EFFECTS OF MARKET SPLITTING ON POWER MARKET AND TRANSMISSION GRID IN GERMANY

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(1) Overview

The operation of the European transmission grid has to deal with more and more network congestions. The major driver for this development is the increase in renewable generation units which are often located remotely from load centers. The second driver is the phase out of capacities which are located in proximity to load areas, especially seen in Germany. In order to cope with these network congestions preventive and curative congestion management methods are applied in network operation as necessary network reinforcements are not yet realized.

In order to achieve a higher impact of the preventive congestion management on the dispatch and therefore on network congestions homogenous power markets can be split into different bidding zones[1]. Concerning the actual design of a market splitting three major degrees of freedom can be distinguished: the delimitation of the bidding zones, the capacity allocation method (NTC vs. PTDF) and the allowed transfer capacity between zones.

The actual market design has to be set by regulation. In order to substantiate the discussion of a market splitting in Germany, the paper intends to investigate the effects on the power market and the transmission grid in Germany by analyzing generation, exchange, market price, congestions, producer surplus, consumer surplus and also redispatch costs. To gain an in-depth understanding of the underlying fundamentals multiple simulations with different assumed market designs are conducted.

(2) Methods

The methodology of this paper shown in Fig. 1 aims to analyze the influences of different regulatory regimes on the power market and the transmission grid. Therefore different possible variants of a market splitting are parameterized. The methodology to analyze the effect of market splitting is constituted of a market simulation and a network simulation which are run subsequently. The hourly market simulation determines the price in each power market and the dispatch of the generation units. Based on this generation dispatch an hourly redispatch simulation –if necessary– is performed. This two-step approach is chosen to guarantee a high coherence between model and reality.

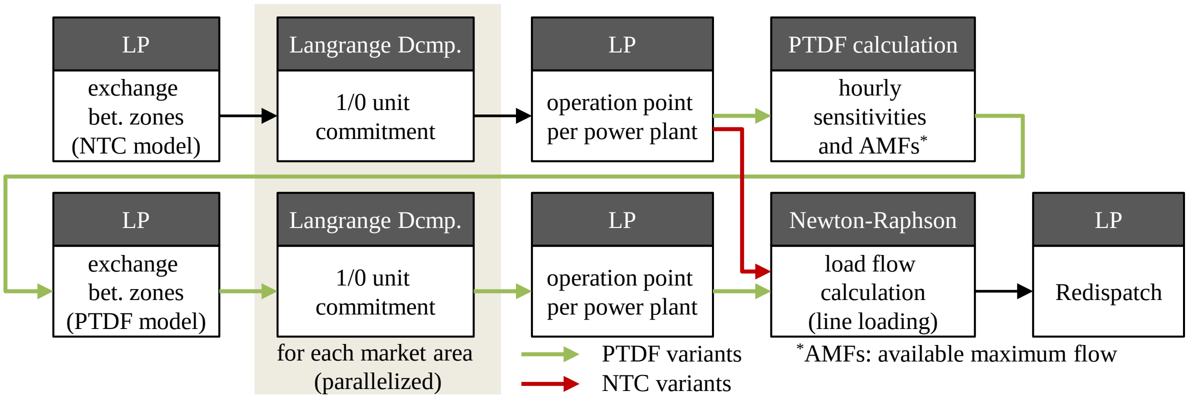

Fig. 1: sequence of calculations

For the investigations a reference system is parameterized first which serves as point of reference for the following investigations. In this paper the situation of the year 2012 is chosen, which has been benchmarked intensively with reality in a first step. After the benchmark of the reference system different regulatory regimes are parameterized. Therefore variants with the currently used NTC model and variants with the alternative PTDF model are investigated. Each model is parameterized also for different transfer capacities.

The simulation models for the market and network/redispatch simulation were developed by IAEW in the recent years and benchmarked in several studies [2-4]. The market simulation achieves a hourly realistic power plant dispatch depending on three-stage optimization shown on the left in Fig. 1. During the stages the network constraints and technical parameters per unit like the efficiency or minimum power output are considered. Also time-coupling constraints per unit like minimum time of operation or storage volumes are taken into account. To reflect the trading of the market areas the simulation of all European countries is necessary.

The hourly grid simulation is used to identify emerging congestions by load flow calculations depending on a Newton-Raphson method. As the way of electricity and power flow in meshed high voltages grids can only be determined with numerical load flow calculation, a simulation of the entire interconnected system is necessary, to reflect transit and loop flows correctly. Afterwards an hourly redispatch simulation focusing on Germany is performed to eliminate network congestions by adaption of power plant generation. The used LP model has the objective function to minimize the redispatch volume and costs.

(3) Results

The reference system is used to identify advantageous borders for the market areas by analyzing the frequency of overloading on the 380-kV-lines in Germany. The result shown in Fig. 2 divides Germany into three market areas. Based on these areas multiple simulations with different parameterizations of the market splitting were conducted and investigated. Although hourly results are obtained by the simulation tools it is advantageous to aggregate the results and to identify underlying dependencies. We analyze in detail:

- The change of power plant generation due to market splitting (e.g. less lignite in eastern zone due to reduced transfer capacities)
- The use of transfer capacities
- The change of network loading due to market splitting
- The change of redispatch volumes and redispatch cost due to market splitting

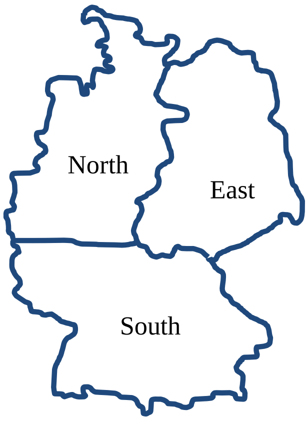

Fig. 2: splitting borders

A market splitting can either decrease or increase the total system cost which is defined as the sum of generation and redispatch cost in this paper. An optimal market splitting will decrease the total system cost – but due to the complexity the optimal splitting is difficult to identify. The total benefit of market splitting is defined as the net change in surplus plus avoided redispatch costs. Fig. 3: It shows the change of consumer surplus, the producer surplus and the redispatch surplus referred to the base system in function of the different market splitting regimes.

This representation therefore has two major outcomings: in case the sum of all surplus is positive, the splitting is beneficial over the base system and it also shows the winner and losers.

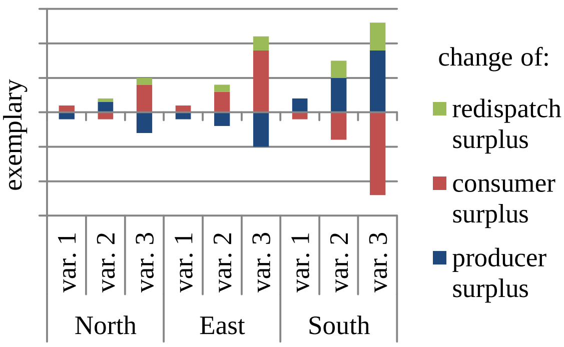

Fig. 3: exemplary presentation of welfare effects

(4) Conclusions

This paper aims to investigate the effects of a market splitting on the power market and the transmission grid in Germany by analyzing generation, exchange, market price, congestions, producer and consumer surplus and also redispatch costs. Based on a fictional splitting of the German market area into three zones, the results of market splitting could be shown. The results showed a tremendous sensitivity towards small changes of parameters, especially in the PTDF calculation where local constraints can lead to a full separation of zones. Before implementing a market splitting in Germany, theses parameters should be further analyzed in detail since a wrong parameterization can bring about net economic losses in the range of several billion euros per year.

References

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