COMBINING CONGESTION MANAGEMENT METHODS IN NEAR REAL-TIME BALANCING PLATFORMS

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Overview

Following the rules set by the Electricity Balancing Guidelines [1], the European electricity markets integration is undergoing a major new stage. Among the more recent projects, TERRE and MARI aim to integrate manual balancing markets, respectively for Replacement Reserve (RR) and Manual Frequency Restoration Reserve (mFRR). They will deeply change the way balancing is performed across Europe. Until recently, each Transmission System Operator (TSO) provided balancing services only for its own control area. TSOs will now submit their balancing needs and the available bids in their area to a common European platform. Bids from all participating zones will be shared and activated according to a Common Merit Order List. The motivation for these projects is to reduce European electricity balancing prices [2] and facilitate greater renewable integration [3].

TERRE and MARI are innovative projects, and their implementation is a challenge. It changes the way network constraints are handled in balancing in a context where the rapid development of renewable energies is already disrupting congestion management. Several solutions are included in the market design in order to manage congestion, among which bid filtering and cross-border capacity management. Bid filtering takes place ahead of market clearing. When TSOs receive bids for their zone, they can choose to filter some that are expected to create internal congestion, preferably bids that are high in the merit-order. Cross-border capacity represents in a synthetic manner in the market clearing how much power can be exchanged on a specific border without causing cross-border congestion.

We wish to evaluate the impact of these balancing platforms on market and network costs with different combinations of congestion management methods. These methods include the current cross-border capacity management method, a proposal for improved cross-border capacity management and bid filtering. The cross-border capacity is currently expressed using an Available Transfer Capacity (ATC) per border and is computed on a network forecasted two days ahead. We propose a cross-border capacity computed with a flow-based methodology and based on a network forecasted one hour ahead, which is compatible with the operational timeframe of TERRE and MARI. The flow-based methodology takes into account interdependency of power flows in a meshed grid in order to better represent physical limitations of the grid [4]. It has already been used for the day-ahead market in the Central Western Europe region since May 2015. We also wish to evaluate different types of interaction between filtering and cross-border capacity. [5] and [6] already proposed a method for filtering and cross-border capacity interaction, but did not evaluate the impact either on market prices or on congestion management costs.

In order to evaluate these methods, we simulate a sequence of day-ahead market, balancing market and security analysis, taking into account the evolution of uncertainties between each. We apply our methodology on an updated IEEE 96-node network [7] over a winter and a summer week.

Methods

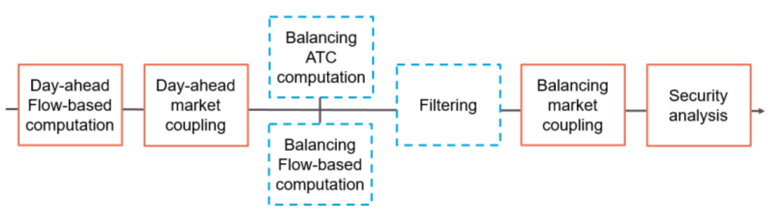

Figure 1. Model Overview

Figure 1 presents the different steps of the model. Each scenario includes the same four full-line steps (day-ahead flow-based computation, day-ahead market coupling, balancing market coupling, security analysis), and a variant of the dashed steps (one of the two methods for cross-border capacity computation and filtering as an option).

The methodologies for the day-ahead and balancing flow-based domains are very similar. First a base case is computed using a Security-Constrained DC Optimal Power Flow (SCOPF), which optimizes dispatch while ensuring the network is N and N-1 secure. For the day-ahead base case, the objective is to minimize total dispatch costs. For balancing, it is to minimize redispatch costs after the day-ahead market. The SCOPF includes optimal topology control: it optimizes the use of preventive and corrective topological actions. The base cases are the input to the flow-based computation, which uses the same methodology as for the CORE day-ahead flow-based. The ATC computation uses the same method as is actually applied operationally [8].

Filtering of offers is based on a prototype developed internally by RTE to perform this task in operation: Each order in the merit order list is examined in turn; its activation is simulated on the network situation modelling the target timestep and a loadflow is run to determine whether the network remains secure; if it does, the order is accepted and added to the network simulation used for the next orders; If not, it is rejected.

Market simulation is performed using the ATLAS model, an agent-based modeling tool designed to simulate a sequence of electricity market stages taking into account the evolution of forecasting uncertainties. The ATLAS model is described in [9]. Cross-border capacities are given to the market clearing.

Finally, the security analysis is run with the same SCOPF as for setting up the flow-based base cases. It checks whether the balancing market outcome is N and N-1 secure. If it is not, it can apply remedial actions (redispatch, topological actions or loadshedding). The objective for the security analysis is to minimize the cost of remedial actions.

Results

The study is run over two weeks on a 96-node network [7]. Topological actions are added to the network using the method described in [10]. In order to compare the different scenarios, we measure the total social welfare of the balancing market and security analysis. We find that the proposed capacity computation leads to higher social welfare than the current capacity computation, but still has important congestion management costs. Filtering reduces market welfare but helps decrease congestion management costs, leading to a higher total social welfare.

Conclusions

In this study, we compare different combinations of congestion management methods for manual balancing markets. These methods include the current cross-border capacity computation, a proposal for improved cross-border capacity computation and filtering. In future work, it would be interesting to add the two additional methods authorized in Balancing Guidelines: bid blocking and capacity reservation.

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