Impact of High Renewable Energy Penetration on ERCOT's Frequency Response Reliability

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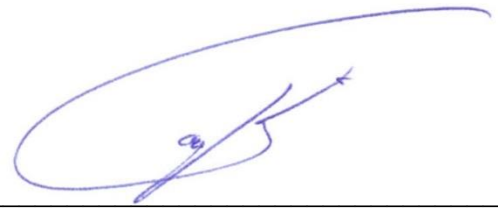
Abstract

The increased integration of renewable energy into the power grid can affect grid reliability during disturbances, as frequency response time is affected by the generation and storage technologies active at the time. As less grid power comes from generators with synchronized rotating machines (e.g., coal, natural gas, nuclear, hydropower), perhaps due to increasing use of renewable energy, the system inertia decreases, making it harder to maintain grid frequency and stability. Fast Frequency Response (FFR) provides rapid power adjustment to stabilize frequency disturbances and maintain stability, and is associated with inverter-based resources, such as renewable and battery storage due to their ability to provide faster response relative to Primary Frequency Response (PFR) from conventional synchronous generators. The Electric Reliability Council of Texas (ERCOT) has witnessed high wind and solar penetration in the power grid, and consequently, a trend of lower system inertia. ERCOT has set rules and standards for generators providing FFR concurrent with the state of the grid. Using a single-generator model based on ERCOT's PFR and FFR parameters and requirements, and 8 years of hourly historical system and day-ahead market prices data, this paper explores the actual historical system response, or frequency behavior, of ERCOT during power loss events as compared to a situation when the grid is projected to be operating at ERCOT's critical system inertia (100 GW-sec) and FFR contribution. The model indicates reliable operation following ERCOT's guidelines and standards as none of the replicated events reach the first stage of load shedding. The economic

effect on the ERCOT market from providing frequency response through FFR presents the cost-savings potential of utilizing inverter-based resources by using a regression approach to get the $/MW coefficient of FFR capacity. The offset capacity valued using this coefficient and savings in fossil fuels costs for one year is approximately $40 million. This work emerges as ERCOT deliberates on the FFR Advancement Project, which incorporates FFR into the Ancillary Services (AS) market and offers additional insights into the future implementation and acceptance of FFR.



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