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Study of Photovoltaic System in different operating Environment using Modelling and Simulation

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Abstract—
In this paper, a scheme has been proposed to focus on the analysis of the various factors which are responsible for affecting the performance of a solar PV system. However, the performance is judged on the basis of the power output from the panel, so the analysis will be done of the factors which directly or indirectly affect the power output thus the power rating of the panel or "Solar PV systems". So, this project provides the theoretical studies also of the photovoltaic systems using its electric equivalent systems. The relation of the power output from the panel is also considered for analysis in this project as to study how increasing or decreasing temperatures affects the power output from the panel. So the temperature effect is analyzed in this project to understand the behavior of the system under the influence of temperature. The proposed model is based on a behavioral cell model for modeling solar radiance to electricity conversion and for implementing electrical characteristic of limited power systems in power simulations. This project work presents the modeling and simulation of solar photovoltaic system for a practical system. The solar photovoltaic (PV) system simulation model using MATLAB/ Simulink simulation environment and MATLAB code is prepared and performance is obtained for different working conditions.

Keywords: — MATLAB, Solar panel with charging system, Storage (Battery) and Inverter.

1. INTRODUCTION

Solar PV cell or simply Photovoltaic cells are the cells that change energy from sun into useful electrical energy using semi conductor PN junction devices. A PV cell can be considered as fundamental unit which generates voltage in that varies in range of 0.5 to 0.8 volts depending on cell manufacturing technology used and is pollution free. To avail this for non-availability of sunshine and night time storage of the generated electricity is needed which can be done by using batteries. Recently, research results have led to the development of low cost "flat-panel solar panels, thin-film devices, concentrator systems," and many innovative concepts also have increased. In the coming time, the costs of small units made of solar power and "solar-power plants" will be economically available for "large-scale production" and use of solar energy. The output available from the solar panel is Voltage, a part this voltage is converted into current by using shunt which is the other parameter of output taken from the panel. Based on the current and voltage output from the panel, the power of the panel is calculated at every recording instant. For this analysis the factors which affect the performance of the system (which according to my belief are shade, dust, and temperature) are considered and their effects on the power rating of the panel (which is the key efficiency parameter) are presented in this project. With the advancement in technology and cost effectiveness has led to the photovoltaic (PV) systems with "doped silicon as the major conducting element" to be manufactured. Because of the inbuilt material property of this semi-conductor, the efficiency of the PV system has been limited to within 15–20%.

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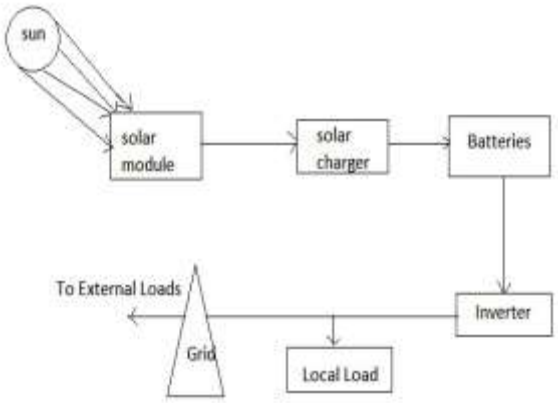


Fig 1: Prototype of SPV module

2. PROPOSED METHODOLOGY

Photovoltaic or solar cells are one of those power supplies which last for a long time. These cells are considered as very useful from the point of view of obtaining energy from the sun, since it converts sunlight directly to electricity with very high efficiency of conversion, also that it can provide nearly a permanent power output and it is available at a low operating cost also that it is pollution free. Since a "typical photovoltaic cell produces less than 3 watts at approximately 0.5 volt dc". The cells must be connected in series –parallel configuration in order to match the power requirements for high power applications

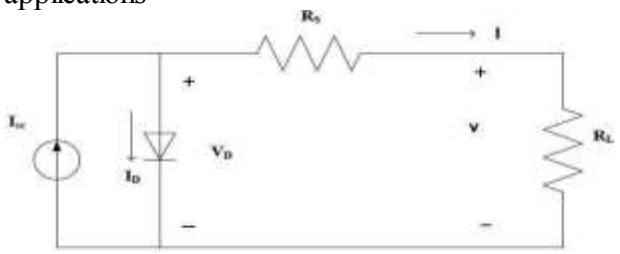


Fig. 2: PV cell with its equivalent electric circuit

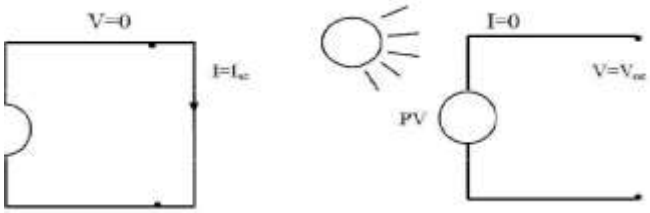


Figure: 2.1 (a) Short circuit current and (b) Open circuit Voltage

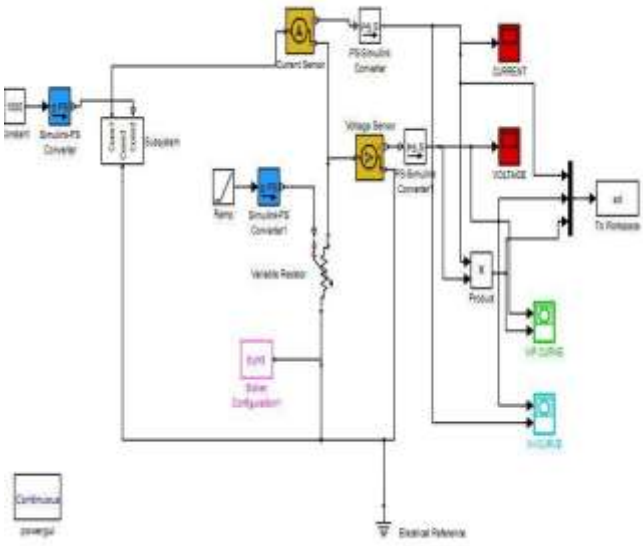
$$I = I_{sc} - I_d \quad \ldots\ldots\ldots\ldots\ldots (i)$$

$$I_d = I_s \left(\frac{qv_d}{e^{nkT}} - 1\right) \ldots\ldots\ldots (ii)$$

Then from equation (i) and (ii) $I = I_{sc} - I_s \left(\frac{qv_d}{e^{nkT}} - 1\right)$

2.1 Sim-Electronics Model for Solar Cell array:

Sim-Electronics model for 6 solar cell model has been shown in the figure. In this the output of solar panel is connected to a voltage sensor the output of which is connected PS S Simulink converter. In this study, we have been taken different irradiance and different resistance values for simulation.



The simulation of solar photovoltaic system is carried out using MATLAB and the characteristics between various parameters are plotted. Current and voltage curves are plotted for different insolations from solar. The power output from the panel is calculated by using the formula (Power = Voltage*Current). This power is not always maximum t throughout the time, but it varies under the influence of various factors, these various factors influencing the power output are:

3. Variable Irradiance:

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The simulation of solar photovoltaic system is carried out using MATLAB and the characteristics between various parameters are plotted.

1. For 1000 watts/m2 irradiance, 25^0 C Temperature voltage-Current and voltage-Power curves are plotted.

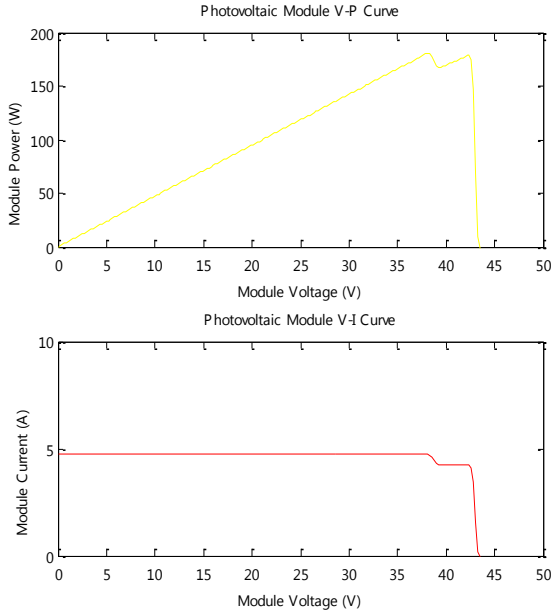


Fig 3.1 PV Module Power and Module Current Vs Module Voltage

2. For 500 watts/m^2 irradiance, 25^0 C temp, voltage-Current and voltage-Power curves are plotted.

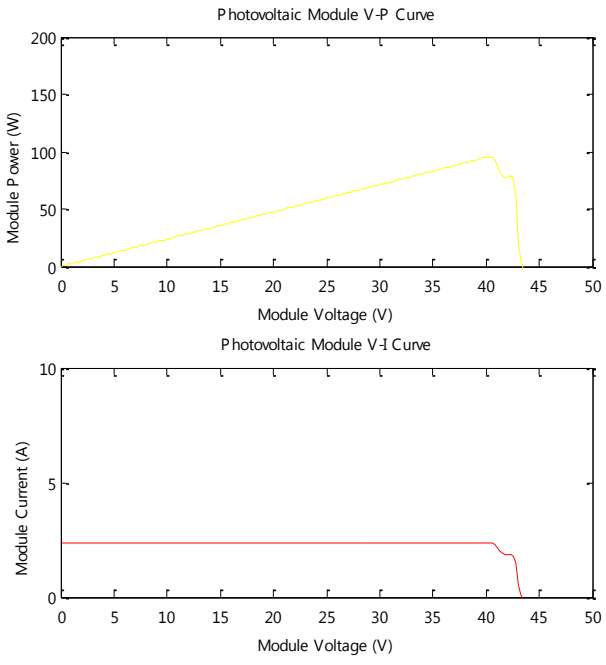


Fig 3.2 PV Module Voltage module Power curve and Module Current curve

3. For 1000,750,500 and 250 watts/m2 irradiance, 25^0 C temp, voltage-Current and voltage-Power curves are plotted.

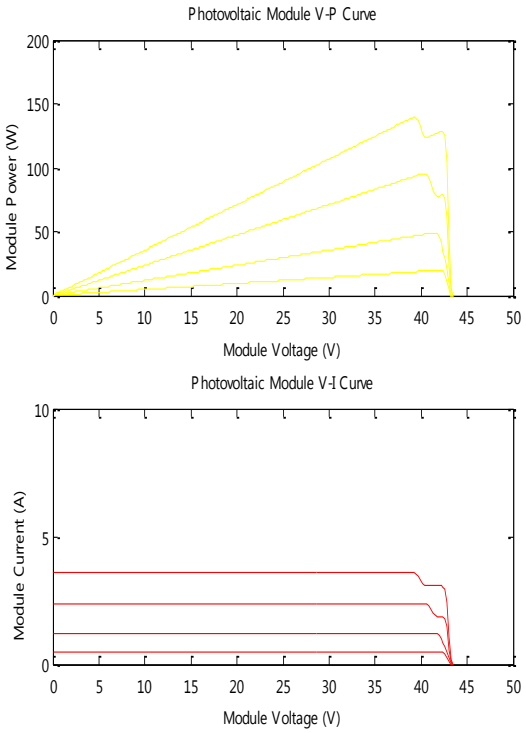


Fig 3.3 PV Module Voltage module Power curve and Module Current curve

4. For 1000 watts/m2 irradiance, and 10, 20, 30 and 400 C Temp, voltage-Current and voltage-Power curves are plotted.

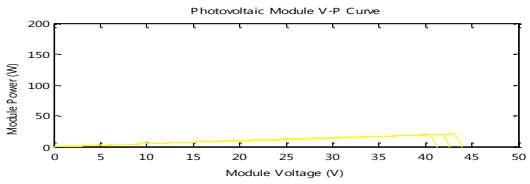
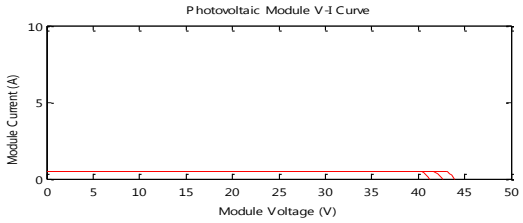


Fig 4.10 (a) PV Module Voltage module

Power curve



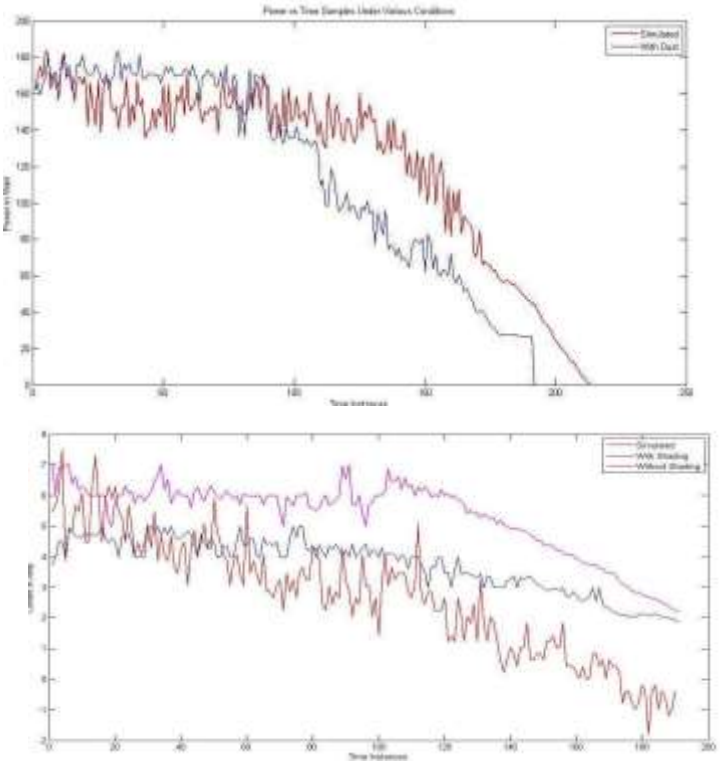


Fig 4.10 (b) PV Module Voltage module Power curve and Module Current curve

4. Dust Effect on the panel:

Dust accumulation on solar panel is the natural phenomenon. It has been found that the accumulation of dust reduces the performance of solar PV system. This reduction in the performance of solar PV system can be up to 50%.

4. RESULTS & DISCUSSION

From the simulation results we see that the performance of solar panel decreased by a significant amount of power and due to dust accumulation of dust. The effective solar irradiance on the panel is decreased so the performance of the panel is decreased. The plots of power and current with respect to time are as follows:

5. CONCLUSION

In this project the modeling and simulation of solar photovoltaic system for various operating conditions have been done. These conditions are normal weather condition, partial shading on SPV array and dust effect for solar PV panel. These simulations are validated using experimental set up to get the various data from solar PV array such as voltage, current and powerReferences

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