Renewable deployment strategies, lignite phase-out and their impact on CO_2-prices

Dominik Möst, TU Dresden, +49 351463 33297, Dominik.Möst@tu-dresden.de
Carl-Philipp Anke, TU Dresden, +49 351463 39896, Carl-Philipp.Anke@tu-dresden.de
Hannes Hobbie, TU Dresden, +49 351463 39894, Hannes.Hobbie@tu-dresden.de
Steffi Schreiber, TU Dresden, +49 351463 39682, Steffi.Schreiber@tu-dresden.de

Introduction

Carbon emission prices in the European emission trading system have significantly increased in 2018 from less than 5 €/t_{CO2} at the beginning of the year to around 25 €/t_{CO2} at the end of the year. As there was a significant surplus of certificates in the market in 2017, the question arises what are the reasons for this price increase and what are the main drivers. Beside current price developments, also mid-term CO_2-price projections and drivers of CO_2-prices are of interest. We develop a fundamental model for the European electricity and CO_2-emission market to explain the respective impact of supply and demand parameters on CO_2-prices for 2018 and estimate price ranges under different scenarios for the year 2025. For future years, especially overlapping political instruments such as renewable deployment targets, lignite and coal phase-out strategies, the market stability reserve, backloading and the discussed magnitude of the emission caps/emission paths have an impact on each other, and which are of interest and shall be analysed in this contribution. Whereas the price interaction has been thoroughly discussed, the concrete effects of caps, renewable deployment targets, national lignite phase-outs, market stability reserve and backloading as well as other parameters, such as fuel price developments have not been analysed in detail with the help of a bottom-up model. This analysis will allow to specify a range of CO_2-prices as well as to identify main impact parameters.

Method

To investigate main drivers of CO_2-prices and the interplay with renewable deployment, lignite phase-out strategies as well as varying emission caps, a bottom-up fundamental model is developed and applied. The basic idea is that main participating players f the European emission trading scheme (ETS) are considered in the model. About 70% of CO_2-emission in the ETS result from public and industrial combustion. The remaining 30% of emissions result from industries, mainly from the sectors iron and steel, refineries, paper, ceramics, glass as well as coke (based on data provided by the Deutsche Emissionshandelsstelle). Analyses have shown that emission reduction measures in these affected industries are often either no regret measures or measures, which are only competitive at very high prices above 150 €/t_{CO2} (see e.g. Hillemacher et al. 2012: Analyse des Einflusses des Emissionshandels auf Produktion und Emissionen ausgewählter Industriesektoren, Proceedings Energiesymposium Graz). In consequence, the potential of industries to significantly contribute to market actions in a medium price range is limited. Due to the huge data effort in a fundamental model the detailed need of process knowledge and the limited impact on results (due to the above mentioned comment), we abstract from modelling these industries and only model main participating and relevant players, which are especially emitters from the public and industrial combustion. In consequence, we model the EU electricity markets based on fundamental input data, including Norway, Switzerland and the Balkan states. The objective function minimises total generation costs, considering the serving of the (national/regional) energy demands (electricity and heat) as well as the emission cap. Furthermore, political instruments, such as backloading and market stability reserve in the ETS system are taken into account.

The model endogenously calculates electricity and CO_2-prices. To verify the explanatory power of the model, the model is backtested (validated) against historical price information. Historical prices – especially electricity but also CO_2-prices – can be well explained by the chosen approach. The mean-absolute error of the sorted electricity prices is in the magnitude of approximately less than 5 €/MWh and around 5.6 €/MWh of the root-mean-square error (RMSE) for the chosen base year 2014. The carbon constraint in the model yields yearly average allowance prices that are very consistent with historical data – 5.92 €/t modelled yearly prices in comparison to historical 5.94 €/t in average in 2014. As the model is based on fundamental data, it allows to analyse the interrelation between renewable deployment, lignite-phase-out strategies as well as adaptations of the emission cap.

Results

Results are still under preparation. To address the research question of the interplay between different emission reduction measures (renewable deployment, lignite phase-out, an adaptation of the emission cap as well as market stability reserve) and the CO_2-price, a scenario-based analysis will be conducted, comprising the year 2014 as

benchmark of the model, 2018 to explain current price developments, especially the strong CO_2-price increase, and 2025 to analyse the impact of different strategies.
Preliminary results show, that depending on the assumption for renewable expansion, emission prices vary in a magnitude between 5 and 30 €/t_{CO2} for the year 2025. Results will be shown for varying renewable deployment scenarios in Europe, but also national strategies, for a phase-out of lignite and coal in selected countries (where a phase-out is discussed), a stronger emission reduction pathway resulting from a lower emission cap as well as effects from the market stability reserve and from backloading. Besides results on emissions and CO_2-prices, also the interplay with the electricity market will be discussed and conclusions, especially relevant for affected market players and policy makers will be drawn.