ELECTRICITY MARKET PRICES UNDER LONG-TERM POLICY SCENARIOS

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Overview

We present a new fundamental electricity market model to explain key drivers of electricity prices under policy scenarios for coupled market areas, comprising in the current analysis the countries Germany, France, Italy, Austria, and Switzerland. In particular, we investigate how the currently most prevalent policy scenarios can influence long-term prices (e.g. the EU Trends and the Swiss Energy Strategy scenarios, which anticipate for example the nuclear phase-out in Germany and Switzerland). Price levels and price volatilities on wholesale markets can deviate significantly from (marginal) cost-based model analysis. Hence, we employ a technology-detailed game-theoretic Nash-Cournot equilibrium model to capture price mark-ups caused by scarcity effects. With the model calibrated to today's scarcity effects, we will show quantitative results on the relative impact of renewable deployment, and of fuel and CO_2 prices on electricity prices and on today's trade patterns between the market areas.

Methods

For the fundamental modelling of the electricity prices, we employ a technology-detailed game-theoretic Nash-Cournot equilibrium model. We model the day-ahead market with the 24 hourly sub-markets in four yearly seasons with the underlying available generation mix. Electricity plants in the countries are aggregated on plant type level, for example, gas-fired plants are represented by steam, single-, and combined-cycle technologies. The model includes the option of seasonal and diurnal storage technologies, and also the technical constraints of thermal production (ramp-up/down, minimal down/up-time etc.) as well as part-load efficiency losses. The elasticities of the demand bids on the day-ahead market are estimated from historical EPEX market data. The numerical model has in total 96 representative load periods for a year, and new investments are assumed (as an approximation) to be executed in a single, long-term step. The linear model was run for the current analysis in deterministic mode with an average availability of intermittent renewables; we will show also results of a stochastic extension.

Results

Electricity market prices in small market regions are highly determined by the supply mix of the surrounding market regions: during all numerical experiments, changes in the supply mix for example in Switzerland (hydro availability etc.) had minor influences on Swiss electricity prices; the interactions with the surrounding countries determine the price for a small player like Switzerland in most of the load periods. That the domestic capacity mix is not a major driver for Swiss prices holds not true for all surrounding countries. For example, in France, market prices in the future are expected to drop because of increased domestic wind generation. For all countries, gas-fueled plants are likely to have a stronger role as price-setters on the wholesale markets than today: raising gas and CO_2 prices are directly reflected in raising wholesale prices in all scenarios in most of the load periods. In terms of trade, Germany and Switzerland become net importers of electricity.

Conclusions

Modelling of electricity wholesale market prices by a fundamental model is challenging in case of multiple, marked-coupled areas, because the changing seasonal and diurnal trade patterns between the market areas must be captured. Hence, modelling must include technical and market details as well as the representation of a mark-up of prices with respect to pure cost-optimization. Our results show that a game-theoretic model can analyze such scarcity price effects, even when the mark-up is not caused by imperfect competition (market power), but by other external events, e.g. unexpected rise in demand.