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Flow-based market coupling, the cheapest path to security of supply

Currently a lot of European countries struggle with the Security of Supply of electricity. Belgium is one of the leading problem cases. In order to achieve long-term security of supply, Europe puts its stake on increasing the interconnection capacity between member states (1). This option is expensive but can be viable. For short-term problems, like shortages in Belgium, the investment plan offers no solution. In research a lot attention is given to complex and challenging solutions like demand side management. But maybe to solution is closer and easier than we expect. Allowing more trade by exploiting the current grid to its full potential could significantly increase the security of supply. It would certainly solve the Belgium shortages. The current exploitation of the market coupling is too conservative. In this context the flow-based market coupling makes its appearance.
On 20 May 2015, the flow-based market coupling (FBMC) is expected to go live in the Central West European (CWE) market zone (5). This new method for coupling the electricity markets should accurately take the network constraints into account and subsequently unlock the full potential of interconnection capacities. However, the current FBMC-implementation proposal still leaves some room for improvements.

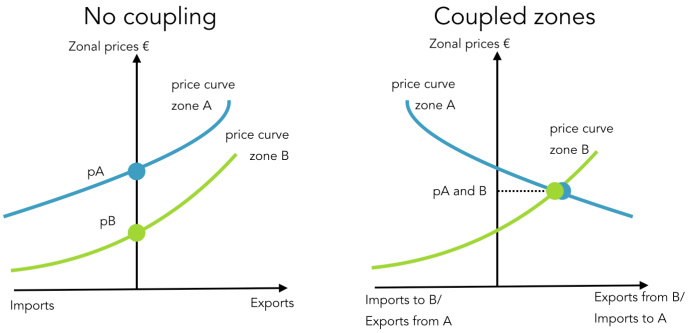

Figure 1: Illustration of coupling the markets of two zones resulting in price convergence and consequently a higher overall economic efficiency (2).

The principle of a market coupling

Since the liberalization of the European electricity markets, the EU strives to achieve a secure and economically efficient electricity system by allowing competition between suppliers on electricity markets. Coupling the electricity markets of different Member States improves the economic efficiency (see figure 1) and enhances the security of supply.

When trade is allowed between different zones it is important to take the network limitations into account. The maximum capacities of interconnection lines induce limitations on the allowable trade. The determination of these limits for the permissible trade capacity is not straightforward. On the electricity market, trades are defined as exchanges between two zones via one commercial path. In reality trade possibilities for zone A to zone B are depending on the trade for B to C as physical flows travel in parallel paths. This is represented in figure 2 for a commercial trade of 90 MW between two zones.

In the currently used Available Transfer Capacity (ATC) based market coupling this problem is solved by making a prediction of the expected trades and their corresponding parallel flows. Considering the parallel flows as already in place, the value for the remaining available exchange capacity is determined and this capacity is given to the electricity market. If the eventual market outcome differs from the prediction, which is highly likely, the parallel flows and the derived ATC values were not exact. Large safety margins are set to cope with this uncertainty. The result is a very conservative network exploitation. A more accurate way would be to simultaneously determine the capacity and energy flows in the market-coupling algorithm. This is the main idea behind FBMC.

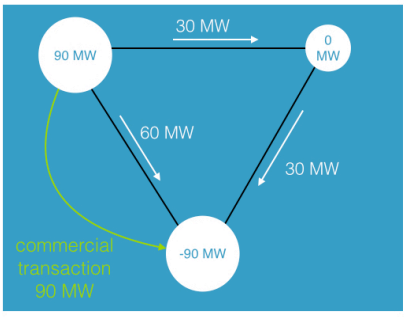

Figure 2: Illustration of the difference between commercial and physical flows for an exchange of 90 MW and equal line impedances.

The flow-based market coupling

The theoretical benefits of a FBMC compared to ATC can be demonstrated with figure 3. For a 3-zone network, the domain in which trade is allowed can be visualized in a two dimensional graph showing the net export position

(NEX) of zone A and B (NEX of C is also determined as the total balance has to be zero). A market outcome, shown as a dot on this graph, will be located within the domain. In the ATC system, an estimation is used to determine the parallel flows. Assuming these flows the exchange limits are drawn. These are straight lines (shown in green) that demarcate the ATC domain. The flow-based domain (shown in blue) on the other hand, determines the limits for exchange between zones considering all possible exchanges of the other zones. This domain takes the physical line constraint of the network accurately into account. Assuming that dot 2 (see figure 3) would be the optimal trade solution, the ATC method would assume this point as infeasible. The FBMC allows the optimal trade solution and therefor unlocks the full potential interconnection capacity. Accurately taking in account the network constraints additionally enables the use of smaller safety margins, which makes even more trade possible.

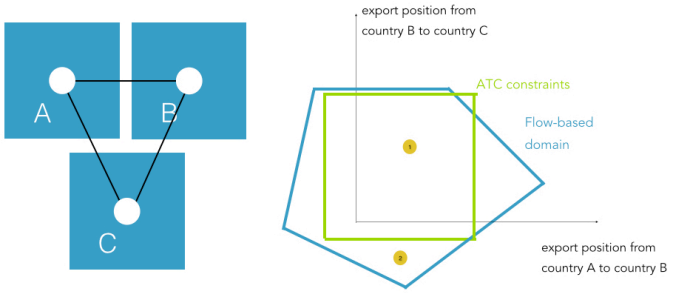

Figure 3: The theoretical difference between the ATC and flow-based domain.

There is much to gain with a clearly defined, simple and transparent FBMC that precisely takes into account the physical flows; more trade, more security of supply and better investment incentives (3). Certainly when unpredictable renewables will further penetrate the market, the flow-based market coupling has the potential to perform better than the current ATC market coupling, as the flow-based capacity calculations are less dependent on market outcome estimations. The current FMBC implementation clearly is a step in the right direction. Yet, it fails to completely unlock the benefits of the flow-based theory.

European collaboration: the key to success

To reach an accurate flow-based market coupling it is of crucial importance that all parties involved exchange their information and that they also determine this information in the same way. In the current FBMC proposal the different TSOs use different capacity calculation methodologies and some important parameters are not clearly defined (4). This results in inconsistencies and inaccurate modeling of flows. To elaborate a highly accurate FBMC, more collaboration between the transmission system operators and power exchanges is necessary. Achieving a unified implementation won't be easy. These parties all have their own interests and goals. Yet, the collaboration is crucial to arrive at a performant FBMC implementation.

Conclusion

The quest for security of supply in the electricity sector is resulting in very lucrative, expensive and exotic proposals that often propose a complete redesign of the system. However, the solution might be closer than we believe. A good infrastructure is at our disposal. It is just not used to its limits. A FBMC could push the network to its limits while keeping operational security. The current FBMC unfortunately lacks simplicity and uniformity to exploit the full potential of the flow-based approach. A harmonized and clear implementation is necessary to achieve the desired accuracy. As so often the key to success and security of supply could lay in European collaboration.

SOURCES

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