ABSTRACT

The availability of energy from renewable energy sources like solar photovoltaic and wind systems is highly intermittent in nature and thus standalone microgrids require energy storage devices (ESD) to supply uninterrupted power to their system loads. The use of multiple storage devices reduce the charge-discharge stress on any single ESD and advantages of different characteristic may be combined together to form a hybrid energy storage system (HESS). This leads to the requirement of efficient control algorithms for power sharing among the different ESDs in the HESS. In this thesis, power sharing algorithms are presented to share power among high energy density and high power density storage devices of a HESS in different microgrid systems. Intelligent power sharing among multiple ESDs ensures maximum utilization of primary sources and energy in the storage devices. A novel adaptive fuzzy logic control (AFLC) algorithm is proposed which considers the instantaneous state of charge of all the ESDs in a standalone DC microgrid and determines the optimal power sharing ratio among the storage devices. The performance of this proposed AFLC is compared with conventional fuzzy control and storage capacity based algorithms. Results are validated through experimental studies on a hardware microgrid setup. The proposed AFLC is implemented in an interlinked standalone DC microgrid system for power sharing among storage devices located on different interconnected microgrids. This proposed control logic ensures maximum utilization of primary energy sources in each microgrid and results in higher energy saving in the storage devices as compared to the conventional methods. Further, a unified power management and control algorithm for inter and intra-microgrid power sharing in a hybrid grid-connected multiple microgrid system is presented to minimize the amount of power import from the utility grid. For this purpose, an adaptive droop control method is proposed and its performance is evaluated through simulation studies.

Keywords: adaptive fuzzy logic control, energy storage devices, multiple microgrids, adaptive droop control.