A Technology-Neutral Electricity Market: Increasing Efficiency through Market Design and Network Tariffs

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Summary

The green energy transition and increased market integration pose major challenges to the Swedish electricity market. Decommissioning electricity production, installing electricity production at new locations, new cables to foreign countries and electrification have substantial implications for power flows in the system. This development may lead to local capacity shortages in the transmission network, which cannot be expanded at a sufficiently fast pace, partly due to slow permit processes. At the same time, system changes imply an increased risk of a shortage of balancing and voltage-control resources. This is due to a decrease in the proportion of production contributing to balancing and voltage control simultaneously as the need for balancing has increased as a result of the expansion of solar and wind power. If measures are not taken, this increases the risk of manual curtailment of consumers as well as nationwide power outages.

Svenska kraftnät is responsible for solving these problems as the designated system operator. Within a few years, it should be possible for them to install network components that control network flows, voltage levels and provide inertia. Compared to other investments in the grid and production, these costs are relatively small. Still, it is often more efficient if electricity production and demand response are used to solve the challenges facing the power system. Market participants need better incentives to implement such solutions. The design of the electricity market and network-tariff structure should be more technology-neutral and economically efficient. Producers should receive more market-based compensation for the energy and system services

they supply and pay market-based compensation for any disturbances they cause. The same goes for consumers.

Hypothetically, the power exchange could be designed to take into account all aspects of the electricity system. Such an exchange would be completely technology-neutral but is probably technically impossible to implement today. It would also entail high transaction costs and insufficient competition, especially when it comes to local products with low liquidity. Instead, our analysis assumes that the regulatory framework for the EU's common power exchange is largely unaltered. Our analysis is qualitative and is not affected by the number of bidding zones being doubled or reduced. The same applies to the duration of the dispatch period.

The power exchange has a simplified view of the power system. It divides the day into 24 dispatch hours, while each country is divided into one or more bidding zones. The power exchange takes into account bottlenecks between bidding zones and sets a spot price per bidding zone and hour. This ensures that electricity production and demand on average are in balance during each hour of operation and that this balance may be maintained without overloading any major transmission line (between bidding zones).

The power exchange neglects what happens to the electricity supply during a dispatch hour or within a bidding zone. Furthermore, the power exchange ignores the voltage level. These aspects are instead handled by Svenska kraftnät. They use ancillary services to keep generation and demand in continuous balance, while also using remedial actions, such as redispatch, to manage bottlenecks within a bidding zone. In addition, Svenska kraftnät has different types of capacity mechanisms. Production and flexible consumption are remunerated for being available in a strategic reserve or disturbance reserve. It is possible to make Svenska kraftnät's various ancillary services, remedial actions, tariffs and procurement of capacity more technology-neutral and economically efficient.

The regulatory framework favours to some extent technologies that cause disturbances in the power system, such as wind power and large-scale nuclear power, and disfavours dispatchable electricity generation contributing to voltage control. Small and medium-sized consumers in rural areas and smaller cities should mainly benefit from a transition

to a more technology-neutral electricity market. This also applies to small and medium-sized dispatchable electricity generation, especially if located in a large city. Really large plants, 500 MW and above, are not obvious winners, and could be losers. The reason is that they may cause very large disturbances in case of urgent rapid shutdowns. A large volume of flexible capacity (equivalent to the capacity of a large nuclear power plant) is on standby in case of a major disruption. Wind farms can also cause major disruptions. Furthermore, many current solar and wind turbines do a poor job in terms of providing voltage control. They are expected to lose out from a transition to a more technology-neutral electricity market.

At the same time, it is feasible for nuclear, solar and wind power, particularly for new investments, to mitigate the disturbances they cause and to improve the delivery of ancillary services through plant design, design choices, location and production planning. The same applies to installations that consume a lot of electricity.

Recommendations

BALANCING MARKETS COULD BE MADE MORE EFFICIENT

The capacity to store electrical energy is relatively small in the current electricity system. To avoid electricity shortages, Svenska kraftnät needs to keep production and consumption in balance every single second. Svenska kraftnät achieves this by using a number of balancing markets, where they buy more electricity when there is a temporary lack of production and sell electricity when production is too high.

We believe that there is a potential to improve pricing in some balancing markets. Furthermore, we advocate that even those contributing to balancing the system without actively participating in the balancing markets should be compensated for this service. For example, dispatchable production plants should be compensated for the inertia they provide. Furthermore, smaller consumers with appliances and battery chargers with a built-in function that contributes to improving the balance should receive a standardised, flat-rate compensation for this service.

THE SETTLEMENT OF IMBALANCES COULD BE MADE MORE DETAILED

Market participants finding themselves in an imbalance compared to the contracts cleared on the power exchange or in bilateral agreements may pay or be compensated in accordance with the prices in the balancing markets. Today, Svenska kraftnät's settlement only takes into account the average imbalance during the given dispatch hour. We believe that the presumption should be that delivered and consumed power is constant during an operating hour. A penalty should be levied on all units that deliver, or consume, uneven power during the given dispatch hour. This penalty should contribute to financing the balancing markets and preventive actions taken by Svenska kraftnät to reduce the power system's sensitivity to disturbances.

One challenge is that not all participants have electricity meters with a sufficiently high time resolution. This type of meter should be mandatory for producers and consumers with large plants.

SPECIAL REGULATION COULD BE IMPROVED

Services procured by Svenska kraftnät during the dispatch period and that do not affect the total power balance, are referred to as special regulation. Such services may, for example, involve remedial actions used to relieve bottlenecks in the grid that risk being overloaded. Production procured under special regulation often receives a premium in addition to the spot price on the power exchange. We recommend that this premium also be paid to production contributing with a corresponding service, even if it does not participate in the special regulation. Such a change would, for example, benefit production in large cities, thereby reducing the risk of local electricity shortages.

TARIFFS IN THE TRANSMISSION NETWORK COULD BE DEVELOPED

The power exchange neglects grid losses, grid constraints within a bidding zone (internal bottlenecks) and reactive power. The latter refers to power that pulsates back and forth in the grid without being consumed. Reactive power can be used to control the voltage in the grid, while tariffs can be used to set a price on these technicalities.

Tariffs are a blunt instrument. However, in view of transaction costs and imperfect competition, tariffs may still be the most efficient solu-

tion to some problems, especially when dealing with the details of the power system. But to increase economic efficiency tariffs could be more detailed than what is currently the case. More detailed price signals contribute to increased technology neutrality, a reduced risk of localised electricity shortages and improved voltage stability.

We recommend that the tariff consists of four components: 1) a fixed element that covers the costs of connection, metering and invoicing, 2) an energy element that covers short-term variable costs in the grid, such as losses, 3) a power element that covers the strategic reserve and capacity increases in the grid within the bidding zones, and 4) a reactive power element that compensates producers for supplying reactive power.

PRICE HEDGING INSTEAD OF CAPACITY MECHANISMS

Effective price hedging makes it easier for market participants to evaluate the profitability of different investments and secure a stable income. This would mean that Sweden's electricity production could be expanded more efficiently and perhaps at a faster pace, thus reducing the risk of electricity shortages in the future. Capacity mechanisms are often used to offer producers greater revenue security. In Sweden, the capacity mechanism is limited to a strategic reserve, a disturbance reserve and capacity procured to be available on the balancing markets. Many jurisdictions, including the UK and the US, have extensive mechanisms where the state determines the total generation capacity in the market and where (almost) all generation receives a capacity payment. This is usually referred to as a capacity market. Svenska kraftnät recommends that a capacity market should be introduced in Sweden as well.

However, capacity mechanisms, and in particular capacity markets, involve several problems: 1) they exhibit difficulties in effectively managing hydro, wind, energy storage and demand response; 2) capacity mechanisms tend to weaken the incentives for generation to be available when it is needed the most; 3) competition is often inadequate when capacity is procured; 4) experience shows that significant over-investments occur when the state is responsible for procuring capacity; and 5) capacity markets increase the administrative burden.

Svenska kraftnät can help facilitate price hedging for market participants in other ways, and they should hedge the procurement of

ancillary services several years in advance. Furthermore, they may contribute to improved liquidity in the financial markets by hedging their congestion rents and network losses. In addition, the government should hedge its electricity consumption several years in advance, while Svenska kraftnät should also consider offering financial hedging of reserve power at market price. We believe that this would reduce the need for capacity mechanisms.

OTHER REGULATIONS

Our focus is on electricity-market design, network tariffs and their technology neutrality, but it is also important that other regulations are technology neutral. One challenge facing Swedish electricity supply has been that energy policy, for ideological or fiscal reasons, has favoured or penalised different production technologies, and that the favoured or disadvantaged ones have varied over time. Such favouritism generates excessive costs for electricity consumers and taxpayers. Sweden needs a more long-term energy policy. Technology neutrality is advocated in the agreement between the current government parties and the Sweden Democrats, the Tidö Agreement, and should serve as a natural starting point in any future political energy agreement.

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