Pathways for Germany's energy transition towards 2050

A model-based analysis on a federal level

Hans-Karl Bartholdtsen[1(1)], Anna Eidens[(1)], Frederik Seehaus[(1)], Felix Wejda[(1)]

[(1)]TU Berlin

Overview

The 2015 UN Climate Change Conference resulted in an agreement of the 196 member states on the limitation of global mean temperature rise well below two degrees Celsius (IEA 2016).
Burning fossil fuels is the biggest driver for global greenhouse gas (GHG) emissions and therefore implies a fossil phase-out (IPCC 2015). Germany follows the international community and has set a carbon dioxide emissions reduction target of up to 95 % by 2050 based on 1990 values (BMUB 2016). The first steps are already taken to transform the country's energy system towards less CO_2 intensity—the German *Energiewende* (energy transition). However, there are still various uncertainties affiliated to the transformation process, for instance, the question about the abandonment of coal as a resource for energy generation.

Methods

In this study, pathways for Germany's energy transition towards 2050 are drawn up based upon three possible future scenarios. It comprises the power, heat, and transportation sector on federal level, as well as trade flows within Germany and those between Germany and neighboring countries. For the analysis, the linear cost-optimizing „*Global Energy System Model"* (GENeSYS-MOD) in its second version (Burandt, Löffler, and Hainsch 2018) is used. The model computes a cost-efficient path of transformation in accordance to the respective scenario, including geographic, demographic, technologic, and economic data as model inputs. The scenarios are developed considering Germany's current climate policies and an in-depth stakeholder investigation. Phase-out dates for fossil sources are political measures with great impact and therefore are especially emphasized in the scenarios.

Results

The results suggest that a high level of decarbonization of the energy system is technically feasible and achievable at low cost. Even in the case of a less strict regulation in terms of climate change mitigation, emissions can be reduced by about 85 % compared to 1990 (see Figure 1). However, phase-outs of fossil fuels are favorable and should not be later than 2035 for any type of coal and 2045 for natural gas and oil, if ambitious climate targets are to be met.

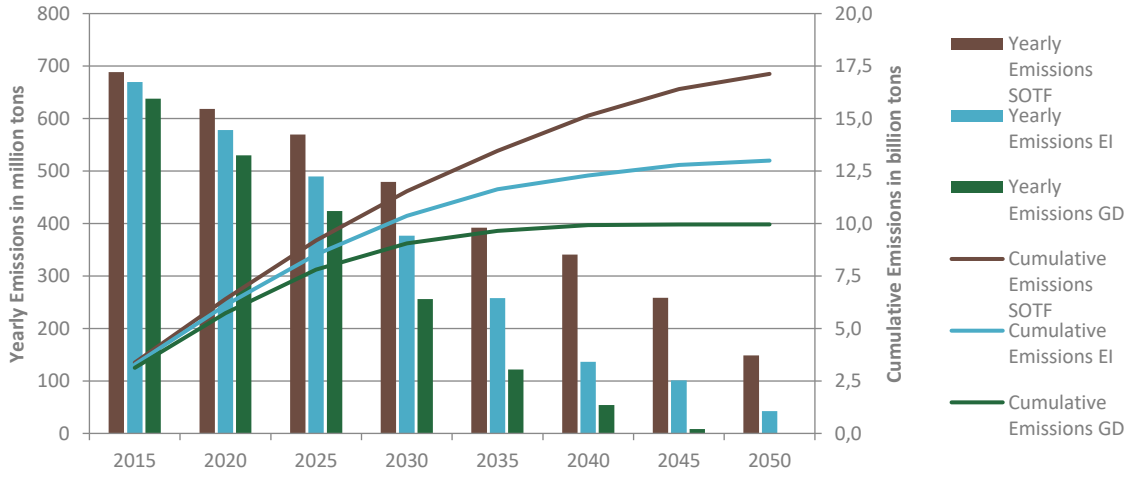

Figure 1: Development of yearly and cumulative emissions of the scenarios; Source: Own illustration

[1] Jungautor, Sekretariat H33, Straße des 17 Juni 135, 10623 Berlin, Tel: +49 30 314 25048, hkb@wip.tu-berlin.de

North Rhine-Westphalia takes a crucial role in the German energy sector, and thus in the energy transformation (Oei et al. 2018). The model results display that a long-lasting continuance of the state's current status as the largest energy generator of the Federal Republic would be enforceable only at the expense of the environment, and a delay—or even a failure—of the German energy transition would be the result. Figure 2 displays the development of the power sector in the ambitious Green Democracy scenario.

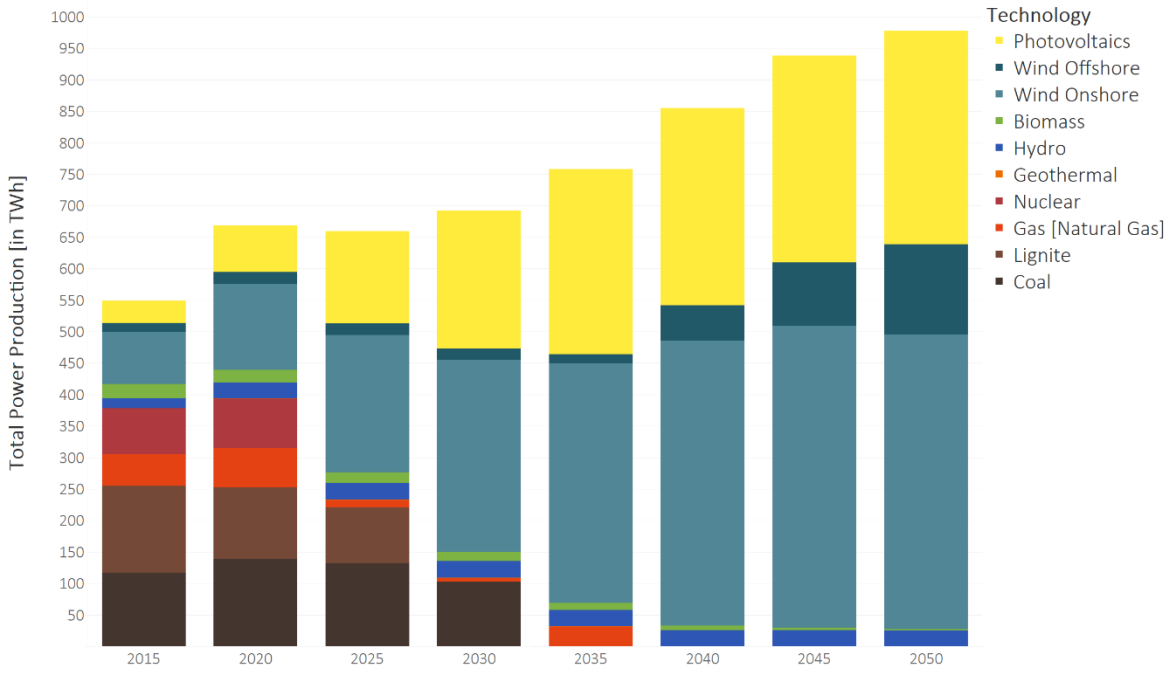

Figure 2: Development of power production in the Green Democracy scenario; Source: Own illustration

The costs associated with the energy transformation, will be primarily covered by the population, either through taxes or via consumer prices. Therefore, socially fair cost burdens have to be respected according to the economic capacity of the society. Regarding overall costs of the energy transition, it becomes apparent that any non-implementation of measures would lead to even higher expenses (e.g. in environmental damages) in the long run.

References

BMUB. 2016. "Klimaschutzplan 2050 – Klimaschutzpolitische Grundsätze und Ziele der Bundesregierung." Zarbock GmbH & Co. KG. http://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzplan_2050_bf.pdf.

Burandt, Thorsten, Konstantin Löffler, and Karlo Hainsch. 2018. "GENeSYS-MOD v2.0 – Enhancing the Global Energy System Model. Model Improvements, Framework Changes, and European Data Set." *DIW Data Documentation*, no. 94 (July). https://www.diw.de/documents/publikationen/73/diw_01.c.594273.de/diw_datadoc_2018-094.pdf.

IEA. 2016. *World Energy Outlook 2016*. Paris: International Energy Agency.

IPCC. 2015. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva, Switzerland: Intergovernmental Panel on Climate Change.

Oei, Pao-Yu, Hanna Brauers, Claudia Kemfert, Martin Kittel, Leonard Göke, Christian von Hirschhausen, and Paula Walk. 2018. "Kohleausstieg in NRW Im Deutschen Und Europäischen Kontext - Energiewirtschaft, Klimaziele Und Wirtschaftliche Entwicklung." https://www.diw.de/documents/publikationen/73/diw_01.c.598424.de/diwkompakt_2018-129.pdf.