Coordinating Cross-Country Congestion Management

Evidence from Central Europe

Friedrich Kunz[*] and Alexander Zerrahn[†]

Executive summary

European electricity systems experience a fundamental shift toward a low carbon infrastructure. As electrical flows depend on the properties of the entire transmission network and are not bound by national borders, changing spatial generation patterns can put pressure on the operation of neighboring electricity systems. In Germany, for example, wind turbines and lignite plants are concentrated in the north and east, while load centers are in the south and west. A share of the resulting electricity flows, so-called loop flows, is transported through neighboring countries, for instance Poland and the Czech Republic, to re-enter Germany in the south. Such spillovers on adjacent transmission systems can pose new challenges for their operation and the management of network congestion. These inter-dependencies highlight the relevance of international cooperation and call for coordinated measures. Against this background, this paper analyzes benefits from coordinating cross-country congestion management.

To gain a deeper understanding, a detailed numerical two-stage model is employed to simulate the operation of the Central Eastern European electricity market and network. The general structure of the model resembles the current European spot market design, consisting of a day-ahead spot market with uniform pricing and a subsequent curative congestion management phase. The spot market accounts for transmission limitations only on international cross-border trade. Internal physical network restrictions are considered outside the spot market in the congestion management approach by the responsible transmission system operator (TSO). The spot market is modeled as a cost minimization problem, where cross-border transmission lines are represented by a transportation model. The model accounts for both commitment and dispatch of individual generation units and is optimized for an entire year in hourly resolution using a rolling planning approach. Key results are the schedules of generation units and international exchanges. Based on these data, the congestion management is carried out. It reflects four different cases of international coordination, which differ in the degree of information sharing, the access to cross-country redispatch capacities, the geographical balancing areas, and the mode of cross-country allocation of network capacities for redispatch. Specifically, we analyze two limiting cases: no coordination (Case 1) and perfect coordination in a flow-based congestion management framework including multilateral redispatch actions (Case 4). In between, we take information sharing, for which actual vehicles exist by 2015, into account (Case 2), as well as possibilities for cross-border counter-trading (Case 3).

The application focuses on the Central Eastern European region, covering Austria, the Czech Republic, Germany, Poland, and Slovakia in 2013. These core countries are considered on a

[*] German Institute for Economic Research (DIW Berlin), Mohrenstr. 58, D-10117 Berlin, Germany.
[†] Corresponding author: Alexander Zerrahn, German Institute for Economic Research (DIW Berlin), Mohrenstr. 58, D-10117 Berlin, Germany; phone: +49 (0)30 89789453, fax: +49 (0)3089789113; email: azerrahn@diw.de.

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detailed level regarding generation units and transmission infrastructure. To account for further international exchanges and flows, the remaining European countries are modeled on nationally aggregated levels.

While spot market generation patterns basically resemble the European electricity market in 2013, numerical results on redispatch show the beneficial impact of closer cross-border TSO cooperation. The central result is in line with intuition: total costs for congestion management strongly decrease for higher levels of coordination. While for the uncoordinated Case 1 costs are above 350 million Euro, they gradually decrease with higher degrees of coordination to 70 million Euro for flow-based congestion management in Case 4. Based on an in-depth analysis of the different coordination cases in congestion management, we identify four central conclusions.

First, cross-border coordination in congestion management, by sharing information for the entire region, substantially reduces costs, as resources in all countries can be used to remove over flows in any country. Moreover, information sharing prevents additional redispatch needs which can be induced by new network congestion beyond a coordinated optimum. Efficiency gains mainly arise through lower redispatch volumes.

Second, an enlargement of the balancing area for congestion management can yield a substantial decrease in specific redispatch costs. It prevents costly energy balancing measures within each country, and instead opens access to the cheapest alternatives. Liquid intraday markets and administrative adjustments are the prerequisites.

Third, flow-based allocation of cross-border network capacities for redispatch and coordinated multilateral redispatch actions substantially decrease total costs. The greater flexibility enables access to cheaper generation, which was kept out by the more restrictive NTC mechanism. In such setting, also re-optimization beyond targeting network congestion is possible.

Fourth, total cost savings are accompanied by distributional effects. Particularly, countries in which more expensive generators are located gain from closer coordination while countries with cheaper generation lose. To align costs and benefits of coordinating cross-border congestion management, prudent mechanisms are required.

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