International integration of the Swedish electricity market

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Summary

The energy crisis has called the EU's internal electricity market into question

A long-standing objective of energy policy in the EU has been to create an internal electricity market to achieve competitive prices, efficient investment signals, increased security of supply and a sustainable electricity supply. For instance, the EU has implemented a common spot (day-ahead) market for electricity to facilitate trade between the member states.

The extent to which electricity may be traded across national borders essentially depends on the capacity of the transmission lines interconnecting the domestic networks in the member states. Decisions on how much of the available capacity to allocate to the market in the short run and how much to invest in transmission capacity in the long run are made by national transmission network owners, which often operate as state-owned monopolies.

In an integrated electricity market, factors occurring abroad may potentially have a great impact on domestic electricity prices. For instance, the exceptionally high costs of fossil fuel electricity generation affecting electricity prices on the European continent in 2022, had a large impact on electricity prices in southern Sweden as well. The energy crisis and the excessive electricity prices have thus resulted in criticism of the EU's internal market project.

This development raises important questions regarding the electricity market. Just how integrated should the electricity market be? Do network operators have distorted incentives to allocate capacity to the

market in the short term and invest in transmission capacity in the long term? How well did market integration work during the energy crisis? How do we improve the regulatory framework to achieve efficient market integration?

Network owners have incentives to withhold international transmission capacity

The electricity market is fully integrated if the capacity of the transmission network is sufficient for managing all trade occurring at the single electricity price that balances total market demand against total supply. Yet, price differences often arise across different bidding zones in the market due to network congestion. Prices increase in zones with excess demand and decrease in zones with excess supply until the point at which the network can handle all interzonal trade. All cleared demand pays the local zonal price while all cleared supply receives the local zonal price. The entire profit from selling electricity from a low-price zone to a high-price zone goes to the owners of the transmission lines connecting the congested zones in terms of a so-called congestion revenue.

As much as possible of the available network capacity should be allocated to the market to maximize the total gains from trade. However, trade results in distributional effects that may create economic incentives to withhold transmission capacity from the market. Capacity withholding lowers the price of electricity in the exporting country. This benefits consumers in the exporting country, who get cheaper electricity, but is detrimental to the country's producers, who receive less compensation for the electricity they supply. The opposite applies to consumers and producers in the importing country, where electricity prices increase when trade decreases. Capacity withholding also affects the size of congestion revenues. The joint distributional effects give network owners an economic incentive to restrict international electricity trade by either withholding export capacity or import capacity. The increase in congestion revenues is more than sufficient to compensate domestic consumers and producers for their joint loss linked to higher or lower electricity prices resulting from the capacity reduction.

EU regulations aim to counteract withholding transmission capacity

The Treaty on the Functioning of the European Union prohibits quantitative restrictions that discriminate between EU citizens. Additional sector-specific competition rules for the electricity market prohibit market manipulation, such as transactions that present false or misleading signals of supply, demand or prices. The Electricity Market Regulation specifies rules concerning international electricity trade, making it a violation to limit network capacity between member states for financial purposes. The conditions for a sufficient allocation of network capacity are fulfilled if 70 percent of the available network capacity has been allocated to the market. In addition, regulators may grant exceptions to the 70 percent rule to maintain the operational security of the electricity system.

What did market integration look like in 2022?

A comparison between the allocated capacity on the day-ahead market with the maximal trading capacity shows that exports from Sweden were limited to below 70 percent of the maximal capacity during 25 percent or more of all dispatch hours with import demand from southern Norway, Denmark and Germany in 2022. There were also substantial export limitations from northern Norway to northern Sweden. These restrictions contributed to reducing electricity prices in southern Sweden and increasing electricity prices in northern Sweden. The Swedish network owner allocated less than 70 percent of the maximal trading capacity between the Stockholm bidding zone (SE3) and the Malmö bidding zone (SE4) during 15 percent of all hours. These restrictions contributed to increasing electricity prices in SE4 relative to the rest of Sweden in 2022.

Were the capacity allocations in 2022 compatible with regulations?

Market integration was satisfactory in the sense that network owners allocated at least 70 percent of the maximal trading capacity during most dispatch hours and on most interconnections in 2022. These

allocations may have been compliant with EU regulations even in instances when market integration was below 70 percent. First, some interconnections had exceptions to the 70 percent rule. Second, the 70 percent rule does not apply between domestic bidding zones. Third, the 70 percent rule should be based on *available* transmission capacity while we use maximal trading capacity as a benchmark. The available capacity is calculated subject to maintaining operational security within each bidding zone. However, it is difficult to verify whether capacity restrictions were imposed due to operational security or for other reasons, as outside observers lack detailed knowledge on how to operate the Swedish transmission network. A concern is that the information advantage enjoyed by network owners enables them to influence whether they have formally achieved the 70 percent allocation requirement by how they calculate the available capacity on their interconnections.

Three proposals to improve the allocation of transmission capacity

Improved transparency regarding how network owners calculate available transmission capacity would facilitate market surveillance. However, the difficulties related to verifying violations of regulations regarding network capacity allocation increase the value of regulations strengthening the incentives to supply capacity to the market. We propose three reforms to move the market in this direction:

1. Price hedging of congestion revenues.
2. New sharing rules for distributing congestion revenues between network owners.
3. Separating network ownership from capacity allocation.

The first two proposals make it more difficult for any network owner to unilaterally increase congestion revenues by withholding network capacity from the market. Hedging congestion revenues through forward contracts reduces the significance of spot prices for congestion revenues. The quantity of auctioned contracts must probably be subject to regulation. Distributing a relatively smaller share of total congestion revenues to a network owner that is unilaterally responsible for a capacity constraint reduces the incentives to withhold capacity.

A legal separation of network ownership and capacity allocation may reduce the importance of bottleneck revenues for capacity allocation in an international market. This holds especially if system operations are extended to cover multiple countries.

Incentives to invest in international transmission capacity are distorted

The value of new transmission capacity includes the benefits of increased trade, improved system reliability, increased competition in the electricity market and reduced greenhouse gas emissions from electricity generation. Complicating factors include third-country effects associated with changes in electricity flows and prices in an international electricity market. All these effects must be internalized to ensure welfare-optimal investments. National investment decisions may be excessive or inferior depending on the magnitudes of these third-country effects and whether they are negative or positive. There are no binding regulations concerning how much to invest in transmission capacity.

Structured negotiations may increase the efficiency of network development

The EU takes third-country effects into account by co-financing projects of common interest. This solution suffers from inefficiencies associated with individual member states lobbying to get their own projects included on the list regardless of their net economic value. A structured negotiation process would improve efficiency by internalizing third-country effects. Under this structure, member states first submit their individual or bilateral network development plans to the EU. A renegotiation process then ensues in which representatives from third countries propose modifications to the original proposals. The original project is implemented if anybody vetoes the renegotiated project. This method gives third countries influence over projects, without granting them undue influence over project development.

To conclude, incentives to allocate available transmission capacity and to invest in new network interconnections are distorted in an international electricity market. However, market reforms may correct

these incentives and thereby improve electricity market integration in both the short and the long run.

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