ABSTRACT

Renewable energy plays a vital role in electric power generation and they contribute 22% of the total electric power generation around the world. Solar power generation is a latent solution to the environmental problems being triggered by fossil fuels. However the efficiency of solar cells is only about 22% and the embedded inverter dynamically dips the mismatch losses, optimizes the solar energy harvest and enlightens the reliability of solar systems. As electricity demand is intensified with supply, the contribution of power generation is shared between the proportions of thermal power station, nuclear energy and other conventional power sources. Yet, if there is any collapse in the above assets will result in the unsafe impacts to the atmospheric conditions. As conventional energy resources are facing recession and negative impacts, there is a need for alternate reliable energy resources. The world hunts for sustainable power source that it is accessible and which turns out the focus on solar and wind. From all the renewable energy resources, solar energy is highly harnessed for domestic application to meet out the demand.

At present, solar energy is one of the efficient renewable energy resources that can satisfy the demand for domestic application. The Government of India also plans to rise the renewable energy generation to 175 GW by 2022 to match the load demanded by the users. The implementation of Solar PV system is still limited as it requires power optimization. To upsurge the power conversion efficiency of the Solar PV system, an optimum DC to DC converter must be chosen. The major demerits in the solar PV system are cost, shading losses and PV panel mismatch losses. In order to rectify these demerits, different Maximum Power Point Tracking (MPPT) algorithms and control techniques are adopted. The existing system

used in Solar PV system is less efficient because of the use of single DC to DC converter i.e. Power Optimizer for each Solar PV module that results in increase of cost for the system as the number of components used for DC conversion is more. In order to lessen the cost of the system components, the proposed topology presents a thorough and precise model for implementation of single power optimizer with two Solar PV modules and a single power optimizer connected with four Solar PV modules. Hence the power optimizers are connected in series, which reduces the overall cost of Solar PV roof-top system for domestic application. The main objective of the research is achieved as the cost of solar PV system get decreased by reducing the number of power optimizers used for DC to DC conversion that is connected to the photovoltaic modules.

The portion of DC to DC converter with MPPT algorithms is focused to maximise the productivity at roof-top solar PV system and also to decline the cost of the overall system. In addition to that, the installed solar PV system should eliminate the panel mismatch losses at all environmental conditions to enable the safer DC Voltage with flexible site design for domestic applications.

There are three part of contributions constituted in the thesis. First part focuses on the identification of best performing Solar PV module technology under different climate conditions for six different manufactures of Solar PV modules such as PERL Technology (Passivated Emitter Rear Locally diffused cell) Technology (3x250 W_p), Interdigitated Back Contact (320W_p), Hetero-Junction Technology (225W_p), PERC Technology (Passivated Emitter Rear Cell) (250W_p), PERL with locally manufactured honeycomb structure (240W_p), Hetero-structure Intrinsic Thin Layer (240W_p) are connected in series and having total rating of 2.095kW_p and it is installed at PSG College of Technology, Coimbatore, Tamil Nadu as a roof-top Solar PV system. An experimental and comparative analysis of above said six solar

PV module technologies using module level inverter topologies is carried out for various seasons namely summer, rainy and autumn season using data collected during the period January to December**.** The best performing Solar PV technology is selected based on the analysis of power generation and energy yield under different atmospheric operating conditions such as shading, irradiance and temperature values. From the comparative analysis, the best performed panel technology is identified.

Second part of the thesis focuses on the analysis of three different combinations of power optimizer applicable to Distributed MPPT (DMPPT) using MATLAB simulation. In this part a very detailed and precise model is created for analysis of the three different DMPPT topologies i.e. one Solar PV module is connected with one power optimizer (1:1), two Solar PV module is connected in series with one power optimizer (2:1) and four Solar PV module is connected in series with one power optimizer (4:1). In order to improve the efficiency and reduce the cost of solar PV system with module level inverter without compromising its performances under constant and varying irradiance conditions analysed. The simulation result of these systems are analysed and compared using MATLAB Simulink model under constant and varying solar irradiance conditions.

The final part of the thesis focuses on the hardware design to experiment a boost converter as a model for power optimizer application and perform a cost benefit analysis for three different combinations of power optimizer i.e. a single power optimizer for one PV module, single power optimizer for two PV modules and single power optimizer for four PV modules. The required data such as output energy, specific yield and other auxiliary parameters are observed and taken for the cost benefit analysis. Finally, it is found that the proposed single power optimizer for four PV modules performing well in all aspects with reduced return of investments.