

Control Algorithm to Optimize Power Balancing in Smart Grid with Voltage Constraints of Distribution Network

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Novel technologies are expected to be incorporated into today's power grid to enhance its functional capabilities while providing increased customer satisfaction through a sustainable power network. Thus, future power networks are expected to incorporate large amount of Distributed Renewable Energy Resources (DRER) while maintaining power quality. Smart grid, which is based on microgrid, is expected to serve these requirements.

However, the intermittent and random nature of DREG, like wind and solar could destabilize the network as conventional power control systems cannot handle high frequency fluctuations. Hence, a high frequency power fluctuation has to be mitigated within the microgrid. Such power balancing algorithm-based diverse optimality criterion has been presented in many papers. However, voltage in the distribution feeder is affected due to variation in power flow. In order to guarantee the power quality, the voltage in the distribution feeder should be maintained within the standard tolerance level. When it comes to smart grid where multiple DREGs are pumping power into the grid at various nodes of the feeder, a fluctuating voltage profile results.

In this paper we have presented a way to incorporate voltage constraints into power balancing schemes with minimal changes to the conventional distribution network. In this study, a 33kV distribution feeder with four 33kV/400V transformers (node) is considered. The aggregated models of wind, solar PV, Combined Heat and Power (CHP), Electric Vehicles (EV), controllable loads and uncontrollable loads below 33kV/400V transformer are combined to represent a node. Voltage tolerance of $\pm 2\%$ was included into an existing power balancing scheme and the simulation results are shown in Figure 1. It can be seen in the figure that voltage of the feeder was always maintained within the limits. It can also be noticed near $t = 0$ s, $t = 183600$ s and $t = 194400$ s, that the Load Tap Changer (LTC) is switched to maximise the solution space of the optimization algorithm.

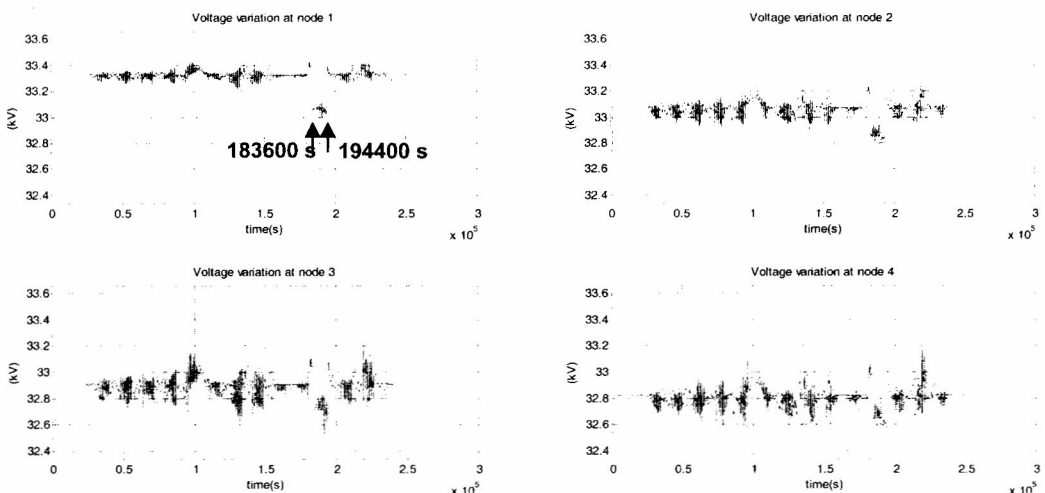


Figure 1. Variation of voltage in each node