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Voltage and Frequency Regulation Using the Third-Party Mid-Size Battery

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Abstract : The recent growth of renewables, e.g., solar panels, batteries, and electric vehicles (EVs) in residential and small commercial sectors, has potential impacts on the stability and operation of power grids. Considering approximately 50 percent share of the residential and the commercial sectors in the electricity demand market, the significance of these impacts, and the necessity of addressing them are more highlighted. Utilities and power system operators should manage the renewable electricity sources integration with power systems in such a way to extract the most possible advantages for the power systems. The most common effect of high penetration level of the renewables is the reverse power flow in the distribution feeders when the customers generate more power than their needs. The reverse power flow causes voltage rise and thermal issues in the power grids. To overcome the voltage rise issues in the distribution system, several techniques have been proposed including reducing transformers short circuit resistance and feeder impedance, installing autotransformers/voltage regulators along the line, absorbing the reactive power by distributed generators (DGs), and limiting the PV and battery sizes. In this study, we consider a medium-scale battery energy storage to manage the power energy and address the aforementioned issues on voltage deviation and power loss increase. We propose an optimization algorithm to find the optimum size and location for the battery. The optimization for the battery location and size is so that the battery maintains the feeder voltage deviation and power loss at a certain desired level. Moreover, the proposed optimization algorithm controls the charging/discharging profile of the battery to absorb the negative power flow from residential and commercial customers in the feeder during the peak time and sell the power back to the system during the off-peak time. The proposed battery regulates the voltage problem in the distribution system while it also can play frequency regulation role in islanded microgrids. This battery can be regulated and controlled by the utilities or a third-party ancillary service provider for the utilities to reduce the power system loss and regulate the distribution feeder voltage and frequency in standard level.

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