INEFFICIENCIES IN ZONAL MARKET COUPLING DUE TO UNCERTAINTIES IN GENERATION SHIFT KEYS

Björn Felten, University of Duisburg-Essen, +49-201-183-3389, bjoern.felten@uni-due.de
Tim Felling, University of Duisburg-Essen, +49-201-183-6706, tim.felling@uni-due.de
Christoph Weber University of Duisburg-Essen, +49-201-183-2699, christoph.weber@uni-due.de

Overview

Since May 2015 Flow-Based Market Coupling (FLB-MC) is online for the Central Western European (CWE) region. Its motivation is inceasing welfare by optimizing the capacity allocation for trading [1]. Its advantage is the comprehensive view on the system state and thereby more integrated optimization of electricity markets. However, with FLB-MC, some shortccomings still remain that are inherent to most zonal pricing regimes. For a second-best market coupling approach like FLB-MC in CWE, in particular, nodal injections are estimated by generation shift keys (GSKs) and only the zonal net export is used as variable of the electricity market optimization problem (EMOP).

The present work examines how the estimation and the resulting uncertainty in GSKs affects capacity margins which have to be considered in the FLB-MC process. A comparison is made between nodal pricing, zonal pricing using FLB-MC and zonal pricing using NTC-based market coupling (MC). Contingencies that have to be foreseen in order to prevent re-dispatch and countertrading are explained. In addition the flow reliability margins (FRM) arrising from GSK uncertainty are derived analytically and assessed numerically for the extended CWE region. This is done not only for a given price zone configuration but also for numerous price zone configurations (up to quasi-nodal pricing) that have been identified by a hierarchical clustering algorithm.

This paper contributes to the improved understanding of advances from NTC-based MC to FLB-MC without ignoring its shortcomings against the first-best solution of nodal pricing. A further contribution is that, by the means of quantifying FRMs due to GSK uncertainties for a fairly large set of price zone configurations, the FRM evolution for an ever-smaller zone configuration can be assessed.

Methods

Two main methods are employed. Firstly the EMOP in its nodal and zonal form are explained. By re-formulation of the zonal EMOP the zonal net export variable can be expressed in terms of a nodal net surplus variable. This allows to illustrate the solution space for the nodal EMOP and the zonal EMOP of a stylized example in the same depiction. Including the range of possible GSK deviations reveals the contingencies that have to be made in order to avoid re-dispatch and countertrading. On the same suppositions the solution space of NTC-based MC is illustrated and it is explained under which rare circumstances it can yield a higher welfare than FLB-MC and under which it cannot.

The second method employed is the derivation of FRMs required to prevent redispatch and countertrading. One result is the identification of determinants for the FRM in analytical terms. Furthermore a numerical application quantifies these FRMs for the actual CWE grid. By combining this algorithm with a hierarchical clustering algorithm developed by Felling and Weber [2] the FRMs can be expressed as a function of the number of zones in the given system.

Results

One qualitative result is the common depiction of contingencies required in the FLB-MC process and the NTC-based MC process compared to nodal pricing. For a stylized example the contingencies are also quantified. For a much higher amount of price zone configurations and based on a real-world example of the extended CWE grid the FRMs due to GSK uncertainty are described as a function of the number of zones in the system.

Conclusions

Nodal and zonal MC approaches have been discussed frequently [3–9] but its contingencies due to GSK uncertainties have not been addressed sufficiently and in a combined manner. Eventually FRMs due to GSK uncertainties are nonexistent for the nodal setup. By deriving FRMs as a function of number of zones in a real-world system the conclusion on the convergence of FRMs towards the nodal setup can be drawn.

References

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