The relevance of grid expansion under zonal markets

Joachim Bertsch[*]*, Tom Brown*[**]*, Simeon Hagspiel*[*]*, and Lisa Just*[*,***]

EXECUTIVE SUMMARY

The market design of the European single market for electricity consists of regional bidding zones, usually aligned to national borders. There is one uniform price per zone, while implicitly neglecting scarce transmission capacities within these zones. In reality, however, this simplification is often inconsistent with physical realities. Ignoring physical grid properties might result in congestion in the grid. In the short term this congestion is resolved and thus the functionality of zonal markets ensured by administratively adjusting the original dispatch, i.e., redispatch. In the long term, functionality of zonal markets shall be ensured by sufficient expansion of the grid infrastructure. In practice, however, grid expansion is often insufficient or at least delayed. For Europe, 30 % of the projects listed in the Ten Year Network Development Plan (TYNDP) are reported as delayed or rescheduled (ENTSO-E (2015)). For Germany the situation is even worse: 50 % of the projects are reported as delayed (Bundesnetzagentur (2013)). At the same time, due to the uniform price for all market participants, the resulting intra-zonal scarcity in transmission capacities is not taken into account in the investment decisions of generation. In fact, (zonal) markets should ensure that sufficient capacity is installed to meet demand on a zonal level. However, there might be a misallocation of generation capacities within the zones due to missing locational price signals. These misallocations are exacerbated by missing grid capacities that might not allow to transport electricity to the customers. Thus, missing grid expansion might severly jeopardize the long-term functionality of zonal markets.

In Europe, the effect of misallocation of generators and missing transmission capacity is particularly relevant due to fundamental changes in the supply and demand structure caused by strong climate protection efforts. A substantial shift from conventional to renewable generation, which is usually far away from current generation and load centers, increases the importance of sufficient grid infrastructure.

We contribute to the existing literature of grid expansions in the short as well as in the long term by investigating the particular relevance of grid expansion under zonal markets. We show that the market design is inherently incomplete due to missing price signals, and that important scarcities in the grid are not properly considered for investment decisions. For this, we build on a long-term fundamental model of the European electricity market developed in Bertsch et al. (2015), allowing the representation of the European zonal markets with redispatch. The model includes generation dispatch, power flows, as well as generation and grid investments. In contrast to Bertsch et al. (2015), we implement the EU 2030 energy strategy to ensure the results are in line with current European policies. Furthermore, we extend the analysis by designing six scenarios that differ with respect to their level of allowed grid expansion. We are hence able to investigate in great detail the relevance of grid expansion for the market outcome.

[*]ewi Energy Research and Scenarios gGmbH, Vogelsanger Strasse 321a, 50827 Cologne, Germany as well as Department of Economics, University of Cologne.

[**]Formerly affiliated to: Energynautics GmbH, Robert-Bosch-Straße 7, 64293 Darmstadt, Germany. Now: Frankfurt Institute for Advanced Studies, Ruth-Moufang-Straße 1, 60438 Frankfurt am Main, Germany.

[***]Corresponding author. Send correspondence to ewi Energy Research and Scenarios gGmbH, Vogelsanger Strasse 321a, 50827 Cologne, Germany. E-mail: lisa.just@ewi.research-scenarios.de.

Our results show that restricted grid expansion together with the inherent incompleteness of the market design of zonal markets has significant effects. We restrict grid expansion per decade from zero, i.e., no grid expansion at all, to 30 TWkm throughout 6 different scenarios. In case of restrictions ranging from 0-15 TWkm of grid expansion per decade, there are energy imbalances of up to 2 % (3 %) for 2020 (2030). Also with less restricted grid expansion, these energy imbalances still amount to more than 0.2 % for scenarios 15 TWkm in 2020. In 2030, however, significant energy imbalances only occur for the scenarios of restrictions of up to 5 TWkm. The highest energy imbalances are found to be in Southern Germany. Thereby, energy imbalances indicate that generation is missing at some locations, entailing the need to either provide additional generation capacity outside of the market (e.g., by means of a grid reserve as in Germany), or to curtail load. Furthermore, no grid expansion jeopardizes the achievement of the EU 2030 climate targets: the share of renewables is 1.5 percentage points lower than in any other scenario, resulting from a curtailment of up to 7.7 % of photovoltaic (PV) generation and over 3 % of wind generation. Missing grid expansion hence results in higher CO_2 emissions in the power sector and implies the need to shift CO_2 emissions from the power sector to other, probably more expensive sectors. DC lines are found to be of particular value for the integration of renewables as they allow point-to-point transfers from renewables generation to load sites.

Overall, the results demonstrate the shortfalls of the zonal market design in the light of restricted grid expansion which is a scenario that appears to be very likely. The more restricted grid expansion is, the more administrative intervention will be needed to avoid energy imbalances possibly causing expensive and politically unwanted load curtailment. One alternative might be to administratively contract generation capacity outside the market. To overcome this problem, a redefinition of zones or introduction of locational price elements may be a suitable way to effectively reduce the amount of administrative intervention. Furthermore, obstacles for grid expansion should be removed in order to ensure sufficient levels of grid to connect generation and load.

REFERENCES

Bertsch, J., S. Hagspiel, and L. Just (2015). Congestion management in power systems - long-term modeling framework and large-scale application. *EWI Working Paper, No. 15/03*.

Bundesnetzagentur (2013). Monitoring Report 2012.

ENTSO-E (2015). 2015 Monitoring update of the TYNDP 2014 Table of projects.