Abstract

Environmental constraints, electricity market and load growth are forcing transmission networks to be operated close to their stability limits, resulting in increased system vulnerability. Under such circumstances, a disturbance in the system may trigger cascading events causing system collapse. This requires efficient monitoring and proper decisive actions to retain system stability. Advancements in the field of real-time computation, communication facility and global positioning system have led to development of wide area measurement system (WAMS). WAMS provides synchronized data from various locations in a network. Applications of WAMS data for improved stability assessment and initiation of remedial measures, in the form of load sheddings, are presented in this work.

Following a disturbance, one or more generators may get severely affected and result in rotor angle instability. Identification of disturbed generators is cumbersome when the reference generator is among the disturbed ones. This may result in erroneous stability assessment. A method is developed using WAMS data to identify the disturbed generators and assess angle stability following a disturbance.

Long-term stability assessment is performed in a system through the formulation of an index. Available indices do not give accurate results under different conditions such as load power factor variations. A new long-term voltage stability index is proposed using WAMs, in this work, which meets the limitations of available ones. A method for calculation of load margins at various buses is also developed which helps the operator in taking preventive measures.

Integration of photovoltaic (PV) plants in the grid causes major challenges due to their variable power output. Exclusion of this feature may result in overshedding or undershedding of load in case of underfrequency situations. In this work, WAMS data are used to develop an adaptive underfrequency load shedding scheme which is step-wise in nature and considers changes in load or generation or PV power.

Presence of induction motor loads in a system may lead to voltage instability in seconds under various conditions such as load increments or line outages. A short-term voltage stability assessment method is proposed in this thesis using WAMS data. In case of possible instability, an adaptive undervoltage load shedding method is developed to maintain system integrity. The proposed scheme is independent of load model, does not require any training and is accurate even with PV plants integrated to the grid.

The proposed techniques have the capability to enhance monitoring and operation of the system in mitigating possible large scale disturbances. Numerous test results in different systems are presented to highlight the superior performance of these techniques.

Keywords: *Wide area measurements, Synchrophasors, Phasor measurement units, Stability assessment, Rotor angle stability, Voltage stability, Load margin, Underfrequency load shedding, Undervoltage load shedding, Solar photovoltaic plants.*