

Abstract of Phd. Thesis

“Power Management of PMSG Based Micro Hydro System Integrated with Battery

and PV Based Solar System”

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Hydropower systems are classified as large, medium, small, mini, micro and pico according to their installed power generation capacity. Micro-hydropower systems are relatively small power sources that are appropriate in most cases for individual users or groups of users, who are independent of the electricity supply grid. This research work attempts to provide simulation, implementation of hardware prototypes for different topologies suitable for off-grid and grid interactive micro grid (MG) systems using a permanent magnet synchronous generator (PMSG) based micro hydro and their integration with other energy source like solar PV array. PMSGs with numerous advantages such as simplified control, high efficiency, less maintenance and robust construction are proven to be better than conventional synchronous generators. For its simplicity, robustness and small size per generated kW, this generator is favoured for micro hydro power plant. The widespread use of these machines, helps in harnessing maximum micro hydro power potential available in mountainous region and also to provide reliable electricity to people residing in those areas, where providing electricity through conventional grid is difficult due to tough geographical and harsh climatic conditions. This work investigates on the use of a PMSG for off-grid and on-grid hydro power generation integrated to renewable energy sources (RESs) and battery energy storage (BES). One of the main highlight of this thesis work, is to provide a derating loop control at MPPT that can de-rate the PV system and protects the BES from overcharging. This work also presents a comprehensive study of different modes of PMSG using RESs for power generation realizing the off-grid or grid interactive MGs feeding a combination of practical loads with viable and successful controllers to ensure desired quality power across loads. Analysis, design, control and implementation of various isolated and grid interactive configurations of micro grids based on PV array, hydro and BES are carried out in this thesis work. A total of 14 hybrid system configurations operating in an IM and in the grid connected mode are presented in this study. MATLAB SIMULINK environment is used to simulate all these 14 configurations and for validation of these simulated results and laboratory prototypes are developed to validate the design, control, and mode of them. The foremost objective of this work is to facilitate quality power for loads at consumer end, consisting of nonlinear loads without effecting the performance of micro hydro generator. In order to maintain continuity in the supply, various configurations based on solar PV array and hydro generators are given in the presented work, which are categorised on the basis of system configuration, i.e. number of power stages (in case of solar photovoltaic -single-stage or two-stage) and load connections (three-wire and four-wire). The VSC with appropriate control algorithm, takes care of power quality and reactive compensation of the system. The VSC also ensures the control of frequency and voltages in these configurations. In varying circumstances, the hydro generator voltages and currents satisfy the requirements of the IEEE 519 standard. In multifunctional system, the grid connected VSC, apart from transferring power from RESs to the grid, it also provides multiple objectives such as harmonics reduction, compensating the reactive power and eliminating neutral current. In this work, the synchronization method is also incorporated for efficient operation. The system is made to operate in an islanded and the grid connected modes by reclosure mechanism. The multimode controlled is used to achieve synchronization operation of these systems and to provide different functionalities at the same time. These methods are incorporated to provide uninterrupted power to loads despite availability of the grid. These systems satisfy at the disconnection from the grid and reconnection to the grid as given by the IEEE 1547 standard.