Impact of Energy Storage on the Stability and Transmission Efficiency of a Remote Grid

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Abstract

This thesis addresses a remote grid fed by a weak transmission line and a local source of renewable generation. Energy Storage System (ESS) is installed at the remote grid. The thesis investigates the use of the Energy Storage System in improving the overall system efficiency and increasing the power system stability for the transmission line and remote grid system.

The Energy Storage System reduces transmission line losses and hence can improve the overall efficiency of the system. The key parameters that are significant to improving the overall system efficiency are derived and a simple mathematical analysis is undertaken to show the criteria for increased system efficiency. A PSCAD/EMTDC simulation is undertaken which is shown to be consistent with analysis both for simple and real wind profiles.

For the case of stability investigation, a large Constant Power Load (CPL) is connected at the remote grid. This thesis performs the mathematical modelling and stability analysis of the combined CPL, grid, wind farm and energy storage. It is shown that CPLs fed by active PWM rectifiers are fundamentally stable if operated below the transmission line load-ability limit, and those fed by diode bridge rectifier can be unstable depending on filter values. It is revealed that the instability can be improved by control of auxiliary units such as an energy storage units.

In order to reduce the simulation time required, a simplified model of a wind farm feeding a DFIG connected to a remote grid is proposed and compared with a detailed model using the PSCAD/EMTDC software.

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