How to facilitate the transition to a low-carbon, competitive and secure EU society

Policy Brief

February 2018

About this report

This report constitutes the First Policy Brief of the REEEM Project on the integrated impact of transition pathways towards a low carbon, secure and competitive EU society. It condenses the main insights obtained in the first 22 months of REEEM. Based on the insights, it proposes keys to read the complexity of the energy system and its inter-linkages with other sectors, thus forming science-based evidence to inform energy strategies.

The report builds on the detailed analyses reported in Deliverable 1.1 – Report on pathway definition with drivers, assumptions, indicators and input data, Deliverable 1.2 – First Integrated Impact Report, Deliverable 2.1a – First Innovation and Technology Roadmap and Deliverable 2.2a – First Innovation Readiness Level report. It further collects information from the wide modelling effort undertaken by all the modelling teams in the eleven partner institutions, some of it published in ad-hoc technical reports within the project.

Authors

Francesco Gardumi (KTH Royal Institute of Technology), Anna Darmani (InnoEnergy), Louise Coffineau (InnoEnergy), Pinar Korkmaz (University of Stuttgart), Ulrich Fahl (University of Stuttgart), Mark Howells (KTH Royal Institute of Technology), Steve Pye (University College London), Francesco Fuso Nerini (KTH Royal Institute of Technology), Georgios Avgerinopoulos (KTH Royal Institute of Technology).

REEEM partners

About REEEM

REEEM aims to gain a clear and comprehensive understanding of the system-wide implications of energy strategies in support of transitions to a competitive low-carbon EU energy society. This project is developed to address four main objectives: (1) to develop an integrated assessment framework (2) to define pathways towards a low-carbon society and assess their potential implications (3) to bridge the science-policy gap through a clear communication using decision support tools and (4) to ensure transparency in the process.

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Other contributors

Julia Welsch (University of Stuttgart), Roland Montenegro (University of Stuttgart), Aira Hast (Aalto University), Sanna Syri (Aalto University) Xi Pang (KTH Royal Institute of Technology), Ulla Mörtberg (KTH Royal Institute of Technology).

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Challenges of the EU energy transition

With the ratification of the Paris climate agreement and the launch of the **Energy Union strategy**, the European Union reaffirmed its commitment to carrying out a transition to a low carbon, secure and competitive society by 2050 and beyond. The energy sector is a core part of this transition, since it accounts for around 80% of the global greenhouse gases emissions [1].

Key actions to facilitate the transition towards a low-carbon, competitive and secure energy system are identified and road-mapped in the legislative framework formed by: the 2020 Climate and energy package [2], the 2030 Climate and energy framework [3] and the Energy Roadmap 2050 [4]. In parallel, the European Commission collected a set of research and innovation priorities for energy technologies through the Strategic Energy Technology (SET) Plan [5,6]. All these packages propose sets of indicative or mandatory policy targets which can be pursued by the EU and Member States. Such targets move beyond the incremental nature of policies to date to promote real structural change of the energy system [7].

This structural change will be fostered by large-scale investment in a range of existing and innovative low carbon technologies (including changes in energy use).

The success of the actions proposed to realise the transition to a low-carbon energy system largely depends on three factors:

- How the political, economic, social, technological and environmental setting will deploy in the decades to come, on a global, EU, national and local level;
- How numerous groups of actors – e.g. investors at various stages of the value chain of energy technologies, users and policy-makers (especially at national, regional and local level) – are affected by the transition, what opportunities they see and how they react;
- The existence of structural barriers and incentives to the technological changes necessary to carry out the transition.

Therefore, in order to facilitate the transition to a low carbon, secure and competitive EU society, it is essential to:

- Identify the impacts of the low-carbon transition on the EU economy, environment and society, under different possible political, economic, social, technological and environmental settings;
- Identify winners and losers of the transition across different groups of actors and propose actions to reduce the divide between them;
- Explore what innovation and technological changes enable addressing the needs of the future energy system and incentivise decisions / investments in favour of the Energy Union strategy.

By using an extensive suite of world class mathematical modelling tools and combining them, the REEEM project aims to address the three questions listed above.

High decarbonisation pathways: policy recommendations from REEEM

In this Policy Brief we discuss potential impacts of high decarbonisation targets (in line with 80% CO_2 emissions reduction from the energy sector by 2050 compared to 1990) in a EU political, economic, social, technological and environmental setting **evolving from the current one without major disruptions**. The future we imagine – even if just one of many possible – was the result of a dialogue process among experts in the low-carbon transition. More futures will be analysed in the course of the

REEEM project. Politically, we assume the European Union holds after the financial crisis, with stronger energy policy parallels within clusters of countries (e.g. in the burden sharing of emission targets). This assumption recalls those of two of the five scenarios featured in the 'White paper on the future of Europe' [8] discussed by President Jean-Claude Juncker at the State of the Union 2017: 'Carrying on' and 'Those who want more do more'. In accordance with views of stakeholders, collected in a workshop held on 6th October 2017 in Brussels, we also assume that:

- The economies will restart growing in the near future, though at different speeds [9];
- The society will take the energy transition as it comes, without strong engagement;
- Climate change will result in localised lower availability of water; and
- The transition will rely on currently commercially available technologies, without breakthrough in any others.

This future could be labelled as '***Coalitions for a low-carbon path***' and is summarised in Table 1.

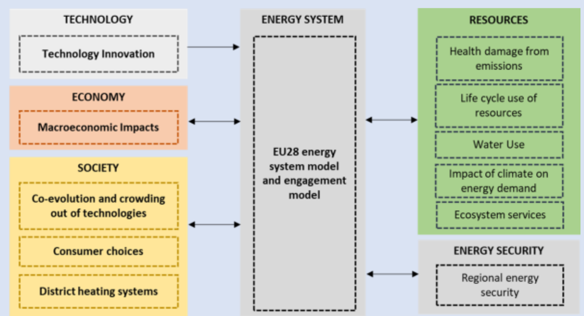
Table 1. Summary of assumptions on EU and world future.

Political	***Economic***	***Social***	***Environmental***	***Technological***	***Global***
Stronger policy parallels within clusters of Member States.	*Growth at different speeds.*	*Likely passive society in transition.*	*Low availability of water (drying climate) and scarce resources.*	*Reliance on currently commercial technologies. No breakthrough foreseen.*	*Climate change mitigation effort driven by some regions / countries.*

We used our set of models to explore the implications of the energy transition in such future. The modelling activities are still ongoing. Moreover, the insights obtained from the models necessarily change as conditions at member-state, European Union and global level change. Therefore, those presented are initial insights and will serve as a starting point for further analyses.

Box 1. Methodology.

A suite of models is used to produce a multi-sectoral, yet integrated, quantitative picture of the impacts of the EU energy transition. Here an overview of the whole set of models.



Burden sharing: an EU approach to meet effectively 2050 targets[1]

According to the modelling results, the EU-wide least-cost way to decarbonise the energy system and meet the Energy Roadmap 2050 targets requires burden sharing between the Member States. If least-system-cost decarbonisation pathways are pursued, **the optimal burden sharing depends on the marginal CO_2 abatement costs different countries would bear for decarbonising their systems by 2050**. The marginal abatement cost is a widely employed economic metric that measures the cost of reducing one more unit of emission. It depends, amongst others, on the resource potential of a country, its energy supply mix and how decarbonised the system already is. The energy systems of UK, Germany, Denmark and

[1] Results of the EU28 energy system model built in TIMES framework [12,13].

Italy see lower marginal abatement costs. Therefore, these countries could overshoot the targets for the ETS sectors and meet those for non-ETS sectors (housing, agriculture, waste and transport excl. aviation) with lower economic burden. This would compensate for countries which would not meet the targets, as they have higher marginal abatement costs to decarbonise their energy systems (e.g. Bulgaria and Slovenia).

A pure macroeconomic perspective may provide limited insights[2]

Traditional macro-economic models show that the decarbonisation comes at some cost: GDP and employment rate seem to be affected negatively. However, such models don't account for the **long-term return on investment in technology learning, the reduction of the brain-drain phenomenon and the decrease of negative environmental externalities**. These need to be taken into consideration, as they may counterbalance the negative effects on the broader economy. Further analyses in REEEM will assess the importance of technological learning and environmental externalities.

Technological changes: potential rise of onshore and rooftop solar photovoltaic, limited storage installation without further cost reduction[3]

Deeper insights come from considerations on how the EU energy system could be practically decarbonised from a technological perspective.

Rooftop solar photovoltaic and onshore wind appear as cost-competitive supply options in the energy transition. Nuclear power also plays a key role in limiting costs when decarbonising the electricity supply. Storage could gain a share in balancing intermittent renewables, especially if the cost of existing technologies (e.g., Lithium-Ion batteries) or new technologies (e.g., Lithium-Air batteries) were to fall and these entered the market. With such price reductions, considerable shares of storage could become competitive with fast ramping fossil-fuel-fired units and grid extensions, as well as Demand-Side Management solutions.

Investment choices impact on the deployment of co-evolving or competing technologies[4]

The strategic direction and the focus of the low carbon transition result in quite different outcomes for different groups of technologies. With a focus on the United Kingdom, we analysed the potential interdependencies in the deployment of technologies, under high decarbonisation targets. A key finding is that Carbon Capture and Sequestration (CCS) technology can be a cost-effective solution to decarbonise the energy system, contributing to decreasing the marginal CO_2 abatement costs. However, its deployment radically shapes the choices not only in the power generation sector but across the system. We find that, without CCS, much higher levels of wind and nuclear generation are deployed (Figure 1), resulting in higher mitigation costs. In addition, the choice of technologies in end use sectors differs significantly. Due to the system wide influence of CCS, we conclude that low or no CCS pathways are critical to explore so that future strategies are not solely defined based on the highly uncertain scale up of CCS technologies, but they are also robust to failure to deploy such systems.

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[2] Results of the global macroeconomic model built in NEWAGE framework.

[3] Results of the EU28 energy system model built in TIMES framework [12,13].

[4] Results of the UK energy system model ESME.

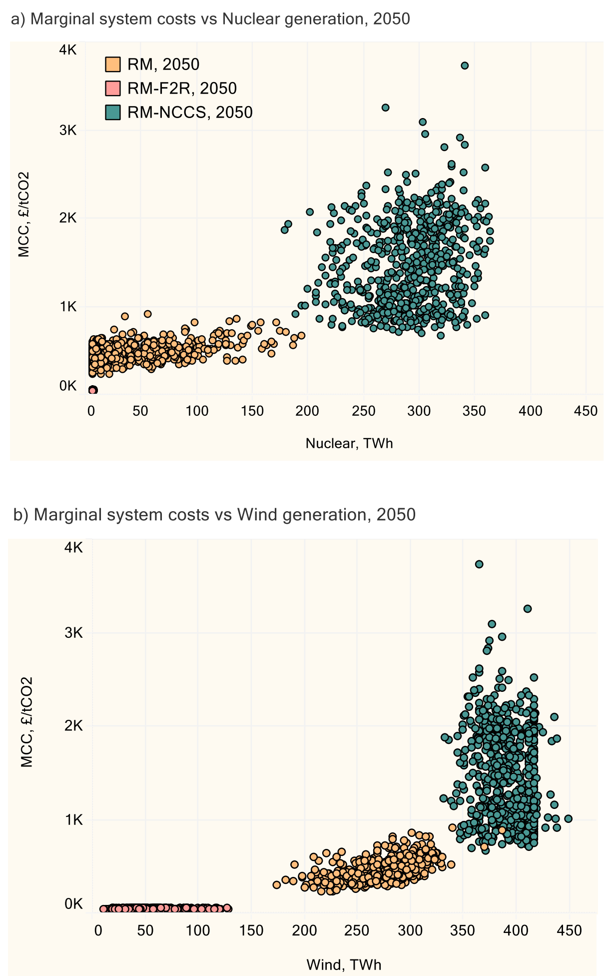

Figure 1. Marginal system costs of mitigation in 2050 versus deployment of nuclear (a) and wind (b) under UK policy targets with (RM) and without CCS (RM-NCCS). RM-F2R is a low ambition case, showing low levels of deployment of wind and nuclear.

National Energy and Climate strategies: approaches for planning and realising the low-carbon transition[5]

The national decarbonisation targets might have **unintended impacts, not evident on a coarse scale, but unveiled at a local level**. When these are not accounted for, the top-down implementation of energy strategies may be slowed down by opposition of local authorities and communities. In a case study focusing on Lithuania, we assessed the implications of the use of forestry biomass to meet the decarbonisation targets included in the Lithuanian National Energy Strategy [11]. If low prices and high availability of biomass are assumed, the latter would likely have a considerable share in the least-cost energy supply mix of Lithuania. However, **the use of biomass would in this case exceed the country's resource base**, causing damage to the ecosystem in the long run. Even when the resource base is not exceeded, **the impact of biomass use on the ecosystem depends on how intensive the forest management is**. Intensive harvesting of biomass for energy use may be detrimental in the long term (e.g. 2030) for ecosystem services such as habitat, recreation and carbon storage, with potential fallbacks on local economies (see Figure 2). These conclusions suggest that, when updating the National Energy and Climate strategies, **a bi-directional and iterative process could be appropriate**, where national policy makers take into account local constraints and availability of resources.

[5] Results of a District Heating network model built in EnergyPRO framework, of a Lithuanian energy system model built in MESSAGE framework [14] and of an ecosystem services model built in LEcA Tool [15].

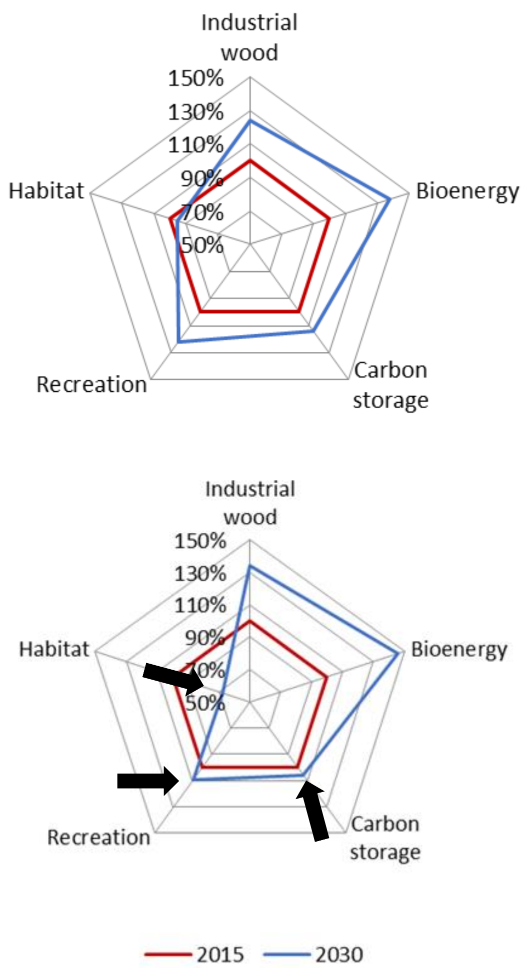

Figure 2. Impacts of the use of biomass for bioenergy on other ecosystem services in case of less intensive (top) or more intensive (bottom) use of biomass by 2030.

After the decarbonisation targets are set, their translation into actionable plans largely depends on **how the actors of the market react on different levels**, e.g. cities. The governments are left with the difficult task to **track the relative contribution of local plans towards the achievement of the national targets they set**.

With a case study on the cities of Helsinki, Espoo, Vantaa, Kaunas and Warsaw, we analyse the potential of District Heating networks for saving primary fuels and carbon emissions. This might contribute to reaching national energy efficiency targets as requested by the EU Energy Efficiency Directive [10]. Specifically, we assume network developments until 2050, combining projections from scientific literature and by District Heating companies, and we analyse their impact. Even though some of the cities are located in different countries, a common pattern of high GHGs emission reduction potential is identifiable. Therefore, the development of District Heating networks in these municipalities **could contribute significantly to meeting the national decarbonisation and energy efficiency targets** for the heating sector. However, if the plans are implemented, the cost for heat supply is expected to increase, with **impacts on the affordability for end consumers**. According to preliminary results, the cost increase by 2050 compared to now could be moderate in Helsinki (+18%), while more considerable in Warsaw (+40%). The impact of the District Heating development plans on the national decarbonisation targets and the affordability will be further analysed in REEEM through a dedicated Case Study Report due in January 2019.

Conclusions

The analyses in the REEEM project are still mid-way towards their completion. Yet, the initial results presented above shed light on dynamics occurring in different sectors and at different spatial scales through the EU energy system decarbonisation. Such dynamics may impact on the effectiveness and velocity of the transition and should be taken into account when formulating policies.

So far, the analyses carried out in REEEM led to the following policy recommendations:

- Account for differences in the marginal cost of decarbonisation between Member States when proposing burden sharing in GHGs emissions reduction;
- Study the influence of different parameters such as technology learning

and environmental externalities, to unveil potential macro-economic benefits of decarbonisation;

- Promote the development of technologies that could effectively contribute to the decarbonisation of the energy industry, such as solar PV and onshore wind;
- Support innovation in storage technologies which could effectively influence the energy system performance;
- Account for different co-development dynamics in the value chain of energy technologies in each Member State;
- Develop bi-directional and iterative processes to turn the targets set out in the National Energy and Climate strategies into actionable plans at a local scale. Practically:
  - During the planning phase, include in the National Energy and Climate strategies hard environmental constraints linked to the local availability of resources (e.g. limitations in the use of biomass);
  - During the implementation phases, estimate the contribution of bottom-up energy efficiency measures at local level towards the achievement of national targets.

The second REEEM Policy Brief on the impact assessment of EU decarbonisation pathways, due in July 2019, will shed more light on these dynamics and others, for a wider range of possible futures.

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