Coal phase-out scenarios for Germany, UK and the EU

Dogan Keles, Karlsruhe Institute of Technology, +49 721608 44566, dogan.keles@kit.edu
Hasan Ümitcan Yilmaz, Karlsruhe Institute of Technology, +49 721 608 44503, hasan.yilmaz@kit.edu
Rupert Hartel, Karlsruhe Institute of Technology, +49 721 608 44584, rupert.hartel@kit.edu
Wolf Fichtner, Karlsruhe Institute of Technology, +49 721 608 44460/44462, wolf.fichtner@kit.edu

Overview

Coal power accounts for a major share within the electricity production in many EU countries. In 2014, the electricity production by hard coal power plants amounted to 30% of the total electricity production of the UK and the installed net capacity amounted to 20 GW. Despite these relatively large numbers, in November 2015 the Department of Energy and Climate Change (DECC) of the UK published plans for the phase-out of coal-fired power plants until 2025 [1]. In Germany, roughly 42% of the total electricity production is produced by coal-fired power plants [2]. According to the 4th monitoring report [3] of the Federal Ministry for Economic Affairs and Energy, Germany will fail reaching its greenhouse gas reduction target in 2020. Thus, a shutdown of the hard coal capacitites and at least a part of the lignite capacities is discussed.

This developments leads us to study at first the economic effects of a complete coal phase-out in Germany and the UK as well as to determine possible future power plant capacities in these two countries. A second objective is to investigate the role of European market integration in compensating the missing electricity production. In addition to that, the question to which extent national measures contribute to achieving Europe-wide greenhouse gas reduction targets is investigated. In a further step, the analysis is therefore expanded to effects of an European-wide coal phase-out and the question which long term CO_2 price would be necessary to reach the same CO_2 emission reduction compared to the coal phase-out imposed by regulation.

Methods

To address these research questions adequately, the optimizing energy system model Perseus-EU [4] is adapted to the underlying assumptions and scenarios and used for different simulation runs. The model provides amongst others results regarding the future electricity mix in Germany and Europe and regarding the related CO_2 emissions for the different scenarios. The main objective of the model is the optimal planning of long-term investments in the electricity sector by minimizing the total system costs. The model is a material and energy flow model, representing the electricity sector of 28 European countries (EU28 without the islands of Cyprus and Malta but including Switzerland and Norway) with a multi-periodic linear optimization approach. The hierarchical structure relies on a directed graph, where all nodes are connected to each other through energy flows and gather several energy conversion unit.

For this study, following scenarios are analyzed applying the Perseus-EU Model: In the BASE Scenario, coal investments are possible also in Germany, whereas coal power plants are decommissioned at the end of their lifetime (40 years). In the PHASEOUT-DE scenario, a linear phase out of the total coal-based capacity until 2050 is implemented, which corresponds to about 1.6 GW p.a. In the PHASEOUT-EU scenario, no coal investment in Europe is allowed (investment moratorium) and coal power plants are decommissioned at the end of their lifetime (40 years). Finally, in the CO_2-CAP scenario, resulting CO_2 emission quantity from the PHASEOUT-EU scenario are set as CO_2 cap and coal power plants are decommissioned at the end of their lifetime(40 years).

We chose to consider the EU ETS prices exogenously by integrating a CO_2 certificate price based on the reference scenario [5] of the European Union in BASE, PHASEOUT-DE and PHASEOUT-EU scenarios. In all scenarios, a target share of 80% in 2050 is set for the renewable power production within the total European electricity generation.

Results

The first results show that in a scenario with high future CO_2 prices and ambitious renewable energy targets, a complete coal phase-out in Germany and the UK has only a small additional effect on the Europe-wide CO_2

emissions. To ensure an additional reduction of the overall greenhouse gas emissions, a coordinated and ambitious CO_2 or coal policy is needed on a European level. Furthermore, the 2050 emission reduction targets can be reached in all scenarios, but the PHASEOUT-EU scenario results in less cumulative emissions over several years (see Figure 1). Especially the emission reduction after 2020 is larger in the PHASEOUT-EU scenario due to the lower coal capacity. Furthermore, in the CO2-CAP scenario (with the same amount of emissions as PHASEOUT-EU scenario) results in a slightly higher coal and lignite and lower gas production.

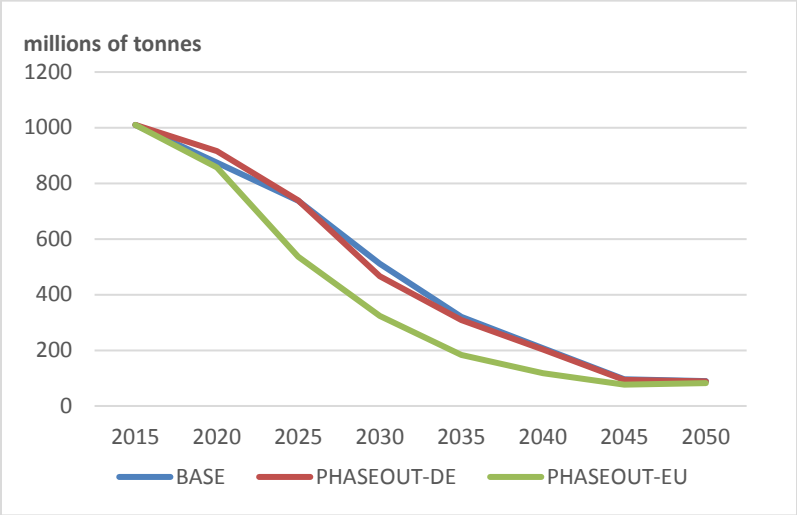

Figure 1: CO_2 emissions in Europe until 2050

Conclusions

In a framework, which is already suitable for energy transition, i.e. high CO_2 prices and renewable targets, a coal and lignite phase-out in Germany and the UK has very little additional impact on overall European emissions. The coal phase-out in these two countries can lead to a "carbon leakage" within Europe. A European coal phase-out reduces the emissions in Europe significantly. However, without a coal phase-out installed by the regulatory bodies, very high CO_2 certificate prices in the long-term ensure the same effect.

References

[1] Department of Energy and Climate Change, Digest of United Kingdom Energy Statistics, London: National Statistics publication, 2015.

[2] AG Energiebilanzen, Bruttostromerzeugung in Deutschland ab 1990 nach Energieträgern, Januar 2016.

[3] Bundesministerium für Wirtschaft und Energie, Vierter Monitoring-Bericht zur Energiewende, Nov. 2015.

[4] H. U. Heinrichs, Analyse der langfristigen Auswirkungen von Elektromobilität auf das deutsche Energiesystem im europäischen Energieverbund, Karlsruhe: KIT Scientific Publishing, 2014.

[5] European Commission, EU Energy, transport and GHG emissions - Trends to 2050 - Reference scenario 2013.