ESTIMATING THE RESOURCE ADEQUACY VALUE OF DEMAND RESPONSE IN THE GERMAN ENERGY-ONLY MARKET

Hamid Aghaie, Junior Scientist, AIT Austrian Institute of Technology, hamid.aghaie@ait.ac.at

Overview

Electricity plays a major role in economic development and social welfare of every society and any interruption in electricity supply would result in a substantial financial loss and reduction in the social welfare. Hence, ensuring long-term generation adequacy in the electricity market is a top priority for market operators and policymakers. As suppliers in an electricity market are required to offer into the market based on their short-term marginal cost due to competitive pressures, it is difficult for some suppliers with high marginal cost such as natural gas-fired plants, to recover their fixed capital costs. Also, current electricity prices in European and US electricity markets do not go high enough for the exiting peaking plants to be able to recover their fixed costs. This issue of revenue insufficiency resulted in lower investment incentives in some electricity markets which can lead to a resource inadequacy problem. A well-functioning energy market should be able to provide cost recovery for all types of generators to ensure a sustainable level of resource adequacy in the system.

In this work, we investigate the resource adequacy value of demand response (DR) as a flexible resource in the German electricity market. In other words, we try to answer the key question of how the flexibility provided by DR could mitigate the resource inadequacy issue in this market. With that objective, we develop a probabilistic framework by modeling the uncertainty in both generation and demand sides of the market. Then, we implement a Monte Carlo analysis to examine all possible economic and reliability outcomes.

Methods

System dynamics is an approach suitable for studying the causal effects of the interactions within the components of a system in time. In our work, a system dynamics approach is used to understand the dynamics of different interactions among the energy market components such as supply, demand, market price, profitability, and investment decisions. We evaluate the hourly prices and profits for all producers, the optimal installed capacity, investment decisions, and profitability of newly installed capacity resources. As a case study, German electricity market with perfect competition is used as the main structure of the simulated market.

Results

The results in this work shows that in any electricity market with high generation share by renewable resources, the value of flexibility provided by DR will play a major role to alleviate the resource inadequacy problem. The value of DR is the German market is significantly high due to low correlation between variable RES generation and load which is estimated be mere 4%. Results show that in the presence of DR capacity with the capital cost of 10000 €/MW.yr and the dispatch price of 500 €/MWh in the German electricity market, by increasing the demand response penetration from 0% to 3% of peak load the economically optimal reserve margin drops from 6.5% to 3%. Besides, the total generation expansion costs decrease from 353 Million Euro to 70 Million Euro (approximately 80% reduction in generation expansion costs). However, the optimal penetration level of DR depends on the capital cost and dispatch price of demand response resources as well as on the share of variable RES in the market.

Conclusions

It is concluded that both energy-only and capacity markets need higher level of flexibility by DR to provide a sustainable level of resource adequacy in electricity markets and hence ensure reliability of the power system. The utilization of DR instead of new thermal plants leads to the significant reduction in total electricity systems costs which is mainly due to the lower capital costs of DR resources compared to other generation technologies. However, system operator needs to consider the risk of exceeding DR dispatch hour limit in order to find the optimal DR penetration in the market.

References

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