National Institute of Technology Rourkela

Defence Seminar

Seminar Title	: Active Power Distribution Scheme in a Hybrid AC/DC Microgrid Integrated with Composite Energy Storage Devices
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Venue	: Electrical Engineering Seminar Hall - EE401 (Online)
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Abstract	: The growing power requirement and the limited availability of fossil fuels make it necessary to use renewable energy resources (RERs) as an alternative. The penetration of renewable sources in the existing power system becomes a big challenge for the safe and reliable operation of the system. In this work, a solar photovoltaic (PV) system is integrated because of its low cost and high efficiency. However, the erratic nature of sustainable energy sources along with the random load variations greatly affect the power quality and stability of the system. Here, by considering the complementary characteristics of supercapacitors with a high power density and batteries with high energy density, a combination of these two storage devices is used with RESs as a composite energy storage devices (CESDs). Optimal utilization of storage devices is very important in microgrid applications as a backup power source to enhance the resiliency and reliability of the system for critical loads. An improved mixed droop technique (IMDT) is proposed with optimized steady-state as well as transient performances of CESDs in this research. With the proposed technique, the supercapacitor compensates the fast power fluctuations in the system, while the battery supplies only the average power at steady-state. This control strategy advances the consistency of the system, dynamic restoration of the DC bus voltage, and reduces current stress from the battery units. Also, a robust sliding mode nonlinear controller (SMC) is implemented instead of the conventional PI controller for the switching regulation of the DC/DC bidirectional converters connected across the CESDs to maintain the required performance of the microgrid despite any changes in system parameters or model inaccuracies and any external disturbances. The insertion of renewable resources and energy storage devices in the existing power grid requires rigorous analysis of the power balance and system stability. Hence, this research work introduces an active power distribution scheme (APDS) for both isolated DC microgrid systems and grid-interactive hybrid AC/DC microgrid (GIHM) systems. The power distribution technique is designed by considering the power disparity between the PV generation and load demand and the available state of charge of energy storage units. Again, a double-loop control structure based on small-signal modeling of the system is presented for stability analysis of the proposed system and to obtain the accurate estimation of the PI parameters by calculating the proper bandwidth and phase margin of both current and voltage loops in the system. Also, a solar PV-powered electric vehicle charging microgrid (EVCM) integrated with energy storage systems and a conventional single-phase grid is proposed in this research to facilitate both grid-to-vehicle (G2V) and vehicle-to-grid (V2G) functions. For charging of EV battery (EVB), an innovative dynamic charging current-constant voltage (DCC-CV) method is proposed to reduce the transient in the system and to avoid the overcharging of EVB. To evaluate the performance and feasibility of the proposed APDS in isolated DC microgrid, hybrid AC/DC microgrid, and EVCM, the respective system models are tested in MATLAB/Simulink, developed prototype in the laboratory using DS1103, and OPAL-RT simulator with an extensive analysis of obtained results.