BALANCING MARKETS AND VERTICAL INTEGRATION: CHALLENGES FROM DECENTRALIZED ENERGY RESOURCES

Diego Cebreros, LGI, CentraleSupélec, Université Paris-Saclay, 91192 Gif-sur-Yvette, France, diego-manuel.cebreros-saettone@centralesupelec.fr
Yannick Perez, LGI, CentraleSupélec, Université Paris-Saclay,91192 Gif-sur-Yvette, France, yannick.perez@centralesupelec.fr

Overview

Balancing service providers (BSP) are important actors in European electricity systems for integrating renewable and intermittent energy like wind and solar power. (Vandezande et al., 2010). Errors in forecasts, either on renewable energy production or on the load, can create power imbalances. Imbalances can cause frequency deviations in the system, leading to equipment damage and blackouts. The role of BSP is to manage the imbalances produced by an individual license holder, broadly defined as any producer, supplier, large consumer, or trading actor participating in electricity markets.

The well functioning of the market design for BSPs has been a core objective for regulators and researchers alike; if market rules provide distorted incentives, BSPs or license-holders can be motivated to game or exceed their balancing responsibilities intentionally. One of the main mechanisms in which markets can create distorted incentives is when parties are vertically integrated and participate simultaneously in markets that have strong interdependence amongst themselves, creating gaming opportunities to maximize their private profits. For example, separating generators from transmission system operators (TSOs) was a substantial part of the liberalization reforms to guarantee well-functioning energy markets. Nevertheless, at the level of balancing markets, despite some evidence that they can be interdependent with other markets, such as cross-border electricity trading (Scherer et al., 2015). To our knowledge, no one has explored the impact of the provisions in the current European balancing regulation (EU 2017/2195), which allows BSP and license-holders to be vertically integrated, on creating market-gaming opportunities for either the BSP or the license-holder.

In this paper, we focus into the gaming opportunities that emerge from the participation of DERs, such as solar panels, electric vehicles (EVs), and heat pumps, in balancing markets. While typically seen as flexible assets that can be very controllable, the inherent uncertainty and variability of DERs availability pose significant challenges for its participation on energy markets. For example, an EV might be not available for discharging energy because its owner is using it for mobility purposes. To address this, intermediaries known as aggregators play a pivotal role in integrating DERs into energy systems by managing their unpredictability and variability. Our hypothesis, is that unlike centralized energy resources, DERs often serve private purposes that are not fully observable by the transmission system operator (TSO), making their capacity more difficult to monitor and validate. In consequence, an aggregators that simultaneously act as BSP while participating in the day-ahead (DA) and intraday (ID) markets, might creates the ideal conditions for opportunistic behavior taking advantage on their priviledge knowledge of DERs availability. This informational advantage can be use as a lever to under- or over-committing DER capacities in DA or ID markets, manufacturing imbalances that they can later profit from in the balancing market. Therefore, we pose the following research question: *"What is the value of prohibiting aggregators from simultaneously performing BSP and non-BSP activities?"*.

Methods

Our approach combines analytical modeling and simulation to investigate the gaming opportunities for aggregators acting as BSPs and participating in the DA and ID markets. First, we construct an analytical model to capture the decision-making process of an aggregator. In this model, the aggregator initially allocates DER capacity across the DA, ID, and balancing markets, optimizing their strategy to maximize revenue. Closer to the delivery stage, the aggregator can adjust its commitments by leveraging updated information about DER availability. This adjustment may create artificial imbalances that the aggregator can later exploit in the balancing market. The model provides a theoretical framework to identify conditions that incentivize gaming behavior.

Building on the insights from the analytical model, we simulate the participation of EVs in energy markets using real-world data from France. This simulation reflects the practical complexities of DERs, including their inherent variability and private usage patterns. By estimating the financial impacts of gaming behavior under different market configurations, the simulation quantifies the value of prohibiting aggregators from simultaneously performing BSP and non-BSP activities.

Results

This study is currently a work in progress. Preliminary results from the analytical model suggest that aggregators with dual roles have strong incentives to manipulate market participation, particularly by exploiting their privileged knowledge of DER availability. The model indicates that this behavior can lead to artificially created imbalances, which are then monetized in the balancing market. The simulation, which is ongoing, will provide quantitative estimates of the economic impacts of such behavior and evaluate the benefits of regulatory measures that mandate role separation.

Conclusions

Our research highlights the vulnerabilities in current market designs that allow aggregators to operate simultaneously as BSPs and market participants in the DA and ID markets. While DERs offer valuable flexibility to balance energy systems, their uncertain and private-use characteristics create significant risks for gaming. This study underscores the importance of regulatory reforms, such as prohibiting dual roles for aggregators, to ensure transparency and market efficiency in an increasingly decentralized energy landscape.

References

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