

NATIONAL-STRATEGIC CROSS-BORDER TRANSMISSION INVESTMENT AND ZONAL PRICING

Friedrich-Alexander-Universität Erlangen-Nürnberg, Chair of Economic Theory, Chair of Industrial Organization and Energy Markets, and Energie Campus Nürnberg (EnCN), Lange Gasse 20, 90403 Nürnberg
jonas.egerer@fau.de

Keywords:

Electricity market modeling, national-strategic grid expansion, congestion management

Abstract

The Internal European Market for electricity has been implemented with mostly national bidding zones and implicit auctioning of cross-border trade capacity. While this market design allowed the development of competitive market places for electricity and efficient auctioning of cross-border capacity, large national bidding zone, as a result of the ongoing decarbonization, become increasingly inadequate to represent the physical electricity system. Required capacity extensions in renewable generation, together with different national timelines for the energy turn-around in the transformation process require changes in either today's bidding zone layout or investments in grid extension, or both of them. The most prominent example in Europe is the discussion of splitting the German-Austrian bidding zone in up to three zones (i.e., northern German, southern German, and Austria). While there is literature on resulting welfare and price effects of introducing additional bidding zones in Germany (Egerer et al., 2016, Plancke et al., 2016) as well as on national-strategy network investment (Huppmann and Egerer, 2015, Nylund and Egerer, 2014), there is limited insight in the interdependency of grid expansion and the reshaping of bidding zones from a national-strategic perspective.

Methods

This paper applies a techno-economic and a game-theoretic model to determine the implications of national-strategic investment incentives in the case of national bidding zones compared to a scenario with zonal market splitting in Germany and at the border to Austria. In a zonal model which represents the electricity market in central Europe, national welfare results in the electricity market are calculated for different levels of transmission investment. The game-theoretic model searches the solution space for stable solutions from a national-strategic welfare perspective. The techno-economic model applies a welfare maximizing objective function to the zonal market results including implicit auctioning of inter-zonal trade capacity. According to the market results of the model, national welfare levels calculate by its zonal consumer and producer rents and an even allocation of congestion rent to the adjacent zones. Transmission investment in cross-zonal lines increases trade capacity but requires investment costs and affect the zonal welfare distribution. The techno-economic model determines national welfare results for a large set of investment combinations in cross-zonal transmission capacity.

In a second step, the papers applies a game-theoretic model to determine stable solutions for the grid expansion plan from a national-strategic perspective of all countries by searching the matrix of step-wise increasing transmission investment levels. Thereby, countries can veto transmission investment into lines within their zones. The final result is a set of equally valid solutions which present stable points in the solution space.

Results

The results will give an indication of the correlation between congestion management and grid expansion (i.e., the scenarios with national bidding zones and market splitting in Germany/Austria). The model implementation is limited to results of three type hours (i.e., high wind availability, high solar radiation, and peak demand with low renewable generation) and analyzes the respective national incentives for grid investments. While internal grid expansion in Germany/Austria only becomes visible in case of market splitting, it is expected that the introduction of bidding zones within Germany/Austria (and the resulting difference in north to south electricity prices) also affects the national grid expansion strategies with neighboring countries.

The paper will include results of the three type hours for the national electricity systems as of 2015 and a scenario of the year 2025. In addition, an additional sensitivity illustrates the effect of including electricity flows in cross-zonal trade in comparison to today's market representation with directed trade flows.

Conclusions

This paper addresses the question of congestion management and its effect on national-strategic cross-border transmission investment. Thereby, it uses the example of Central Europe which faces increasing demand of grid expansion as a result of the energy transformation and also shows a high potential of conflict due to the large German-Austrian bidding zone. While not addressing the demand of intra-zonal transmission expansion, the results can illustrate the potential (national) welfare losses of national-strategic grid expansion planning and the effect market splitting has, both, on national-strategic cross-zonal transmission investment levels and national welfare results.

References

- Egerer, Jonas, Jens Weibezahn, and Hauke Hermann (2016): Two price zones for the German electricity market — Market implications and distributional effects. *Energy Economics*, 59: 365–381. doi: 10.1016/j.eneco.2016.08.002.
- Plancke, Glenn, Cedric De Jonghe, Ronnie Belmans (2016): The Implications of Two German Price Zones in a European-Wide Context. 13th International Conference on the European Energy Market (EEM). IEEE, pp.1–5.
- Huppmann, Daniel and Jonas Egerer (2015): National-strategic investment in European power transmission capacity. *European Journal of Operational Research*, 247 (1): 191–203. doi: 10.1016/j.ejor.2015.05.056.
- Nylund, Hans and Jonas Egerer (2014): Regional versus bilateral cost sharing in electricity transmission expansion. In: 29th Annual Congress of the European Economic Association. Toulouse, France.