Abstract of Ph.D. Thesis
“Control of Microgrids Employing Wind Driven Switched Reluctance Generator and Photovoltaic Array with Seamless Synchronization”
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ABSTRACT

In this thesis, a number of grid-connected and standalone configurations of microgrids are designed for integrating renewable sources such as solar and wind based on areas, applications, type of energy sources, supply reliability, cost, and the power quality (PQ) aspects for providing uninterrupted power to the loads. Moreover, with battery energy storage (BES) and coordinated control, the proposed microgrid solves the problem of intermittent renewable generation. Here, a switched reluctance generator (SRG) is adopted for converting the mechanical power output from the wind turbine (WT) into electricity. Moreover, the SRG is operated with a sensorless technique to determine the position and speed for its effective control with the ability to harvest the peak power available in the wind energy.

The proposed microgrids address the problems related to electrification in the accessible areas of the electric grid and in regions with a weak or nonexistent grid. In grid-connected configurations, the power generated by the RES is shared between the local loads and the utility grid. In the standalone systems, the microgrid is combined with a diesel generator (DG) set to realize a reliable solution to provide uninterrupted electricity to local loads at remote places. Moreover, it is guaranteed through the control and the storage battery that the DG set is always utilized optimally by operating into the fuel-efficient zone, irrespective of the variation in the load demand.

The unbalanced, distorted, and failure of the utility grid are severe concerns in the microgrid. As a result, it must guarantee that the microgrid operates without generating any interruptions in supplying the critical loads. Moreover, substantial power electronics converter-based nonlinear loads are used in domestic applications, which have given rise to serious PQ issues, such as harmonics, unbalanced loading, poor power factor operation, voltage distortion, etc., and have drawn the most attention in distribution systems. This causes mal-operation of appliances, increased losses, and poor power factor on the grid. Therefore, algorithms are needed to manage the voltage source converter (VSC) with rapid reaction, fluctuation-free, and well-structured operation. In this thesis, robust control techniques are designed and developed for multimode operations of microgrids as well as to regulate the voltage and frequency of microgrids irrespective of the load condition and renewable sources availability.

All microgrid configurations are modeled and simulated in the MATLAB/Simulink platform. Simulated performances are validated using an experimental microgrid setup developed in the laboratory. The results showcase the satisfactory performance of microgrids under different practical scenarios.