Performance Analysis of Solar PV Systems Under Shadowing With Different Temperatures

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Abstract- *Solar Energy is very useful and important in current scenario as energy consumption is increasing day by day. Solar Photo voltaic (SPV) may be the alternate source of energy but dependency of weather is its limitation. In this paper, Modelling of solar PV system is done under shadowing and performance is measured by Temperature variation. Result shows that increase in the temperature of SPV module result in less current and power generation*

Keywords- PV cell, SPV, Partial Shading and Temperature

I. INTRODUCTION

Solar energy has several advantages over conventional energy sources such as abundance of raw material, non polluting in nature, no running cost etc. Whereas there are some disadvantages too such as high installation cost, lack of efficient technology etc.

The alarming rate of depletion of fossil fuels and earth's degrading health as a result of increasing power demand to use maximum of technologies developed till date by us has subsequently led us to discover yet another technology termed as SPV or Solar Photovoltaic Technology. This technology works on Photovoltaic effect using the solar energy so called solar photovoltaic technology. There are a number of solar cells connected in series and parallel making up a working solar photovoltaic module or panel. The effective component of a solar panel is thus the solar cell(s).[1-5]

Solar cell is the primary device for solar photovoltaic system. Pure silicon with high crystal quality is needed to make solar cells. To enable silicon material to generate electrical energy, impurities, the doping atoms, are introduced into the crystal lattice[15-20].

It is a device that converts solar energy directly to DC electric energy. Two dissimilar doped Silicon semiconductor (n-type and p-type) are sandwiched together to form a pn junction diode. Solar cell is basically a diode. The n-type material is exposed to sunlight which has electrons as majority charge carriers[6-10].

"The generation of voltage across the p n junction in the semiconductor due to the absorption of the solar radiation is called photovoltaic effect"[22]. When solar cell is exposed to light, photons are absorbed by the electrons. This input of energy breaks the electron bonds[10-15].

In this paper Modelling of solar system under shadowing is done using MATLAB Simulink. Performance is measured by plotting V-I and P-V characteristic of the solar PV module. Reverse biased characteristics of a SPV cell are required to model the partial shading conditions of the solar PV array. During reverse bias the shunt resistance rash is an important parameter affecting the behavior of the cell. Most of the researchers have either taken rash as constant or have neglected it. In this paper an empirical relation has been established through a series of experiments and the insolation dependent resistance has been added in the model to improve its accuracy.

II. SYSTEM MODULE

Ideal equivalent model of photovoltaic cell is shown in Fig. 1. "The basic equation from the theory of semiconductors [1] that mathematically describes the I-V characteristic of the ideal photovoltaic cell is":

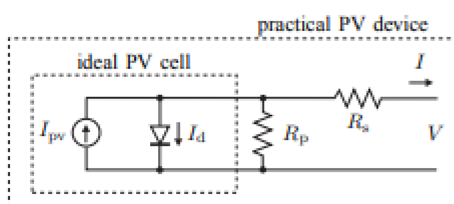

Fig. 1 : photovoltaic cell

$$I = I_c - I_0[\exp(\frac{qV}{akT}) - 1] \quad (1)$$

"where I_c is the current generated by the incident light , I_d is the Shockley diode equation, I_o [A] is the reverse saturation or leakage current of the diode , q is the electron charge [1.60217646 · 10^{-19}C], k is the Boltzmann constant

[1.3806503 · 10^{-23}J/K], T [K] is the temperature of the p-n junction, and a is the diode ideality constant"[21].

These Cells may be grouped and arranged to form panels or modules. Panels can be grouped to form large photovoltaic arrays. The term array is usually employed to describe a photovoltaic panel or a group of panels. "Most of time one is interested in modelling photovoltaic panels, which are the commercial photovoltaic devices"[22]. Modelling used for solar panel is shown in Fig,2 .

The Fig. 3 shows the interconnection of two series connected PV module in which one PV module is unshaded and the other is selected for shading conditions.

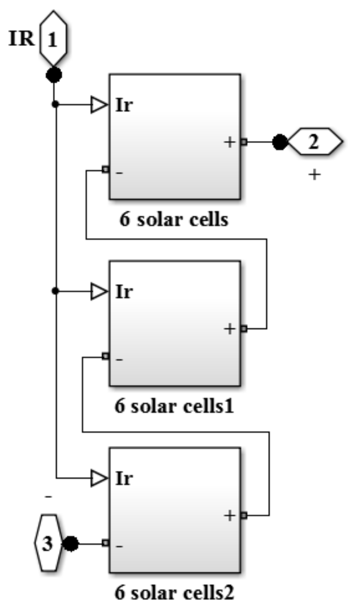

Fig. 2 Modelling of SPV System under shading effect

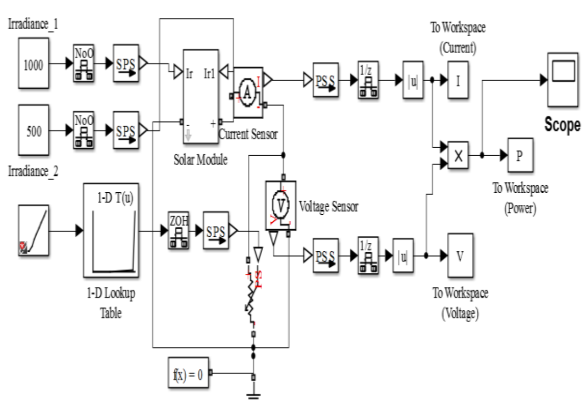

Fig. 3 Modelling of SPV System under shading effect

The net output voltage is the sum of the output voltage of these two solar module and the output current is same. Rate transition block handle transfer of data between ports operating at different rates. Configuration options allow you to trade off transfer delay and code efficiency for safety and determinism of data transfer. "PS Simulink Converter converts the unit less Simulink input signal to a physical Signal. The unit expression in 'Input signal unit' parameter is associated with the unitless Simulink input signal and determines the unit assigned to the Physical Signal"[22].

III. RESULT

Figure 4 and 5 show the V-I and P-V characteristic of solar cell. In fig 4, X-axis represent Voltage (V) Y-axis represents current (I). In fig 5, X-axis represent Voltage (V) and Y-axis represents Power (P).

Solar cell converts solar energy into electrical energy, so it depends on the intensity of light falling on it. Change in intensity of light changes the number of photons entering the cell that proportionally changes the current.

The intensity of light here is termed as Irradiance (I_r) and its unit is Watt/m^2 or Watt/cm^2. Higher the Irradiance, higher will be the output power from the cell. The final power output of the cell is nothing but the product of voltage and current output of the cell.

The performance of solar cell increases with high Irradiance but up to a limit because above that the temperature, the temperature of the cell increases undesirably. The voltage in each case reaches the optimal value but the current has decreased drastically thus the power output of the cell. Hence the solar cell acts as DC voltage source.

The performance observation of Solar PV module under shadowing as shown in Fig 3 is simulated in MATLAB simulink under the effect of different temperature. The resulting I-V and PV curves of the SPV system is shown in Fig.6 and Fig.7. Module temperature taken for simulation are 25ºC, 30ºC, 35ºC and 40ºC at solar irradiation of 500 and 1000 W/m^2 on shaded and unshaded module respectively.

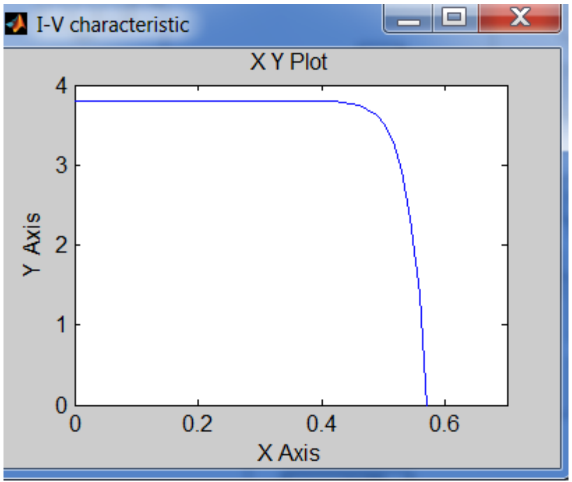

Fig.4: *I-V* Characteristics of PV cell

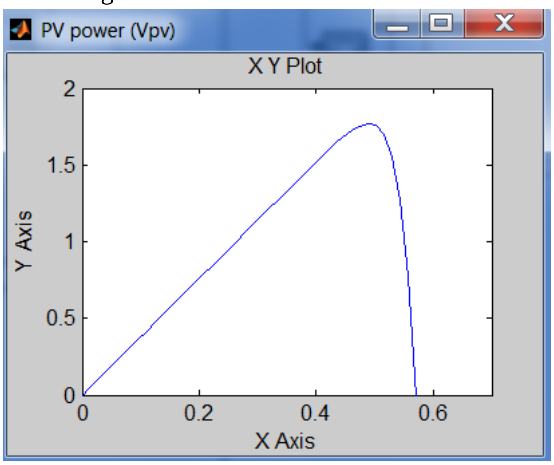

Fig. 5 : *P-V* Characteristics of PV cell

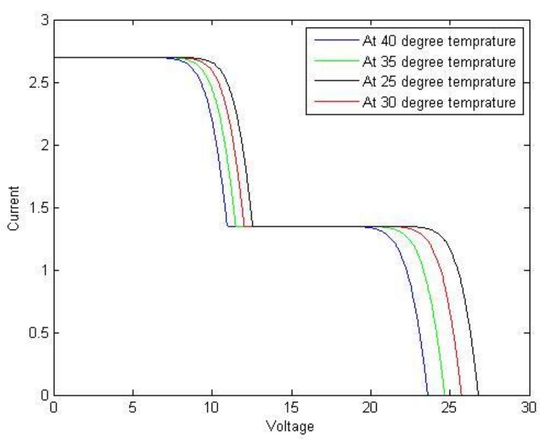

Fig.6 **:** *I-V* Characteristics of SPV System under shading with different temp.

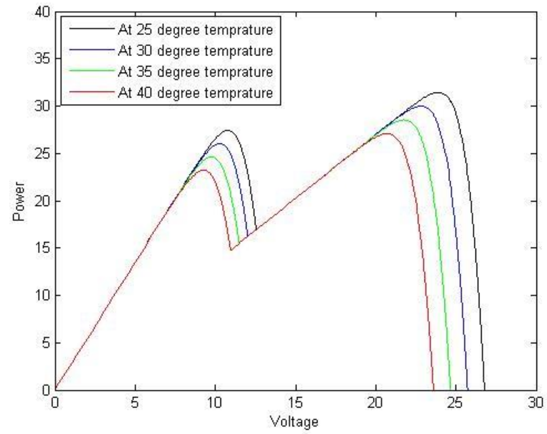

Fig. 7 : PV Characteristics of SPV System under shading with different temp.

IV. CONCLUSIONS

This model is more accurate when applied to analyze SPV module characteristics under partial shaded conditions. It can be interfaced with power electronics circuits to see the impact of shading and can be used to develop new methods to reduce the adverse effects of partial shading. Series connection of solar cells in an array is essential to get practically utilizable voltage. In series connection, the shaded cells may get reverse biased, acting as loads, draining power from fully illuminated cells. The impact of partial shading with temperature is studied and it is observed that performance of system is decrease with increase in module temperature..

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