THE IMPACT OF MARKET DESIGN ON TRANSMISSION AND GENERATION INVESTMENT IN ELECTRICITY MARKETS

Christian Sölch, University Erlangen-Nürnberg, +49 (0)9115302-669, christian.soelch@fau.de
Veronika Grimm, University Erlangen-Nürnberg, +49 (0)9115302-224, veronika.grimm@fau.de
Bastian Rückel, University Erlangen-Nürnberg, +49 (0)9115302-96285, bastian.rueckel@fau.de
Gregor Zöttl, University Erlangen-Nürnberg, +49 (0)9115302-767, gregor.zoettl@fau.de

Overview

In many liberalized electricity markets uniform prices for large market areas are determined at the electricity spot market (the major platform being usually a power exchange). Potentially arising network congestion is then alleviated through a system of redispatch. This system is found for example in most European countries and Australia (whereas the US, Canada and New Zealand are relying on a system of nodal prices which does not require redispatch). Such system does not provide incentives for proper location choice of production capacities taking into account potentially arising network congestion. Missing incentives for proper regional choice of producing facilities might then result in an excessive need of network expansion.

Methods

In this paper we propose an equilibrium model that allows to compare different market mechanisms which provide incentives for locationally differentiated choice of production facilities. Our framework takes into account both generation investment decided upon by private investors and redispatch and network expansion decided upon by a centralized network planner. In order to take into account the different objectives and decision variables of those different agents in our equilibrium framework, our approach exhibits a multilevel structure. We analyze the case of different price zones which are already taken into account at the spot market, where potentially arising regional price difference provide long run investment signals. The resulting investment and production decisions can be compared to an equilibrium model in the absence of such regional differentiated investment incentives and an overall optimal (first best) benchmark.

To provide economically and politically relevant statements based on our computation we calibrate our framework for the German Electricity market. The nodes of the network considered represent the German federal states and the neighboring countries. Potential network and generation capacity expansion are taken from publicly available data provided by the German authorities (BNetzA) which serve as an input for the regulated network expansion of the German electricity transmission grid (the German Netztentwicklungsplan).

Results

Our results reveal that price zones do have a significant impact on locational choice of generation facilities and can result in a reduced need for network expansion. The annual welfare gains amount to approximately 270 Mio. € for the German market. Our results furthermore reveal an interesting side result closely related to our network expansion planning: Very large welfare gains can be implemented by taking into account curtailment of renewable energy sources (RES) and a flexible handling of dispatch and redispatch decisions at the time of planning network expansion. Those gains amount to over 1.3 billion € per year.

Conclusions

The latter scenario is the most efficient alternative market design of our analysis. It shows that only small adjustments to the current market design could be necessary to increase the efficiency of the system a lot. In contrast, changing the uniform price system in Germany to a market splitting system with several price zones would require severe adjustments to the regulatory framework while welfare can only be increased by a fraction of the improvement in the best scenario.

Another finding of this analysis is that it is possible to reduce the required network expansion significantly and still stick to the necessary RES expansion path in order to fulfill climate targets over the next decades. The results also showed the importance of choosing the right modelling approach depending on the research question and that using a system optimum approach to approximate the market behavior of the different market participants might lead to completely different outcomes in long-run considerations. Therefore, we recommend to use a model like our Generation And Transmission Expansion (GATE) model to analyze generation and transmission expansion in liberalized electricity markets with uniform price zones.

References

Grimm, V., G. Zöttl, B. Rückel, and C. Sölch (2015). “Regionale Preiskomponenten im Strommarkt.“ Monopolkommission.

Grimm, V., A. Martin, M. Weibelzahl, and G. Zöttl (2016a). “On the long run effects of market splitting: why more price zones might decrease welfare.” In: Energy Policy 94.C, pp. 453–467.

Grimm, V., A. Martin, M. Schmidt, M. Weibenzahl, and G. Zöttl (2016b). “Transmission and generation investment in electricity markets: The effects of market splitting and network fee regimes.” In: European Journal of Operational Research 254.2, pp. 493–509.

Grimm, V., B. Rückel, C. Sölch, and G. Zöttl (2016c). “Zur Reduktion des Netzausbaubedarfs durch Redispatch und effizientes Engpassmanagement: Eine modellbasierte Abschätzung.” In: List Forum für Wirtschafts- und Finanzpolitik 41.4, pp. 465–498.

Grimm, V., M. Ambrosius, B. Rückel, C. Sölch, G. Zöttl (2017). “Modellierung von liberalisierten Strommärkten – Herausforderungen und Lösungen.“ In: Perspektiven der Wirtschaftspolitik, vol. 18, no. 1, pp. 1-30.

Prognos/FAU/EnCN (2016). “Dezentralität und Zellulare Optimierung – Auswirkungen auf den Netzausbaubedarf.“ Gutachten im Auftrag der N-Ergie AG, Nürnberg.