CHAPTER – 7

Conclusion and Future Scope

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7.1 Conclusion

In this thesis, the study of the photovoltaic system with maximum power point controller has been developed. From the theory of the photovoltaic, a mathematic model of the PV has been presented. Then, the photovoltaic systems with DC-DC boost converter, maximum power point controller and resistive load have been designed. Finally, the system has been simulated with Simulink MATLAB. The work presents comparison between different MPPT strategies. The PV simulation set up under MATLAB/Simulink environment has been established by the electrical specifications of the PV module.

In chapter 2, the objective is to analyze the different environmental effects on the output characteristics of solar Photovoltaic system with experimental results.

Different characteristics of output current (I) *vs* voltage (V) and output power (P) *vs* voltage (V) of the solar PV system were studied under environmental conditions *e.g.* cleanliness, shading, solar irradiance *etc.* to realize the energy conversion capability of the module in the existing conditions. The results were validated with the experimental results. The output of solar cell is maximum i.e. V_{oc} = 19V and I_{sc} = 0.22A in clean condition with an efficiency of 6.27%. For the wavelength of red colour light produces maximum output i.e. V_{oc} = 20.3V and I_{sc} = 0.43A with an efficiency of 11.14% which reduces to 4.71% for violet colour. In partial shading condition the output of solar cell decreases significantly with the increase in percentage of shading that is from 0.093% to 0.01%. Also the output of solar cell increases with increase in irradiance level i.e. V_{oc} = 1.7V and I_{sc} = 0.27A at 800 W_p/m^2. The efficiency increases from 3.54% at 165W_P/m^2 to 6.38% at 250W_P/m^2. Again, energy storage technology used for PV system has been depicted in details in the work.

In chapter 3, the objective is to analyze the different control strategies of Maximum power point technique to be used DC-DC boost converter for obtaining maximum output power from solar PV system.

The photovoltaic system with DC-DC boost converter and maximum power point controller has been designed and constant voltage of 21.5V is maintained at the output side of the converter at chapter 3. For the specified input variation, a regulated dc output voltage of 21.5V has been obtained resulting in an efficiency of 95%. It is concluded that Perturb &

Observe method has better efficiency compared to Incremental Conductance method at low power. In this case, Perturb & Observe method gave an increase of 2.6% in voltage, 5.3% increase in current and 7% increase in power at low power output, but is inefficient in case of sudden change in irradiance level. From the modelling of boost converter, it was also observed that the output voltage of the boost converter increases along with the increase in duty cycle.

In this chapter 4, the objective is to design a stand-alone photovoltaic system and to analyse the output characteristics for different loads.

It was observed that the output voltage of standalone PV system with efficient battery charging controller was constant for the change in load and solar intensity. When the load was 60W, the converter was working in mode 1 with a current of 1.4A for battery discharging current of 0.5A. Further, at 30W load the converter was working in mode 2 supplying a current of 0.6A with battery charging current of 0.1A. This validates the converter to function properly at two different modes as required by a standalone PV system. Different characteristics of battery power for different load in close loop as well as in open loop condition have been studied for better operation of the system.

In chapter 5, the objective is to design a Cuk converter to be operated with MPPT technology and to analyse the output characteristics for different irradiation level.

The results of the Cuk converter in solar PV system with MPPT technology were analyzed at different irradiance level in chapter 5. It was found that output voltage of 27V at irradiance level, $1000W_P/m^2$ was reduced to 25V when irradiance level decreased to $400W_P/m^2$. Similarly, the current decreased from 7.8A to 2.8A when irradiance level decreased from $1000W_P/m^2$ to $400W_P/m^2$. Also the output power decreased from 200W to 76W due to the decrease in irradiance level from $1000W_P/m^2$ to $400W_P/m^2$. It was found that the voltage, current and power were steady after 0.1 second, which was the response time for given MPPT.

In chapter 6, the case study of a $50kW_P$ at KIIT campus is used to analyse the output chacteristics of solar cells used in the solar plant and load curves for different inverters.

Different characteristics of output current (I) *vs* voltage (V) and output power (P) *vs* voltage (V) of the module ($230W_p$) installed at 50 kW_p Solar PV Station at KIIT campus has been drawn to realize the energy conversion capability of the module in the existing conditions in chapter 6. Again, a study on 50kWp solar PV station at KIIT campus has been made incorporating the output voltage of inverter annually. From the case study at KIIT Campus it was found that Solar PV station not only gives supply to campus but also it connects with the online grid. It was concluded that there has been most significant role of solar PV system in India by connecting utility grid in which more amount of energy can be generated and consumed.

7.2 Scope for Future Work

Different algorithms for maximum power control may be developed for application on other renewable energy sources such as fuel cells and wind power. Artificial neural network algorithms can be developed to improve the performance of the solar energy conversion function of the MPPT. Intelligent devices like microprocessors, Programmable Logic Controllers (PLC) may be added to the system to keep the operating point (maximum power point) for maximum efficiency. To take care of the uncertainty in the insolation level, use of fuzzy control may be done. Use of feedback path for automatic control-position control servo for changing the transformation ratio of variac can be used. The simulation of the PV with three-phase inverter and current control can be performed. Grid Connected PV system with Smart Grid functionality, there is a great need of designing the control system that would control the designed inverter power. The control would be able to integrate the inverter with other renewable energy sources available. The control strategy plays an important role of making the system smart by coordinate with the IT systems such as internet synchronization Ether CAT networks.