AGENT-BASED ANALYSIS OF CROSS-BORDER EFFECTS FOR SWITZERLAND BY INTRODUCING A DECENTRALIZED CAPACITY MARKET IN FRANCE AND A STRATEGIC RESERVE IN GERMANY

Florian Zimmermann, Chair of Energy Economics, Karlsruhe Institute of Technology (KIT), +49 721 608-44580, florian.zimmermann@kit.edu
Dogan Keles, Chair of Energy Economics, Karlsruhe Institute of Technology (KIT), +49 721 608-44566, dogan.keles@kit.edu
Wolf Fichtner, Chair of Energy Economics, Karlsruhe Institute of Technology (KIT), +49 721 608-44460, wolf.fichtner@kit.edu

Overview

Some changes of market designs have been decided in the past few years in large European electricity markets. Germany introduces a strategic reserve (named as “Kapazitätsreserve”). The aim is to ensure generation adequacy (and the reduction of carbon emissions until 2020). France sets up a decentral capacity market to ensure generation adequacy and to incentivize demand response measures. As Germany and France belong to the largest electricity markets in Europe, influences on neighbouring markets cannot be ruled out.

With regard to Switzerland, as a price taker (acc. to Dehler et al., 2016) for electricity prices in large parts of a year, these changes will have influences on its electricity market and thus, on the electricity wholesale prices and investments (Zimmermann et al., 2017). Therefore, this work is a contribution to identify cross-border effects, influences on investments and prices with a focus on Switzerland.

Methods

For this purpose, the agent-based simulation model PowerACE (e.g. Genoese, 2010, Keles et al., 2016) is used as a method to investigate the Swiss electricity market. The model includes the market areas of Germany, France, Belgium, Netherlands, Luxemburg, Switzerland and Italy. If one of these markets is going to introduce or has already implemented an additional market for capacity (capacity remuneration mechanisms), this is modelled as well.

PowerACE simulates the day-ahead spot market with an hourly resolution for each year until 2050 including a welfare optimizing market coupling for all simulated market areas. The day-ahead prices result from a merit-order model satisfying the residual demand (demand minus renewable production and net imports). The bids in the merit-order are based on the variable costs of the power plants (fuel and CO2-costs) and a mark-up to cover fixed costs and investment expenditures. Input data are renewable energy production and profiles, conventional power plants (including their techno-economic characteristics), demand, fuel prices and prices for CO2-certificates.

Every year, market agents evaluate possible investments in new flexible power plants. The decisions are based on a net present value (NPV) calculation that takes into account the expected future cash flows and the investment expenses for the power plants. All investment options are evaluated step by step and the agents invest in the option with the highest positive NPV. For calculating the cash flows, a price forecast is done before each investment decision. The agents will invest as long as there is a need for capacity and as long as there are options with a positive NPV. (Keles et al., 2016)

An advantage of agent-based simulation models is their ability to reflect investment uncertainties and imperfect markets (Ventosa et al., 2005). This makes the approach suitable for analysing cross-border effects and investment incentives in different market areas.

Results

The model produces detailed results regarding investments into flexible power plants and the underlying decisions (see Figure 1), the development of power plant capacities, electricity exchange between neighbouring markets, hourly prices, cash flows of the related power plant dispatch, hours in which the demand cannot be served, CO2-emissions, and the market results of capacity remuneration mechanisms.

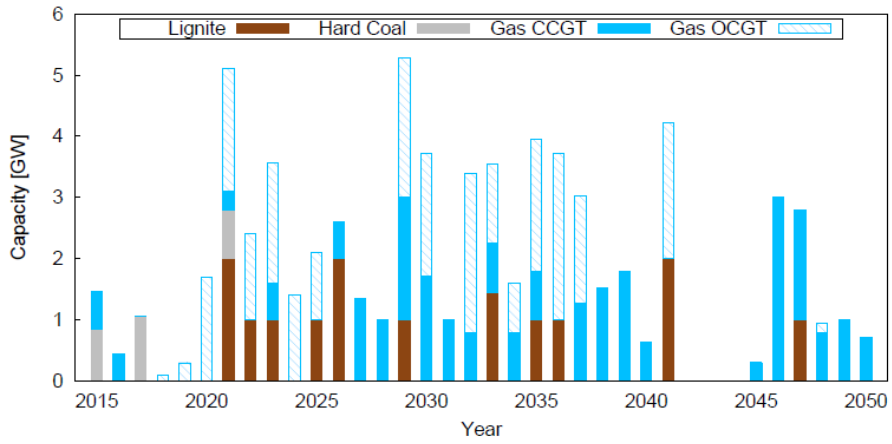

Figure 1: Newly built capacities in a market area with an implemented central capacity market (Keles et al., 2016)

The focus of this analysis is set on the cross-border effects and the effects on power plant investments (and decommissions) in Switzerland. To evaluate the different effects, several scenarios have been developed using the PowerACE model. In the first scenario, the markets in Germany and in France have been modelled without any supporting mechanisms such as a strategic reserve. In the second scenario, the electricity markets are extended with a strategic reserve in Germany and a capacity obligation market with decentralized trading in France. Afterwards, the different effects on the Swiss electricity market are analysed.

A preliminary result shows that lower mark-ups could be set on prices if capacity remuneration mechanisms are introduced in Germany and France. Therefore, prices in the German and French market areas decrease. This influences the prices in Switzerland and in other neighbouring countries in the similar direction.

Conclusions

Cross-border effects on electricity prices could influence the investments in neighbouring countries. As generation adequacy is strongly dependent on investments into flexible generation capacities, it should be monitored continuously in the different market areas. Switzerland, which is already influenced from surrounding electricity markets, needs to analyse the political decisions regarding market design changes deeply and react to developments in the neighbouring countries.

Furthermore, some political recommendations can be derived with regard to changes in market coupling and market design (supporting remuneration mechanisms) in Switzerland.

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