Cost Benefit Analysis of Transmission Grid Expansion in the Continental European Electricity Market

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Overview

The distinctions of wholesale electricity prices in different European regions are the result of different power plant portfolios, on the one hand, and from limited transmission capacities between the countries, on the other hand. The increase of side specific RES-E generation technologies, not necessarily located nearby load centers can lead intensified price differences if no further transmission extension will be implemented. To counteract, the European Network of Transmission System Operators for Electricity (ENTSO-E) has published documents where the importance of transmission grid expansion is accounted in detail. This paper introduces a method for analysing the costs and benefits of future cross-border transmission capacity extension between different electricity price areas in central Europe. Based on a market coupling algorithm [1], an n-point model, where each point represents a defined market area, will be presented. The methodology being implemented in MATLAB delivers the economic influence of the expanded transmission grid between different market zones and allows a detailed discussion on system benefits (e.g. like the increase of the social welfare, fossil fuel savings and the CO_2 emission reduction). The congestion rent [2] will be compared with the costs of the transmission grid extension.

Methods

The market coupling algorithm is based on net export curves (NECs) [1], [3], which are defined as difference between local supplier and consumer bidding curves and represents the availability of import/export of electrical energy of a market zone. The market clearing price is equivalent to the NECs intersection with the vertical axis. The stepwise NEC is generated graphically by shifting the demand curve horizontally over the supply. Each intersection between supply and the shifted demand represents the NECs price level on the shifted volume. The NECs of different market zones are used for the calculation of the social welfare and the congestion rent (fig. 1), which are benchmarks for the economic analyses of future transmission grid extension.

Figure 1 shows the NEC of the market with the lower market clearing price (market B) and the mirrored net import curve (NEC') of the market with the higher market clearing price (market A). If the available transfer capacity (ATC) is at least the same as ATC2 (in fig. 1), price convergence will occur. Therefore the congestion rent and the congestion losses are equal to zero, because the transmission capacity is high enough to reach convergence. The area between the two NEC represents changes in the social welfare. If the ATC is equal to ATC1 (in fig. 1) the line is congested and price convergence will not be reached. The resulting market prices are illustrated as p'$_A$ and p'$_B$ in fig. 1. The price reduction results in an increase of the social welfare in the markets. The congestion rent is used as benchmark for the economics analysis and represents the benefits of the owner of the transmission line. The illustrated market coupling methodology of two neighboring market zones is implemented in the extended algorithm of the n-point model. The approach is based on an optimisation and implemented in MATLAB.
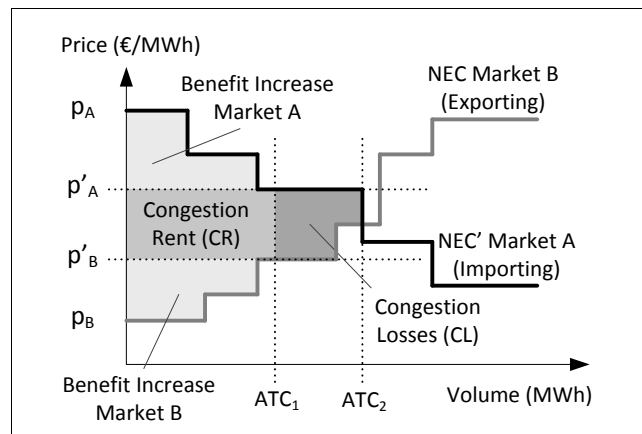

Fig. 1: Market Coupling with Net Export Curves according to [2]

Results

Empirical results will be derived in the next couple of weeks and presented at the IAEE European Conference 2013.

References

[1] Belgium Power Exchange (BELPEX) "Trilateral Market Coupling – Algorithm Appendix", Brussels, March 2006.

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