ABSTRACT

The increase in electric power demand is inevitable as there is a steady growth in industrial developments. The fast depleting nature of conventional energy sources is standing on the way of socio-economic growth in the developing and underdeveloped countries. Therefore it is a rational idea to encourage renewable sources for power production. Among the renewable sources, the photovoltaic (PV) is really a game changing technology as it is clean, green, portable, scalable etc. The two traditional barriers that PV power encounters are high capital cost and low power conversion efficiency. Also, PV panels exhibits nonlinear voltage-current characteristic, with a divergent maximum power point (MPP), which relies on two decisive environmental factors like insolation and temperature. To yield maximum power from the solar panels, they have to be maneuvered at their MPPs despite the unavoidable changes in the environment. This technique of extracting the maximum possible peak power in a given time from the PV panel through appropriate power electronic converter and controller is called maximum power point tracking (MPPT).

Over the past decades many MPPT techniques have been explored.

The first module of this research work emphasize on studying the PV models in detail and the dynamic characteristic curves influenced by irradiance and temperature. The model is analyzed in detail by including series and parallel resistance so that model is accurate. The realization of the PV model is done three different ways in MATLAB environment, which facilitates the further research in right direction.

The second work stressed upon here, study the prevailing MPPT techniques and suggest a new feed forward direct maximum fixing algorithm which has an edge over the widely accepted perturb and observe (P&O) MPPT algorithm in terms of power oscillations and quick convergence. The scalable nature of PV system facilitates the usage of high power inverters. Multi level inverters (MLIs) known for its high power capacity with less distortion. In this research work,
acompone nent reduced cascaded multilevel inverter; known for its reduced component usage, is realized and the versatility of the proposed feed forward direct maximum fixing algorithm MPPT is tested in the MLI setup.

The next facet of the research work extends to study the performance descent in a PV array when the panels receive non uniform irradiation. The impact of the shading depends on the pattern of shading, location of the panels and other factors. There will be substantial power loss in other words mismatch loss which is the difference between the sum of the power of individual panel with respect to the maximum power of the entire PV array. Also the most important consequence of shading is the existence of multiple peaks in P-V characteristics of the PV array. The occurrence of multiple peaks will surely delude the conventional MPPT algorithms viz. P&O, and incremental conductance (INC) from grasping the maximum power.

This research demonstrates three different ways of combating the shading effect in a PV array. Those are, reconfiguring the PV panels in an array to assuage shading impact, deploying module integrated inverter to the system which introduces a MPPT in each panel and thereby regulating the power disparity within the shaded and non shaded panels, and using evolutionary algorithms like particle swarm optimization (PSO), differential evolution (DE) and shuffled frog leap algorithm (SFLA) which have inherent capacity to sweep the whole search space and identify the highest peak power.

All the above said research contributions are done for a standalone PV system and the techniques proposed are reasoned well, realized in simulation environment in MATLAB/Simulink and PSIM. The simulation results are validated through hardware prototypes using a versatile microcontroller dsPIC30F2011/dsPIC30F4011. The simulation and hardware results reveal that all the research contribution discussed in this work improve the performance enhancement of the stand alone PV system which is taken for study.