Modelling, Control, And Power Management for A Grid-Integrated Photo Voltaic, Fuel Cell, And Wind Hybrid System

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Abstract

Power management in a grid-integrated power system consisting of distributed renewable energy sources is necessitated by ever-increasing energy consumption, the high production cost, the limited fossil fuel resource, and the worsening global environment. Wind and solar power generation are two of the most promising renewable power generation technologies. The growth of wind and photovoltaic (PV) power generation systems has exceeded the most optimistic levels of expectations. Fuel cells (FCs) also have great potential to be green power sources of the future because of the many merits they have, such as high efficiency and zero or low emission of pollutant gases. In this paper the modelling, control, and analysis of grid-connected PV power, a proton exchange membrane fuel cell (PEMFC), and a wind energy system (WES) connected through a common DC bus linked to an AC grid is discussed. In coordination with the PEMFC, the hybrid system's output power becomes controllable so that full utilization of PV and wind power takes place based on its availability and the DC bus voltage is maintained constant even at varying load conditions for the desired power sharing between the distributed generation (DG) sources, load, and the AC grid. The hybrid system is controlled through a combination of two proposed control modes, namely the DG control mode and grid control mode. The coordination of the power controller, voltage source converter controller, and load controller is such that the transition between the two control modes is done as smoothly as possible. Thus, the total DG power will be a combination of PV power, WES power, and power produced by the PEMFC. Any additional power if required up to the maximum loading will be supplied by grid. If the load exceeds its maximum value, then the load controller will carry out load shedding. The composite system is available for safe operation in on-grid as well as of-grid mode satisfying voltage and power balance constraints. Different modes of operation have been demonstrated to verify and validate the desired power management among the DG sources, load, and the grid. MATLAB/Simulink software was used for simulating the composite model.