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EXECUTIVE SUMMARY OF THE 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

Energy Roadmap 2050

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1. PROBLEM DEFINITION

The well-being of our people, industry and economy depends on safe, secure, sustainable and affordable energy. Energy is a daily need in a modern world and is mostly taken for granted in Europe. The energy system and its organisation evolved over centuries if not millenaries using different fuels and distribution systems. Our current energy system and ways of producing, transforming and consuming energy seem unsustainable for the future due to: high GHG emissions; security of supply risks and competitiveness risks related to high energy costs and underinvestment.

It will take decades to steer our energy systems onto a more secure and sustainable path. There is no silver single bullet how to change this. There is no energy source that is abundant and has no drawbacks in terms of its sustainability, security of supply and competitiveness (price). That is why the solution will require trade-offs and the market alone under current regulatory environment might not be delivering. Significant investments will however be needed in the near future to replace energy assets in order to guarantee a similar level of comfort to citizens at affordable prices; assure secure and competitive supplies of energy inputs to businesses and take respect of the environment.

Relying on more low-carbon, domestic (i.e. intra EU) or more diversified sources of energy, produced and consumed in an efficient way, can bring significant benefits not only for the environment, competitiveness and security of energy supply but also in terms of economic growth, employment, regional development and innovation. What are the barriers? Why the shift to a low-carbon, more competitive and more diversified sources using energy system is not, or too slowly happening?

There are several factors that hamper the shift:

1) Energy market prices do not fully reflect all costs to society in terms of pollution, GHG emissions, resources' depletion, waste, land use, air quality and geopolitical dependency.

2) Inertia of the physical system
The majority of investments in the energy system are long-term assets leading to significant lock-in effects and any change to the system materialises only gradually.

3) Public perception and mindset of the users
Perception of the risks related to the construction of new power plants and infrastructure by general public can be more negative than expert judgements. It can also take a long time and adequate incentives or regulation to persuade people to change the way they heat their houses; transport themselves, etc.

4) Uncertainty concerning technological, demand, prices and market design developments
The energy system is characterised by a large proportion of long-term fixed costs that need to be recovered over several decades. Uncertainty can significantly increase investors' risks and costs and makes consumers and businesses reluctant to invest.

5) Imperfect markets
There is weak competition in some Member States where markets are still dominated by incumbents. Another factor is market myopia, i.e. the fact that long-term investments are not necessarily pursued by market actors who are generally drawn towards shorter-term gains. Developing markets for energy efficiency services and decentralised RES are faced with low number of actors and the lack of enabling regulatory framework.

2. ANALYSIS OF SUBSIDIARITY AND EU VALUE ADDED

The EU's competence in the area of energy is set out in the Treaty on the Functioning of the European Union, in Article 194[1]. EU competences related to combating climate change including GHG emission reductions in energy and other sectors are enshrined in Art. 191-193. From an economic perspective, many energy system developments can best be achieved on an EU-wide basis, encompassing both EU and Member State action while respecting their respective competences.

3. OBJECTIVES OF EU INITIATIVE

The general objective is to shape a vision and strategy of how the EU energy system can be decarbonised by 2050 while taking into account the security of supply and competitiveness objectives.

To achieve the general objective more specific objectives are being proposed:

(i) Provide more certainty to investors as regards possible future policy orientations at the EU level by showing different decarbonisation pathways for 2050 as well as their main economic, social and environmental impacts;

(ii) Show trade-offs among policy objectives as well as among different decarbonisation pathways and identify common elements in all decarbonisation pathways;

(iii) Set milestones after 2020 to mobilise stakeholders and give more certainty for period after 2020.

The Roadmap 2050 should be based on the current objectives of the EU energy policy – sustainability, security of supply and competitiveness.

4. POLICY OPTIONS

This impact assessment is not a classical one that lists policy options to meet certain policy objectives and then assesses impacts of these policy options to determine a preferable one. It rather examines a set of possible future developments to get more robust information on how the energy system could achieve 85% reduction of energy related CO2 emissions compared to 1990 (corresponding to 80% GHG emissions reductions by 2050) and improve security of supply and competitiveness, without selecting one of them.

Several useful scenarios could be proposed for a decarbonisation analysis of the energy system. The design of scenarios was extensively discussed with various stakeholders. Stakeholders and the European Commission identified four main decarbonisation routes for the energy sector – energy efficiency impacting mostly on the demand side and RES, nuclear and CCS predominantly on the supply side (lowering the carbon intensity of supply). The policy options (scenarios) proposed explore 5 different combinations of the four

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[1] Article 194:
1. In the context of the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment, Union policy on energy shall aim, in a spirit of solidarity between Member States, to:
(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;
(d) promote the interconnection of energy networks.

decarbonisation options. Decarbonisation options are never explored in isolation as interaction of different elements will necessarily be included in any scenario that evaluates the entire energy system. All decarbonisation scenarios achieve 85% energy related CO2 emissions by 2050 and it will be carefully assessed whether each policy option also improve security of supply and competitiveness of the energy sector as well as lead to affordable energy costs.

	Policy options
1	Business as usual (Common Reference scenario[2])
1bis	Current Policy Initiatives – CPI scenario (updated Reference scenario)
2	High Energy efficiency scenario
3	Diversified supply technologies[3] scenario
4	High RES scenario
5	Delayed CCS scenario
6	Low nuclear scenario

5. ASSESSMENT OF IMPACTS AND COMPARISON OF OPTIONS

Environmental impacts

As regards environmental impacts, all policy options significantly reduce energy consumption with the largest reduction coming in the High Energy Efficiency scenario. The composition of energy mix would also differ significantly in a decarbonised system with strong increase in RES in all scenarios. Nuclear developments depend on policy assumptions taken and ranges from 2 to 18% share in primary energy consumption. The share of gas is the highest in Low nuclear scenario with significant CCS penetration. Oil and solids decline. Electricity share in final energy consumption doubles from current levels and electricity become the most important final energy source. All decarbonisation scenarios achieve 80% GHG reduction and 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 40-41%.

Economic impacts

Various analyses of carbon and energy policies on GDP suggest that impact is rather limited. Depending on the decarbonisation scenario, there are no average annual additional energy system costs due to the pursuit of this major decarbonisation as a part of a global effort compared with the Reference and CPI scenarios, or they are small. As regards electricity prices, some policy options show a small decrease in electricity prices as compared to Reference and CPI scenarios (Energy Efficiency and Diversified supply technologies) while some others show increases (High RES and to a lower extent Low nuclear). ETS carbon prices are significantly higher than in the Reference and CPI scenarios, while fuel prices are lower. All policy options require more and more sophisticated energy infrastructures (electricity lines, smart grids and storage) with High RES scenario having the highest requirements.

Social impacts

Social dimension of decarbonisation roadmaps is crucial as transition to low carbon economy will require an in depth change in several sectors affecting companies, employment and

[2] Used also in the Low Carbon Economy Roadmap and Transport White Paper.

[3] Scenario 3 reproduces "Effective and Widely Accepted Technologies" scenario used in Low Carbon Economy roadmap and Transport White Paper on the basis of scenario 1bis.

working conditions. Education and training need to be addressed at an early stage in order to avoid unemployment in some sectors and labour shortages in others.

The impact of decarbonisation policies on employment are not substantial by 2020 as shown by several studies but investments in new technologies might trigger demand for higher skilled jobs. Security of energy supply measured as import dependency improves in all policy options by 2050, the biggest improvements being in the High RES scenario. As regards affordability of energy costs by households, all policy options show significant fuel savings but also higher capital and energy efficiency investment costs. Total energy expenditures by households are higher in all policy options, the highest increase being in options showing strong energy efficiency policies and RES penetration.

Options were compared based on their **effectiveness; efficiency and coherence.**

As regards effectiveness, the 3 objectives of energy policy – sustainability, security of supply and competitiveness - were taken. All policy options were designed to reach 85% reductions of energy related CO2 emissions in 2050, so all are effective. It should be noted that some options are highly dependent on success of new commercially yet not proven technologies. As regards security of supply, all policy options reduce import dependency. However, in more electrified world, stability of the grid might be of much higher concern. As regards, competitiveness, some policy options show a small decrease in electricity prices as compared to Reference and CPI scenarios while some others show increases. ETS prices are significantly higher than in the Reference and CPI scenarios, while fuel prices are lower. The model triggers adequate investment which are driven by specific policies or carbon prices and investment decisions are based on perfect foresight assumption.

In terms of efficiency, the analysis demonstrates that the costs of decarbonisation of the energy system are similar in all scenarios and that most decarbonisation scenarios even show cost savings compared to the Reference scenario. The least costly scenarios are Delayed CCS and Diversified Supply Technologies scenarios with significant penetration of nuclear.

All policy scenarios are coherent with other EU long term objectives (on climate, transport, etc). There is no clear winner among policy options scoring the best in all criteria and several trade-offs will need to be taken into account.

6. CONCLUSIONS

Current trends projections show only half the GHG emission reduction needed; increased import dependency, in particular for gas; and rising electricity prices and energy costs**.** The model-based analysis has shown that decarbonisation of the energy sector is feasible; can be achieved through various combinations of energy efficiency, renewables, nuclear and CCS contributions; and that the costs are bearable.

Common elements to scenario analysis

- There is a need for an integrated approach.
- Electricity makes major inroads in decarbonisation scenarios reaching 36-39% share in 2050.
- Significant energy efficiency improvements happen in all decarbonisation scenarios.
- The share of renewables rises substantially in all scenarios**,** achieving at least 55% in gross final energy consumption in 2050.
- The increased use of renewable energy as well as energy efficiency improvements require modern, reliable and smart infrastructure including electrical storage.

- Nuclear has a significant role in decarbonisation with the highest penetration in case of CCS delay.
- CCS contributes significantly towards decarbonisation in most scenarios, with the highest penetration in case with nuclear constraints.
- All scenarios show a transition from high fuel/operational expenditures to high capital expenditure.
- Substantial changes in the period up to 2030 will be crucial for a cost-efficient long term transition to a decarbonised world, economic costs are manageable if action starts early so that the restructuring of the energy system goes in parallel with investment cycles.
- The costs of such deep decarbonisation are low in all scenarios given lower fuel procurement costs with cost savings shown mainly in scenarios relying on all four main decarbonisation options.
- Costs are unequally distributed across sectors, with households shouldering the greatest cost increase coming from higher costs for direct energy efficiency expenditures in appliances, vehicles and insulation.
- The external EU energy bill for importing oil, gas and coal will be substantially lower under decarbonisation due to substantial reduction in import quantities and prices.

Some policy relevant conclusions can be drawn based both on the results of the scenario analysis as well as on comparison of the idealised market and technological conditions needed for modelling purposes and what is found in the much more complex reality.

Implications for future policy making

- Successful decarbonisation while preserving competitiveness of the EU economy is possible. If there were no global climate action, carbon leakage might be an issue and appropriate instruments could be needed to preserve competitiveness of energy intensive industries.
- Predictability and stability of policy and regulatory framework creates a favourable environment for low carbon investments. While the framework until 2020 is mainly given, discussions about policies for 2020-2030 should start now. Milestones and targets can help avoiding stranded costs. Uncertainty can lead to a sub-optimal situation where only investment with low initial capital costs are being realised.
- Functioning of internal market is a must to encourage investment where it is most cost-effective.
- Energy efficiency tends to show better results in a model world than in reality. Energy efficiency improvements are often hampered by split incentives, cash problems of some group of customers; imperfect knowledge and foresight leading to lock-in in some outdated technologies, etc. That is why there is a strong need for targeted support policies, e.g. for more energy efficient consumer choices.
- Strong support should be given to R&D and demonstration in order to bring costs of low-carbon technologies down.
- Due attention should be given to public acceptance of all low carbon technologies and infrastructure as well willingness of consumers to undertake implied changes and bear higher costs.
- Flanking social policies might need to be considered early in the process given that households shoulder large parts of the costs. While these costs might be affordable by an average household, vulnerable consumers might need specific support to cope with increased expenditures.

–	Flexibility. The future is uncertain and nobody can predict it. That is why preserving flexibility is important for a cost efficient approach, but certain decisions are needed already at this stage in order to start the process that needs innovation and investment, for which investors require a reasonable degree of certainty from reduced policy and regulatory risk.
–	External dimension, in particular relations with energy suppliers, should be dealt with pro-actively and at an early stage given the implications of global decarbonisation on fossil fuel export revenues and the necessary production and energy transport investments during the transition phase to decarbonisation.

7. MONITORING AND EVALUATION

The Roadmap is not a one-off exercise and will be regularly updated taking into account the most recent developments. In addition, the Commission will constantly monitor a set of core indicators which are already available and are being currently used.