EXPERT SUMMIT ON ELECTRICITY MARKET DESIGN 2030-2050

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ENSURING A SUSTAINABLE AND RELIABLE FUTURE ELECTRICITY SYSTEM

Summary

The SynErgie Expert Summit taking place on July 4 and 5, 2022, at Castle Hohenkammer (near Munich, Germany) provided a platform for international policymakers and academic experts to discuss electricity market design options for a carbon-neutral future. The summit was organized by the Branch Business & Information Systems Engineering of the Fraunhofer FIT, the Research Center Finance & Information Management FIM, and the Technical University of Munich (TUM). It featured invited talks of the European Association for the Cooperation of Transmission System Operators for Electricity (ENTSO-E), the European Commission, the European Union Agency for the Cooperation of Energy Regulators (ACER), the Florence School of Regulation, the TenneT TSO GmbH, the US Advanced Research Projects Agency - Energy (ARPA-E), and various academic institutions such as FIM, Fraunhofer FIT, the Norwegian School of Economics, the National Technical University of Athens, and the TUM.

Towards 100% renewables with demand response

Challenges and opportunities of market design in the transition to 100% renewables were at the core of the presentations and the panel discussion at the end of the summit. It was widely acknowledged that power system flexibility, including the demand response of industrial and household consumers, is key to dealing with variable renewable energy sources such as solar and wind. Statistics shown illustrated the substantial and largely untapped potential of demand response. Demand response requires locational price signals to better incentivize demand adjustments in both time and location when and where such flexibility contributes to overall grid stability, an increase in overall economic surplus/welfare, and an increase in the usable share of renewables.

Local demand response requires locational price signals

The current European market design is mostly based on large price zones, such as in France, Germany (together with Luxembourg), or Spain. Once per day, the allocation and prices of the day-ahead markets across the EU are computed via the Euphemia algorithm. This algorithm determines a single price per MWh for each price zone. However, for instance, in Germany, there is often a significant share of electricity from wind turbines in the north that cannot be transported to the south due to grid congestions. The European capacity calculation, which provides the basis for the Euphemia algorithm, does not consider such transmission constraints within price zones. This has led to increasing levels of redispatch and RES curtailments over recent years to deal with intra-zonal transmission constraints.[1] As a result of the current zonal pricing in Euphemia, there are especially no locational prices to incentivize demand response where it is needed within Germany, which yields high social welfare loss, unnecessary high consumption of imported gas for redispatch, and avoidable CO_2 emissions.

[1] In recent years, these costs have regularly exceeded €1 billion in Germany and will rise significantly in the coming years. This year, redispatch costs are expected to increase sixfold.

Smaller price zones or nodal prices

There was widespread agreement that locational price signals are crucial to leverage demand response and address the intermittent characteristics of renewable energy sources such as wind and solar. One way to move towards more locational price signals is to revise the current bidding zone configurations in Europe. The Bidding Zone Review (BZR) is currently being assessed by ENTSO-E and TSOs to evaluate the efficiency of the current bidding zone configuration in Europe. ACER decided in August 2022 on alternative electricity bidding zone configurations. So, a possible direct goal might be to split the larger price zones into smaller ones. During the discussion and in several presentations, it became clear that defining an optimal configuration of bidding zones is a major challenge and that introducing additional pricing zones is not necessarily a “simple” market design option. First, optimal partitioning into price zones depends on weather conditions and demand patterns as well as on the current production/consumption infrastructure, which all change over time. Second, the administrative effort to revise price zones in multiple iterations is very high and lengthy, which also leads to uncertainty for investors. Thirdly, adjustments of pricing zones will require adjustments of forward contracts, which often cover 3-4 years unless they are implemented with a corresponding time lag. This problem also arises when moving to nodal pricing, but only once. Last but not least, introducing multiple bidding zones within a country has also profound political implications (as generators and consumers are subject to different prices across the country), which in some countries like Germany has led to strong opposition.

Considering the challenges to adopt an optimal and acceptable bidding zone configuration, several participants argued for a direct move towards nodal pricing, where prices differ between nodes (only) in time periods of congestion and are otherwise identical. The communication of the European Commission (COM (2022) 236) raised attention to more locational signals in the European market design. This communication references a study of 2019 that identified cost savings of 4% from introducing locational pricing in Europe. A study of 2020 anticipated a 10% higher system cost in the absence of locational prices by 2040. The communication finally emphasizes that “the greater the increase of renewables in the energy mix, the more important these benefits are expected to become”. Nodal prices or fine-grained price zones could leverage these benefits.

An implementation of nodal prices in Europe as a whole may be even more challenging in one step than introducing smaller bidding zones - however, it only has to be done once and does not require subsequent adaptations of the bidding zones when supply (e.g., increasing RES) or demand changes. First, market participants need new instruments in the forward markets to hedge price risks, a topic discussed in a recent ACER paper on the EU Electricity Forward Market. Second, computational complexity can be a concern: The day-ahead markets would need to consider the transmission constraints not only between zones but also within zones, which will have an impact on the runtimes of Euphemia. Already now in the flow-based region, Euphemia deals with internal Critical Network Elements under a Contingency (CNECs), if they are affected by cross-zonal trade for more than 5%. As such, these computations might be feasible. A separate issue relates to block bids that are commonly used in the EU and which need to be revisited, e.g., by evaluating alternative bidding formats like multi-part bids that could also positively impact the computational hardness of the problem. Overall, the computation times are significantly driven by the current iterative price computation in Euphemia, an issue that could be addressed via non-uniform prices, which ACER allows to explore in the CACM 2.0 amendments. Finally, governance implications of

the new market arrangements (e.g., the role of system operators and power exchanges) were also seen as an implementation challenge for nodal prices.

Several workshop participants considered the introduction of nodal pricing at a limited geographical scale (i.e., in one country or a group of neighboring countries) as a possible pragmatic approach to test its costs and benefits, possibly moving to a step-wise implementation at a larger scale. For this purpose, they recommended amending current European regulations to allow more flexibility for the Member States to experiment with alternative and innovative market design approaches such as nodal pricing, while still preserving the key benefits of the internal energy market.

Experimentation, open data, and open innovation

Recent developments related to the war in Ukraine and the European Commission's REPowerEU program will lead to a rapid expansion of renewable energy sources in all EU countries. As described above, several participants mentioned that experimentation and swift implementation of new market designs are crucial for the next few years. Contrary, any innovation and major market design change towards locational price signals is made very difficult for states or regions.

Bid languages and price computation were seen as topics that deserve attention already in the short term. New bid languages - beyond hourly and block bids - can help to better express demand flexibility and at the same time reduce the computational hardness of the allocation and price calculation. Some participants emphasized the role of non-uniform prices mentioned in CACM 2.0. Finally, the impact of smaller price zones or nodal prices deserves a thorough evaluation.

Academic participants also pointed to the fact that there is no publicly available data for sufficient experimentation and that the Euphemia algorithm is proprietary. These statements echoed earlier worries by, e.g., the Austrian Energy Agency, about a lack of transparency. The ARPA-E research and development programs were highlighted as examples of open innovation that draw on the ideas of academic and industry experts for specific market design questions. For example, some participants argued that the data used for the recent ENTSO-E report on nodal pricing (June 30, 2022) should be made available to the public considering eventual privacy issues.

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