ESTIMATING THE VALUE OF DISTRIBUTED DEMAND SIDE MANAGEMENT TECHNOLOGIES IN CENTRAL WESTERN EUROPE – ASSESSING REGIONAL DIFFERENCES IN VIEW OF LOCATIONAL PRICING MECHANISMS

[Hendrik Kramer, University Duisburg-Essen, +49 201 18-33994, hendrik.kramer@uni-due.de]
[Florian Boehnke, University Duisburg-Essen, +49 201 18-36504, florian.boehnke@uni-due.de]
[Christoph Weber, University Duisburg-Essen, +49 201 18-32966, christoph.weber@uni-due.de]

Overview

Currently, most EU member states apply a zonal pricing mechanism associated with a uniform electricity market price for each market zone. Accordingly, scarce transmission capacities are mostly neglected in European electricity markets. With the continued rapid expansion of distributed renewable energy sources (RES) and delayed grid expansion, the shortcomings of the zonal market design including remedial actions to relieve internal grid bottlenecks will amplify. As a consequence, transitioning the market architecture towards a nodal market design is proposed by various scholars. An unbiased, local electricity price signal is proven to incentivize more adequate generation and storage investment as benefits for the system and individual profits coincide. In this study, we are investigating the local value of various flexibility options in terms of their contribution margin. The study is focused on battery energy storage systems (BESS), electric vehicles (EV) and heat pumps and presumes a nodal electricity market design in Central Western Europe (CWE) including Austria, Belgium, France, Germany, Switzerland and the Netherlands.

Methods

Our approach is twofold: First, we compute hourly nodal electricity price timeseries for each high voltage grid node in CWE for the year 2030. The underlying market model is a well-established fundamental electricity market model, namely the Wilmar Joint Market Model. For the purpose of this work, we extended the market model towards the nodal design. The grid representation is based on TYNDP data from the ENTSO-E. RES timeseries and generation capacities originate from the EU-funded project OSMOSE (grant agreement no. 773406) and have been allocated from zonal to nodal level applying technical bottom-up modelling from future's expected capacities and weather data (wind speed and solar irradiance based on COSMO-EU) and voronoi polygons. Second, we compute the nodal value of incremental flexibility. We create linear optimization models representing each flexibility option (BESS, unidirectional EV smart charging, bidirectional EV smart charging, heat pump) as a storage unit that aims to maximize temporal arbitrage margins given the storage constraints at each node and a perfect foresight horizon of one year.

Results

Our results indicate different comparative advantages of flexibility types at different locations. Correlations between the standard deviation, as well as maximum daily price spreads concerning the contribution margin of flexibility options at a certain node are assessed. Preliminary results show the extend of the higher determination of correlation of bidirectional flexibility options (BESS, bidirectional smart charging) compared to unidirectional flexibility options (unidirectional smart charging, heat pump). Counterintuively, no correlation between the locations' population density or local RES capacity concerning the contribution margin at the relevant nodes was identified. Our research underlines the importance of local price signals.

Conclusions

We show that the value of flexibility options varies depending on their location. In consequence, we state that the value of demand side flexibility has a geographic diversity. Through a modified market mechanism, congestion in the grid might be eased by adequate investment incentives.

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