out all support for renewables post-2020. Most respondents predicted that some renewables technologies would be competitive in that time frame and support should therefore be targeted to those which will not have reached this stage yet. Operative support could be provided for those relatively close to the market whereas at the very initial stage of development R&D support might according to some respondents be more appropriate. Technologies mentioned most often in this context were various forms of ocean energy as well as geothermal. Offshore wind, new solar applications as well as second generation biofuels were also mentioned. As for the conditions under which support for renewables continued to be justified, the absence of full internalisation of external costs, including through a robust carbon price, as well as removal of all subsidies for conventional generation were most often mentioned. On the other hand, some respondents argued that limits to renewables support should be defined ex-ante e.g. in terms of deployment volume, market penetration or time frame.

Replies on the need for more common approaches towards support schemes were quite mixed. As to the level of support 36% considered these should remain under exclusive national control, 22% considered benchmark values for support at national level appropriate and 27% argued in favour of EU-level benchmarks. The support for EU-wide benchmarks was slightly higher among industry respondents than on average (34%). On the other hand, more than two thirds of public authorities responded that support should remain under exclusive national control. For the structure of support more respondents rejected EU-wide alignment than supported it (45% over 37%). Again, strongest opposition to alignment came from public authorities (67%), followed by NGOs (46%), whereas a slight majority of industry respondents favoured structural alignment (43% over 40%).

In general there was wide support for making support schemes more market-oriented. As to which support schemes are most distortive, the majority of respondents avoided a response with explicit reference to generic support types, but rather referred to abstract principles and stressed that distortions were highest in case of over-compensation, respectively lack of proper downward adjustments of support levels. Nevertheless a number of respondents stressed the importance of exposing renewables to market price signals in order to reduce distortions and mentioned a move from feed-in tariffs to feed-in premiums as a step in the right direction. Some respondents also referred to priority access rules as well as non-exposure of renewables to balancing risk as specifically distorting elements.

4 Administrative procedures

Asked about non-cost related obstacles to further renewables penetration, the length and complexity of administrative procedures relating to authorisation, certification and licensing was identified as a key obstacle to further growth of renewables by most respondents (62%, multiple replies possible). Lack of commonly agreed technical specifications and lack of credible and certified training and qualification were the other biggest obstacles seen in this category. From the side of the renewable energy sector the absence of clear deadlines for authorisation procedures leading to excessive lead times was stressed as a key problem.

As to the appropriate policy response only very few respondents considered the approach of the current directive sufficient (8%). Most participants either called for more direct intervention into national procedures or even for more harmonisation or mutual recognition in this field. A more European approach to authorisation procedures for infrastructure projects of common interest was also welcomed in this context with reference to the recent infrastructure package proposed by the Commission.

5 Grid integration of electricity from renewable energy sources

In relation to the rules on grid access for renewables as laid down in Article 16 of the current Directive, respondents were asked whether they considered obstacles for grid connection of renewables were likely to persist after 2020. Grid connection rules were mentioned most frequently in this context (39%, multiple answers possible), followed by balancing and cost-sharing rules (both 29%). The curtailment regime was regarded as less problematic (23%). A minority anticipated that all obstacles related to grid access for renewables would be removed in a post-2020 perspective (19%). This result was mirrored by another question asking about which of the current rules of Article 16 should be continued after 2020. The obligation on network operators to develop the network as well as priority or guaranteed access were mentioned frequently whereas priority dispatch and counteracting curtailment were regarded as relatively less important.

The consultation also confirmed the need to increase flexibility to enable electricity systems to cope with a higher share of renewable energy from variable sources (i.e. wind and solar). Respondents were given several options how this could be achieved. Increasing availability of demand response and further improvement in infrastructure development and interconnections turned out to be the most favoured options (both supported by 45% of respondents, multiple replies possible). Increasing the availability of storage was also regarded as an important option (40%). Among the diverse options given, dedicated mechanisms to increase the availability of flexible generation capacity (capacity payments) proved most controversial (only 21% in favour). This was mirrored in some of the explanations received on market design issues (see also section below) where respondents expressed reserves about capacity mechanisms or stated that should they be considered necessary, they would in any case have to be designed in a way so as not to introduce new distortions in the internal market.

6 Market integration

In this chapter respondents stated that they saw a need to make support schemes more market oriented. On how to achieve more market integration two elements of reform to support schemes to expose renewables more directly to market signals were most frequently quoted: a requirement to trade renewables production on wholesale markets and an exposure to balancing risk. In line with these preferences, when it comes to the concrete support mechanisms to be used, many respondents argued for a gradual shift away from feed-in tariffs towards premiums. There were also quite a few respondents who considered quota systems in general more market oriented. As to balancing responsibility some basic preconditions were frequently mentioned that had to be in place to allow exposure in particular of wind power. This included the possibility to trade close to real-time, including liquid intra-day markets, as well as cost-reflective imbalance prices.

Respondents were also asked whether they considered today's market design an appropriate framework for integrating a larger share of renewable electricity. Only a small majority considered that the current wholesale market model based on short-run marginal cost pricing was appropriate (8%). A frequent reply was that wholesale markets would have to move towards reflecting full costs (33%) although some respondents added that this could already be observed in some successful markets. It was also stressed in that context that remaining distortions in the market such as in particular price caps would have to be removed. Moreover an evolution of electricity markets into energy service markets where revenues would be earned from more than just selling electricity was also regarded favourably (25%).

Finally, a number of respondents, especially from the NGOs, stressed that they regarded the current market as grossly distorted by subsidies to conventional and nuclear energy forms which would in any case have to be removed to allow for renewables being successfully integrated into the market.

7 Renewables in Heating and Cooling

Asked about the main barriers against a stronger uptake of renewables in the heating and cooling sector, costs or lack of financial support was most often cited (43% of all respondents, multiple replies possible). Other obstacles that received a lot of attention were lack of awareness or unfavourable building regulations. Respondents also took the opportunity to expand on a number of other problems for renewables in the heating and cooling sectors. The decentralised nature of the sector was often cited as a main barrier against a stronger uptake. Split incentives of market actors, as e.g. in the case of landlords and tenants, are considered to make the implementation of changes difficult and respondents see the need for a comprehensive policy approach involving all administrative levels. Furthermore, the respondents reported the lack of a supportive tax policy, which would address the issue of cost competitiveness e.g. through a carbon component in the price of heating fuels. A lack of education and training for installers to ensure a sufficient number of qualified staff was also frequently mentioned. Widespread in the submissions is the general notion that so far the political attention is too much focussed on electricity, not reflecting the size and potential of the heating and cooling sector.

On the most promising pathways for heating and cooling, perhaps surprisingly solar thermal is the technology which received the most support among the respondents to the public consultation (44%, multiple replies possible), clearly ahead of biomass which was named similarly often as geothermal (both by around 33%). Electrification on the basis of a higher share of renewables in electricity production received somewhat less support (24%). On biomass, respondents raised concerns about the limited availability, alongside concerns on sustainability and the call to operate biomass facilities on highest efficiency levels. Concerning other technologies, heat pumps and heating & cooling storage are mentioned most often, with storage having the potential for increasing grid stability. A high number of comments asked for a neutral policy approach, which is not picking winning technologies beforehand.

8 Renewables in transport

Regarding the main barriers against a stronger uptake of renewable energy in transport, the respondents see the costs of a further deployment as the most challenging problem (39%, multiple replies possible). This goes along with a lack of the necessary infrastructure – an issue which was raised to a similar extent. For a faster increase of RES in transport, the respondents also see the need to set standards more quickly – some ask the European Commission to set deadlines to the industry in this respect, with a standard set by the Commission as the fall back option. Another big concern among the respondents was whether sustainably produced biofuels can be supplied on a big scale. As well in this policy area, respondents ask for a long-term regulatory certainty in the entire EU, given the high investment need for a major shift towards renewable energy sources in the sector. Other concerns relate to public acceptance, which can be linked to a lack of suitable information, but as well to sustainability concerns such as indirect land-use change. As a way forward, a high number of respondents proposed to increase the share of RES via electrification and a modal shift, alongside a reduction of energy demand.

Regarding transport sectors where renewables penetration is most likely to be successful, most respondents cited road transport for passengers (46%, multiple replies possible) and rail transport (44%). Whereas good transport by road was still regarded as relatively open to renewable penetration, there was considerably more scepticism among respondents about the possibility to expand the use of renewables in air and water transport.

9 Sustainability

Only one question was asked about the future of sustainability criteria in the questionnaire, but the message coming from this was quite clear. When asked about the need for additional sustainability criteria in the period post-2020, a clear majority of respondents confirmed that in their view sustainability criteria should in the future be applied to both all biomass and fossil fuels (51%).

Besides, around 19% considered that additional criteria would be necessary to ensure only the best performing biomass was promoted. Respondents frequently pointed to increased competition for the limited resource biomass and called for taking into account effects of its use on overall carbon stocks. There were nevertheless diverging views in how far aspects of land-use change should be reflected in sustainability criteria. Respondents also made reference to existing regulations in the forestry sector as a basis for ensuring sustainable biomass use. Overall, only a minority of respondents considered that the implementation of the existing criteria was sufficient.

10 Regional and international dimensions

Given the lack of practical experience so far with application of the cooperation mechanisms, a slight majority of respondents considered that current rules for cooperation between Member States foreseen in Directive 2009/28/EC where not sufficient or had to be supplemented to become operational (41% over 34% who considered the current arrangements sufficient). Most frequently, more detailed guidance on the use of the flexibility mechanisms was requested from the Commission, including on procedural aspects. Some respondents also called for reinforced efforts to move to a more regional planning when it comes to the use of renewables or at least considered more visibility on the position of Member States towards target fulfilment useful. Some industry respondents also asked that private sector initiatives should be possible without relying explicitly on national governments. Finally, there were also calls for an EU level joint framework rather than relying on purely bilateral initiatives.

A similar point was also made regarding cooperation between the EU and third countries on the development of renewables. In general this was seen as quite a positive course of action, with a clear majority of respondents favouring further promotion of such cooperation (58% over 30% who favoured focusing exclusively on EU domestic resources). Again, more respondents favoured an approach based on agreements between the EU and third countries rather than bilateral agreements to be concluded by Member States (45% over 19%). Among the instruments that could be used to strengthen this dimension, enhanced visibility and transparency for existing projects as well as forecast of third country contributions were mentioned. Contributors also stressed the need for enhanced infrastructure given that physical transfer of electricity is a precondition for joint projects with third countries under Article 9 of the Directive. This concerned not only interconnection between Europe and third countries, but also enhanced interconnection within Europe. Beyond the immediate use of the cooperation mechanisms there were also calls to promote reciprocal investments and market access in bilateral dialogues with all partners.

As far as the preferred partner regions for cooperation on renewable energy is concerned, unsurprisingly North Africa was most often mentioned, followed by other neighbours such as South East Europe (the Energy Community in particular) and Norway. Nevertheless enhanced cooperation with further away countries such as the US or China was also mentioned beyond the context of the cooperation mechanisms.

11 Technology development

Based on the choices made for current SET plan, respondents were asked where they saw the remaining key challenges for the technologies currently covered by European Industrial Initiatives (wind, solar and bio-energy in the area of renewable energy). Technology performance and cost-competitiveness were identified as the most important elements in this context (46% of respondents, multiple replies possible), ahead of issues linked to system integration (39%) and industrial manufacturing and supply chain issues (20%). A number of respondents also replied that it was not only about system integration of new technologies, but also about a transformation of our energy systems due to these new technologies. On the existing industrial initiatives a number or comments were also received arguing for enhanced focus on small-scale and more local applications; these respondents perceived the current initiatives (still) to be too much focused on large scale technologies. The need for more training and education programs linked to these technologies was also underlined.

When asked about technologies other than those covered by today's industrial initiatives that had the potential for industrial scale application in a post-2020 perspective or should be in the focus of future research and industry cooperation, the fields most often mentioned were storage technologies, ocean energies such as wave and tidal and forms of geothermal energy. On a more horizontal level, several themes were identified that would also merit stronger focus. This concerned material research, dedicated small-scale/distributed generation initiatives, flexible fuel car fleets in the transport sector as well as waste heat utilisation schemes.

Most respondents considered the EU's current R&D policy only partially successful in promoting a broader technology portfolio. One of the key challenges identified was to further facilitate the step from basic research to deployment and commercialisation although the European Industrial Initiatives were acknowledged as step in the right direction. An even stronger coordination of national (and regional) research agendas and consolidation into a more strategic European approach was also frequently mentioned. Other perceived problems concerned a lack of funds or dedicated budget lines for certain research priorities as well as high administrative burden for participation in the EU's research programmes, in particular for industry. Finally, an improvement in communication efforts to disseminate the results was also considered necessary by some respondents.

Annex 2: Primes modelling used for the Energy Roadmap 2050

The PRIMES model simulates the response of energy consumers and the energy supply systems to different pathways of economic development and exogenous constraints and drivers. It is a modelling system that simulates a market equilibrium solution in the European Union and its member states. The model determines the equilibrium by finding the prices of each energy form such that the quantity producers find best to supply match the quantity consumers wish to use. The equilibrium is forwarding looking and includes dynamic relationships for capital accumulation and technology vintages.

The model is behavioural formulating agents' decisions according to microeconomic theory, but it also represents in an explicit and detailed way the available energy demand and supply technologies and pollution abatement technologies. The system reflects considerations about market competition economics, industry structure, energy /environmental policies and regulation. These are conceived so as to influence market behaviour of energy system agents. The modular structure of PRIMES reflects a distribution of decision making among agents that decide individually about their supply, demand, combined supply and demand, and prices. Then the market integrating part of PRIMES simulates market clearing.

PRIMES is a partial equilibrium model simulating the entire energy system both in demand and in supply; it contains a mixed representations of bottom-up and top-down elements. The PRIMES model covers the 27 EU Member States as well as candidate and neighbour states (Norway, Switzerland, Turkey, South East Europe). The timeframe of the model is 2000 to 2050 by five-year periods; the years up to 2005 are calibrated to Eurostat data. The level of detail of the model is large as it contains:

- 12 industrial sectors, subdivided into 26 sub-sectors using energy in 12 generic processes (e.g. air compression, furnaces)
- 5 tertiary sectors, using energy in 6 processes (e.g. air conditioning, office equipment)
- 4 dwelling types using energy in 5 processes (e.g. water heating, cooking) and 12 types of electrical durable goods (e.g. refrigerator, washing machine, television)
- 4 transport modes, 10 transport means (e.g. cars, buses, motorcycles, trucks, airplanes) and 10 vehicle technologies (e.g. internal combustion engine, hybrid cars)
- 14 fossil fuel types, new fuel carriers (hydrogen, biofuels) 10 renewable energy types
- Main Supply System: power and steam generation with 150 power and steam technologies and 240 grid interconnections
- Other sub-systems: refineries, gas supply, biomass supply, hydrogen supply, primary energy production
- 7 types of emissions from energy processing (e.g. SO2, NOx, PM)
- CO2 emissions from industrial processes
- GHG emissions and abatement (using IIASA's marginal abatement cost curves for non CO2 GHGs).

Further information on the assumptions behind the modelling done for the Energy Roadmap 2050 can be found in the Commission Staff Working Paper SEC(2011) 1565, part 1 and 2.