Abstract of Ph.D. Thesis

"Control of Reliable Charging Infrastructure for EVs with Renewable Energy Grid Interface"

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In view of the proliferation of EVs, the development of the multi-functional EV charging infrastructure is of paramount importance. In addition, integrating renewable energy into the core of the EV charging system is crucially significant. Therefore, this thesis deals with the design, control and implementation of various configurations of PV array, wind energy conversion system (WECS), storage battery, grid/DG set based EV charging station, beneficial for EVs, domestic loads, and utility. For EVs and the household loads, the charging stations are designed to operate in multi-modes such in an islanded mode, the grid connected mode and the DG set connected mode with automatic and seamless mode transition among them, to provide the uninterruptible power. Moreover, it takes care of the harmonics distortion created by the EVs and the household loads by mitigating them locally, thus avoiding the penalty from the utility. For utility, the charging station provides the facility to exchange active and reactive powers with the grid in vehicle-to grid (V2G), grid-to-vehicle (G2V), storage-to-grid (S2G), grid-to-storage (G2S) etc., without compromising the power quality at grid side. Besides, the charging station supports other multi-functional operations such as vehicle-to-home (V2H), storage-to-home (S2H), storage-to-vehicle (S2V), vehicle-to-storage (V2S) and vehicle-to-vehicle (V2V), which improves the operational efficiency of the charging station. In the designed charging station configurations, a single voltage source converter is used to performs various tasks, such as energy management among different energy sources, extraction of maximum power from the PV array, the regulation of voltage and frequency of the DG set etc. The charging station also ensures the maximum power point operation of the renewable energy sources for maximum utilization of them. All the designed charging station configurations are modelled and simulated in the MATLAB/Sumulink environment using the Simpower technology blocks and the same has been verified through the laboratory prototype. The performance of the charging stations are discussed in various steady state conditions and the dynamic conditions.