Reserve prices under scarcity conditions improve with a dynamic ORDC, new research finds

16 February 2021

Credit: CC0 Public Domain

Historically, most electric transmission system operators have used heuristics (rules based on experience) to hold sufficient reserves to guard against unforeseen large outages and maintain system reliability. However, the expansion of competitive wholesale electricity markets has led to efforts to translate reserve heuristics into competitively procured services. A common approach constructs an administrative demand curve for valuing and procuring least cost reserve supply offers. The technical term for this is the operating reserve demand curve (ORDC). A new paper quantifies how better accounting for the temperature-dependent probability of large generator contingencies with time-varying dynamic ORDC construction improves reserve procurement.

The paper, "Dynamic Operating Reserve Procurement Improves Scarcity Pricing in PJM," by researchers at Carnegie Mellon University, was published in *Energy Policy*.

"A dynamic ORDC increases reserve prices when there is higher probability of scarcity conditions, but has minimal effects on total market payments," says Jay Apt, a Professor and Co-Director of the Carnegie Mellon Electricity Industry Center, who co-authored the paper. "The results are directly relevant to the modeled two-settlement electricity market in PJM, which is currently studying changes to its ORDC."

The researchers pulled their data from PJM Interconnection, the largest system operator by load in North America. PJM, which serves 65 million customers in 13 mid-Atlantic states, manages a competitive two-settlement wholesale electricity market, with day-ahead and real-time settlements. The researchers chose PJM due to its current policy relevance, though they write that the results are broadly relevant to any market operators with similar two-settlement market designs and proportion of conventional generation resources.

PJM and other system operators are aware that probabilistic methods will better quantify the optimal quantity and type of reserves to hold across different timeframes. But competitively procuring reserves to reliability serve electricity load given uncertainty requires either computationally intensive stochastic optimization methods or improved heuristics for reserve procurement demands. Traditionally, uncertainties have included large conventional generator failures and load forecast error, and developing heuristics to respond to these uncertainties has led wholesale market operators to integrate reserve procurement via an administrative demand curve. The ORDC has become a market-based method for reserve procurement as it recognizes that the optimal quantity of reserves to hold will depend on a probability distribution of near real-time deviations between forecast and actual load and generation

availability.

Following previous research demonstrating that generator reliability depends on temperature, the researchers proposed a dynamic formulation of an ORDC to implement scarcity pricing in a wholesale electricity market. They validated their model's price formation during two historical weeks—Jan. 4-10, 2014, and Oct. 19-25, 2017, representing high and low load weeks, respectively—and compared its performance to three alternative approaches for procuring operating reserves, two of which reflect historical and proposed practices at PJM.

The researchers found that a dynamic ORDC increased reserve procurement and prices during very hot and cold hours with heightened risk of generator forced outages. Increased reserve procurement reduces the probability of a reserve shortage during extreme temperature events, such as the Jan. 2014 Polar Vortex, and also enables generators to realize benefits for enhancing reliability during these events through increased reserve prices. By using ORDCs that account for day-ahead generator failure probabilities conditioned on forecast temperature, operating reserves can reduce the need for out-of-market administrative interventions and improve market efficiency.

More information: Luke Lavin et al, Dynamic operating reserve procurement improves scarcity pricing in PJM, *Energy Policy* (2020). DOI: 10.1016/j.enpol.2020.111857

Provided by Carnegie Mellon University