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ESTIMATING THE VALUE OF DEMAND RESPONSE FOR RESOURCE ADEQUACY

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Introduction

One of the top priorities for market operators and policymakers in electricity markets is to guarantee the long-term generation resource adequacy. By increasing the demand response (DR) penetration in electricity markets, one of the important questions for resource adequacy relates to the contribution of DR to the reliability and resource adequacy in an electricity system. Unlike the high availability of conventional generators, DR resources are typically constrained by the number of load curtailment events during a given time. These constraints can potentially limit the capacity credit (or resource adequacy value) of DR. In this paper, we investigate the capacity credit of DR as a flexible demand 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.

Method

A probabilistic model is proposed to evaluate the capacity credit of DR in an electricity market. As the majority of DR utilization events are associated with a low probability and infrequent circumstances which are produced due to the combination of periods of extreme limited supply and high load, a probabilistic approach is required to examine a full range of potential DR utilization outcomes and capture wide distributions of generation and load variables.

Following the main objective of this study, the uncertainty in both generation and demand sides of the market is modelled and a Monte Carlo analysis is utilized to examine all possible economic and reliability outcomes. In order to estimate the capacity credit of DR, system operator would need to consider the risk of exceeding different DR limitations such as maximum number of DR call hours per day in a given year, maximum number of days with DR utilization per year, and maximum amount of MWh dispatched DR per hour or per day in a given year. It is assumed that DR capacity would be dispatched if the load exceeds the reserve margin. Therefore, DR would be dispatched only for reliability purposes in order to avoid blackouts in extreme reliability situations.

Results

In this section, DR utilization values reflect the probability-weighted average of DR utilization over a large number of scenarios with varying demand and generation conditions in a given year. In presence of the economically optimal reserve margin and 20 % share of variable RES in the German market, the total number of DR call hours in a given year is 29 hours, the maximum number of DR call per day is 5 hours and the maximum number of dispatched DR per day is 1,760 MWh/day.

Therefore, any DR dispatch constraint which is lower than these values will result in a capacity credit value of less than 100 % for DR. In the presence of a fixed DR dispatch constraint, higher reserve margin results in a higher capacity credit of DR. For instance, by considering a limit of maximum 4-hour call per day for DR capacity, the average capacity credit of DR is approximately 16 % at 0 % reserve margin, 40 % at 3 % reserve margin, 65 % at 6.5 % reserve margin and 100 % at 9 % reserve margin. The capacity credit of DR in the German electricity market in presence of the economically optimal reserve margin and with maximum 4 hours dispatch limit per day is 65 %, while this value of DR in Colorado electricity market in presence of the same dispatch limit is around 70 %.

The difference in capacity credit of DR across different markets comes from the fact that resource adequacy value of DR mainly depends on the type of provided DR and the characteristics of each electricity market such as share of RES, DR penetration, reserve margin, peak load season and period and the type of DR dispatch constraints.

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Conclusion

The capacity credit of DR mainly depends on the characteristics of a DR program and the dispatch limitations of procured DR. Besides the above-mentioned factors, the capacity credit of DR depends on the operational characteristics of the market such as the share of variable RES, DR penetration level, installed generation capacity, and peak load season.

DR dispatch limitations can be defined as maximum DR-call hours per day limit, maximum DR-call hours per year limit, and maximum MWh dispatched DR per day limit. System operator would need to consider the risk of exceeding different DR limitations in order to estimate the contribution of DR to resource adequacy.