[*DIFFUSION RATE OF RENEWABLE ELECTRICITY GENERATION*]

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Overview

Limiting global warming in the long term to two degrees or less requires a fundamental transformation of our energy system (Intergovernmental Panel on Climate Change and Edenhofer, 2014). Within this process, the integration of large quantities of renewable energy constitutes a pivotal element. The European Union – en bloc – aims at minimum target of 27% of renewables in the gross final energy consumption by 2030. Since the transformation is expected to lead to increasing electrification of the building-, industry- and transport sectors, the electric power generation provided by renewable energies plays a key role (Ellabban et al., 2014).

The potential market diffusion of renewable energy supply (RES) in the electricity sector mainly depends on the relative cost of RES to its alternatives and on the ability of the system to integrate volatile generation. Both determinants are dynamic and vary both in time and in dependence to the previous diffusion process.

The focus of the presented work is on the qualitative and model-based quantitative analysis of the variation of said diffusion in response to the following developments:

- Increasing coupling of electricity, transport, industry and heating sector through Power-to-X. This may have a positive effect on the market value of the electricity that can be supplied and thus lead to an increase in the optimal share of renewable electricity.
- Changes in learning rates and the innovation system of renewable energy technologies.
- Infrastructure adjustments in the form of increased network expansion.

In other words, how does the market diffusion of renewable energy supply in the electricity sector change if one assumes a given target of RES in the total final energy consumption?

Methods

We determine the sensitivity of the diffusion rate of renewable energy supply in the electricity sector through the coupling of two complementary energy system models:

The Enertile model[1], developed by Fraunhofer ISI, is an optimization model that enables the analysis of the long-term development of the power sector. The model includes endogenous investments in and the dispatch of generation capacity, storage- and flexibility options as well as transmission networks. Its main strength lies in the high temporal (hourly) and spatial (EU & MENA) resolution.

Green-X is a specialized energy system model focused on renewable energy in the areas of electricity, heat and traffic. It includes a detailed implementation of European energy policy instruments. Thus, it allows for a detailed simulation of the market diffusion of mature and emerging renewable energy technologies, while taking into account current political framework conditions.

The interplay between Enertile and Green-X works as follows: In a first step, Enertile is used to calculate transformation pathways in dependence on the developments mentioned above. The sensitivities are transmitted as input data to Green-X via annual RES market values and average electricity prices. Green-X then determines which share of RES occurs in the electricity sector under the premise of a given RES share on the cross-sectoral final energy consumption

[1] For further information on the two models, see www.enertile.eu and www.green-x.at

Results

The presented study design and its results are based on the case study "diffusion rate of renewable electricity generation „within the SET-Nav project[2]. At the halfway point of the project, only preliminary results can be used. However, as model extensions and the model linking between Enertile and Green-X were scheduled and completed in December 2017, it is certain that final results will be available for the 41st IAEE international conference Groningen in June 2018.

By means of this energy modelling exercise, insights can be gained regarding the optimal diffusion of renewable electricity generation under various conditions and sensitivities. Building on this, conclusions will be drawn on the design and requirements of future transformation pathways, as well as on the establishment of operational trajectories and the cross-sectoral integration of energy systems.

Figure 1 provides a glimpse at the scenarios examined preliminary.

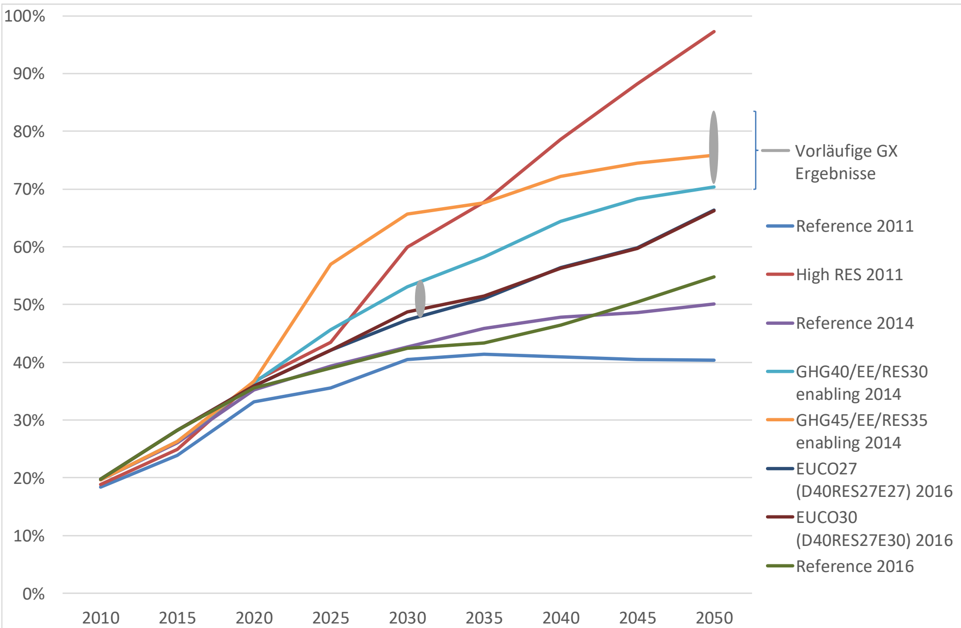

Figure 1 Comparison of the share of renewable energy supply in the electricity supply for different scenarios. Source: Own analysis (Green-X) and Prime's main scenarios.

Conclusions

As illustrated in the scenario results from Figure 1, possible shares of renewable energies in the electricity sector seem to exceed significantly those suggested by the Primes scenarios of the European Commission. A faster diffusion of RES in the electricity sector in favor of a less ambitious expansion rate in the transport and heating sectors appears - based on our preliminary results - to be a more cost-efficient variant of the transformation of the European energy system

References

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Intergovernmental Panel on Climate Change, Edenhofer, O. (Eds.), 2014. Climate change 2014: mitigation of climate change: Working Group III contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York, NY.

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[2] SET-Nav is a currently ongoing research project, see http://www.set-nav.eu/. We gratefully acknowledge the intellectual and financial support provided by the Horizon 2020 programme, operated by the European Commission, Executive Agency for Small and Medium Enterprises