The Merit Order Effect of Wind and PV Generation in Germany 2010-2012: Estimation and Implications

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(1) Overview

Generation from renewable energy sources in Germany has experienced a considerable uptick in recent years. Mainly responsible for this development is the German Renewable Energy Sources Act (Erneuerbare Energien Gesetz, EEG), which establishes priority feed-in, purchase guarantee and fixed prices. The costs of this law are passed on to electricity consumers in the form of a surcharge. These consumers are split into a privileged and a non-privileged group. On a liberalized electricity market, the feed-in of electricity generated by renewable energy sources lowers the wholesale price, since they offer electricity at close to zero marginal costs. This merit order effect, in conjunction with the design of the surcharge, is likely to lead to considerable distributional effects between the group of privileged and non-privileged consumers.

We estimate the merit order effect of both wind and photovoltaic (PV) electricity generation in Germany between 2010 and 2012 and discuss implications for a reform of the Act, in particular of the surcharge for privileged consumers. We then use results to simulate revenue factors for electricity generated by wind and PV out to 2015 and discuss what this means for the future design of renewable energy support policies in Germany and further distributional consequences.

(2) Methods

We use time-series regression analysis of hourly price and generation data (and of daily averaged data as a sensitivity check) to determine the merit order effect of wind and PV generation on the spot (day-ahead) electricity price in Germany. The time series are data published by exchanges (EEX, EPEX) and network operators (entso-e). We explore different functional forms and look at the whole sample and the possibilities of truncation, due to some hours with special conditions.

In order to forecast the revenues attainable by electricity generated by wind and PV between 2013 and 2015, we build a simulation tool that forecasts the build-up of renewables out to 2015 and associated price effects (on an hourly basis), taking into account the results from the merit order effect analysis.

(3) Results

The results indicate that electricity generation by wind and PV has had a considerable effect on the spot market price of electricity. This effect has become more pronounced over the past three years. We estimate that an additional GW of generation by wind and PV lowers the spot price by between 0.90 and 1.30 €/MWh, depending on market conditions in the specific year, and that the total merit order effect of wind and PV has risen from 5 € in 2010 to more than 10 € in 2012, i.e. 1 ct/kWh as compared to 0.05 ct/kWh privileged consumers are paying for the surcharge.

Forecasting revenues attainable by renewables out to 2015, shows that those revenues fall significantly as the merit order effect reduces revenues exactly in those hours electricity generated by wind and PV is fed into the grid. We estimate that revenue factors (average spot prices earned by wind and PV compared to overall average spot prices) fall from around 0.9 for wind and more than 1.0 for PV in 2012 to just over 0.8 for both technologies in 2015.

(4) Conclusions

The immediate reform of the EEG should take into account the merit order effect, which likely overcompensates privileged consumers for the surcharge they pay. This surcharge could be increased to be at least equal to the merit order effect.

The near- and long-term reform of the EEG needs to take into account the fact that revenues attainable by wind and PV on the spot market for electricity will continue to fall. In its current design the EEG has little incentives for wind and PV to generate in hours with high prices. Taken in combination with the fixed feed-in tariff, this means that the surcharge for non-privileged consumers could rise further if no changes to the current design of the EEG are made. Options include incorporating an electricity price signal in the tariffs paid to renewable energy sources supported by the EEG or limiting the feed-in of renewables in hours with very low prices in order to avoid negative prices. Finally, implications for the overall electricity market design can be drawn, e.g. a transition from energy-only markets to markets rewarding generation capacity.