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Developed Simulated Circuit of Photovoltaic Array under Partially Shading Conditions

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ABSTRACT:
Increasing price of fossil fuel and awareness of global warming have drawn attention towards the use of solar energy. The application of solar energy is the mainly focusing on photovoltaic system. The performance of photovoltaic system is affected by temperature, solar insolation, shading and array configuration. This paper is mainly focusing on partially shaded PV system. The PV system gets shadowed, completely or partially by the passing of clouds, trees, poles, towers and neighbouring buildings. Under partial shading conditions the P-V characteristics get more complex with multiple peaks. The mismatch losses and hotspot effects caused by partial shading cannot only affect the power of solar system, also can bring security and reliability problem. This paper presents MATLAB based simulated circuits, I-V and P-V characteristics under non uniform solar insolation due to partial shading. To study the effects of partial shading, the number of PV array connected in series with different solar irradiation.

KEYWORDS:
Renewable energy; Solar cell; PV Array; I-V; P-V characteristics; Partial shaded condition; Matlab/Simulink

I.INTRODUCTION

Due to limited reserve of fossil fuel along with their environmental impact has encouraged gradually growth and drift towards renewable energy resources [4]. Renewable energy sources is replenished on a human time scale such as sunlight, wind, rain, tide, waves etc. The main renewable energy is solar energy, which is taken by sun. The application of solar energy is PV System, Photovoltaic system is widely considered for generating the electricity. Photovoltaic system requires special design considerations for generating solar power due to varying nature resulting from unpredictable and sudden changes in the solar irradiation and operating temperature [5]. Photovoltaic energy is one of the most promising energy; it is inexhaustible, clean, and free to harvest [6]. The main draw backs of photovoltaic system are high installation cost and nonlinear characteristics due to weather changes.

A PV cell consists of P-N junction silicon diode, and a single PV cell generates a voltage around 0.5 to 0.8V. This voltage is very small and not much for commercial use. To increase the voltage, requires PV modules, which is made by number of PV cells connected in particular configuration. PV module is further connected in series or parallel configuration to form a PV array as per the system requirements [10].

II.PV ARRAY MODELING AND ASSUMPTIONS

The solar cell converts the solar energy into DC electrical energy by means of photovoltaic effect. Being exposed to the sunlight, photons with energy greater than the band gap energy of semiconductor creates some electron hole pairs proportional to the incident solar irradiation [8].

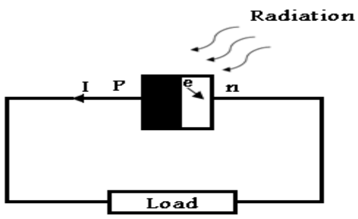

Figure:-1

When sunlight falls at the junction and it provides an electric current flow across the junction. The net current is determined by the difference of normal current and light generated current [9]. It is important to understand the components and the operation of a single photovoltaic cell, the operation of the under different condition and shading is easier to understand.

An ideal photovoltaic cell consists of a current source and diode. A non- ideal model of a PV cell has an additional shunt resistance connected in parallel to the diode and a series resistance. An equivalent circuit of photovoltaic cell is shown in figure 2.

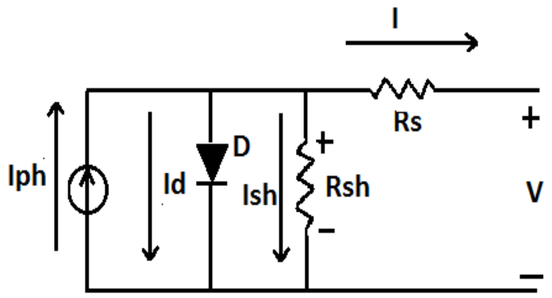

Figure 2 equivalent circuit of PV cell

The output current of PV cell is thus calculated by the following equations.

$$I = Iph - Id - Ish \dots\dots\dots\dots\dots\dots\dots \quad (1)$$

$$Iph = [Iscr + Ki(T - 298)] * \frac{\gamma}{1000} \dots .(2)$$

$$Irs = \frac{Isr}{\left[exp\left(\frac{qVoc}{NsKAT}\right) - 1\right]} \dots\dots\dots\dots\dots\dots\dots (3)$$

$$I0 = Irs\left[\frac{T}{Tr3}\right] expq * \frac{Eg}{Bk\left\{\frac{1}{Tr} - \frac{1}{T}\right\}} \dots\dots\dots (4)$$

$$Ipv = Np * Iph - Np * I0\left[exp\left\{q * \left(\frac{Vpv + IpvRs}{NsAkT}\right)\right\} - 1\right] \dots\dots\dots\dots\dots .. (5)$$

Where,
V_{pv} =Output voltage (V)
I_{pv} = Output Current (A)
T_r = Reference temperature=298 K
T = Operating temperature in K
I_{ph} = light generated current (A)
I_o = module saturation Current (A)
K = Boltzmann Constant
A= Ideality factor
Q=Electron Charge
K_i = temperature Coefficient
Eg= Band Gap
Ns= No. Of cell connected in series
Np=No. Of cell connected in parallel

III.A SIMULATED PV MODEL

As the output of PV module varies with the variation in solar insolation and operating temperature. We have considered these parameters in the development of PV simulated model. The model is developed in masked subsystem form with several stages in MATLAb/Simulink software.

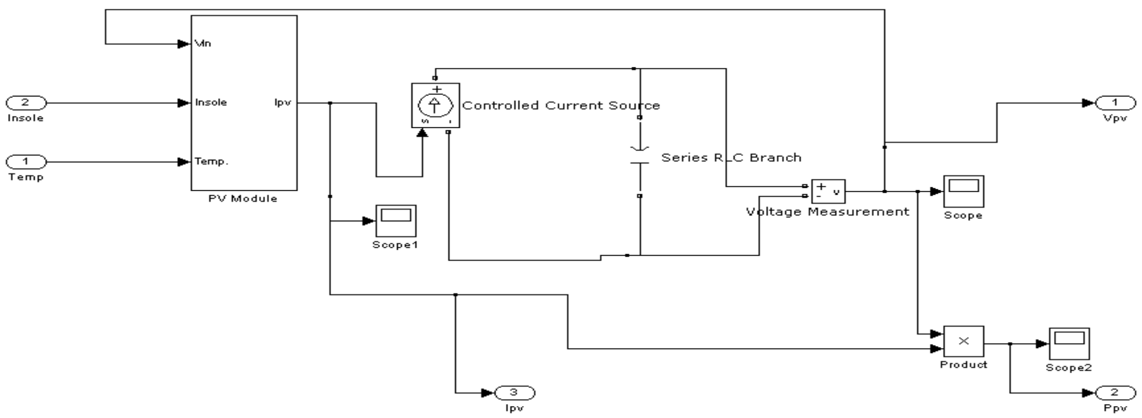

Figure:-3 Simulink Model of PV array

The output Characteristics of PV module is totally depending on Irradiance and Ambient Temperature. Shows the I-V and P-V characteristics of PV module at constant solar irradiation 1000W/m^2 and constant temperature at 25 degree.

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Irradiance is the power of electromagnetic radiation per unit area incident on the surface. Global irradiance is the sum of direct and the diffuse irradiances. The output of the PV Cell is directly proportional to the global irradiation. When the global irradiation increases, the output current of the cell is also increases, while the open circuit voltage of increases only slightly.

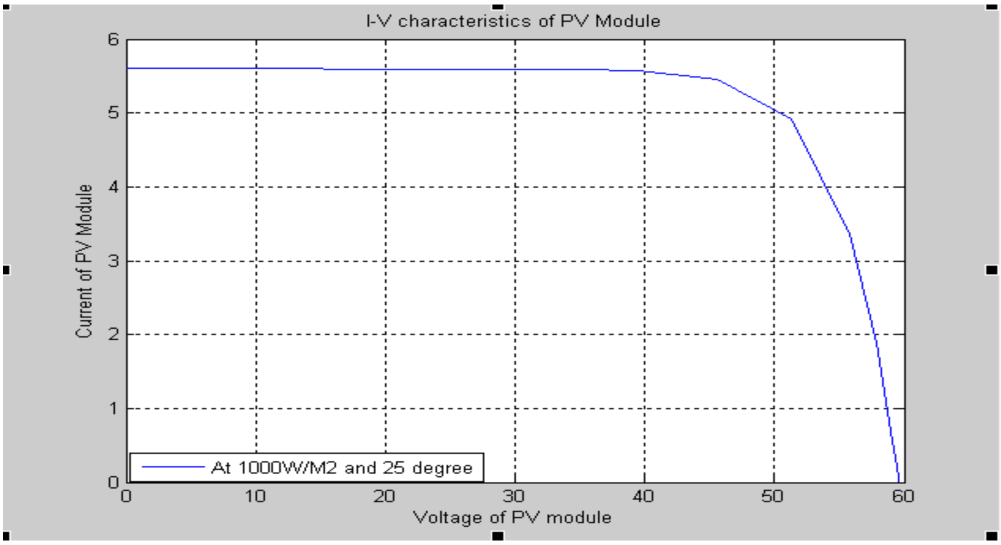

Figure:-4 I-V characteristics of PV Module

Ambient Temperature of the photovoltaic cell is the temperature surrounding the cell. When the ambient temperature is increased, the output of the cell slightly increases, while the open circuit voltage decreases. The efficiency of the output power of the cell decreases with increasing the ambient temperature.

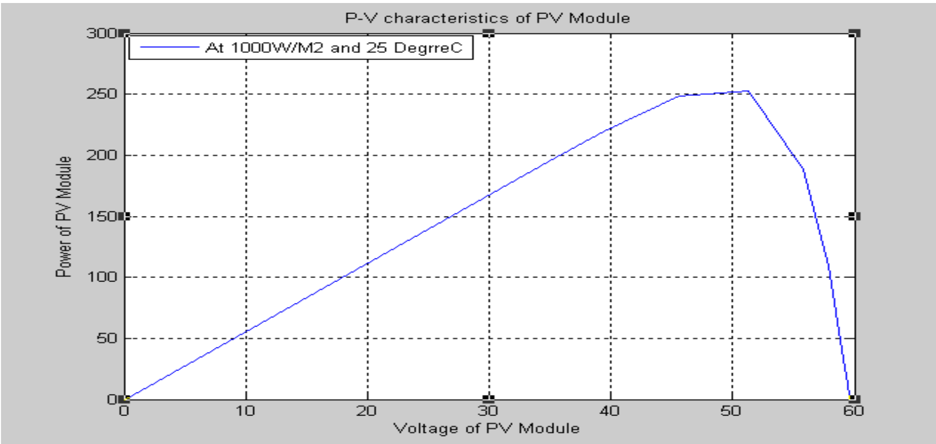

Figure:-5 P-V Characteristics of PV Module

IV.PV Array under Partial Shading Condition

The uniform illumination intensity in a panel is not obtained continuously due to clouds, trees, buildings, poles and daily sun angle changes; in this situation we can say the PV array work in partial shading condition [1]. Due to partial shading power loss occurs, current mismatch in series string and voltage mismatch between parallel strings. The Crystalline Silicon module will contain by pass diode to prevent damage from reverse bias on partially shaded cells. A shadow falling on a group of module will reduce the total output power by two mechanisms (a) by reducing input energy to the cell (b) by increasing energy losses in shaded cells [1].

To study of PV Array under partially shading conditions, the two PV modules connected in series with different insolation at Constant operating temperature. When PV modules connected in series, they will conduct at the same current but the voltage across them will be different [1]. These voltages are added together to determine the resultant output voltage. The two PV modules connected in series at different insolation is shown in figure6.

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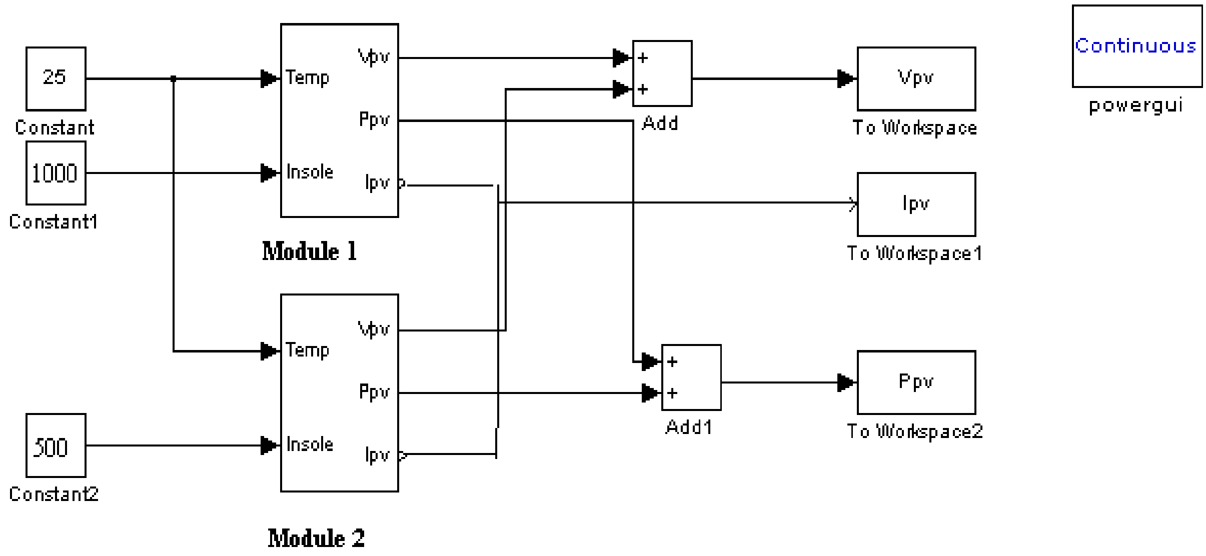

Figure:-6 Two modules connected in Series

V. RESULT AND DISCUSSION

In figure 7 we can see the I-V characteristics of PV Array under Partially Shaded condition. The First curve shown that the solar insolation of first module is 1000w/m^2 and second module is 500W/m^2.

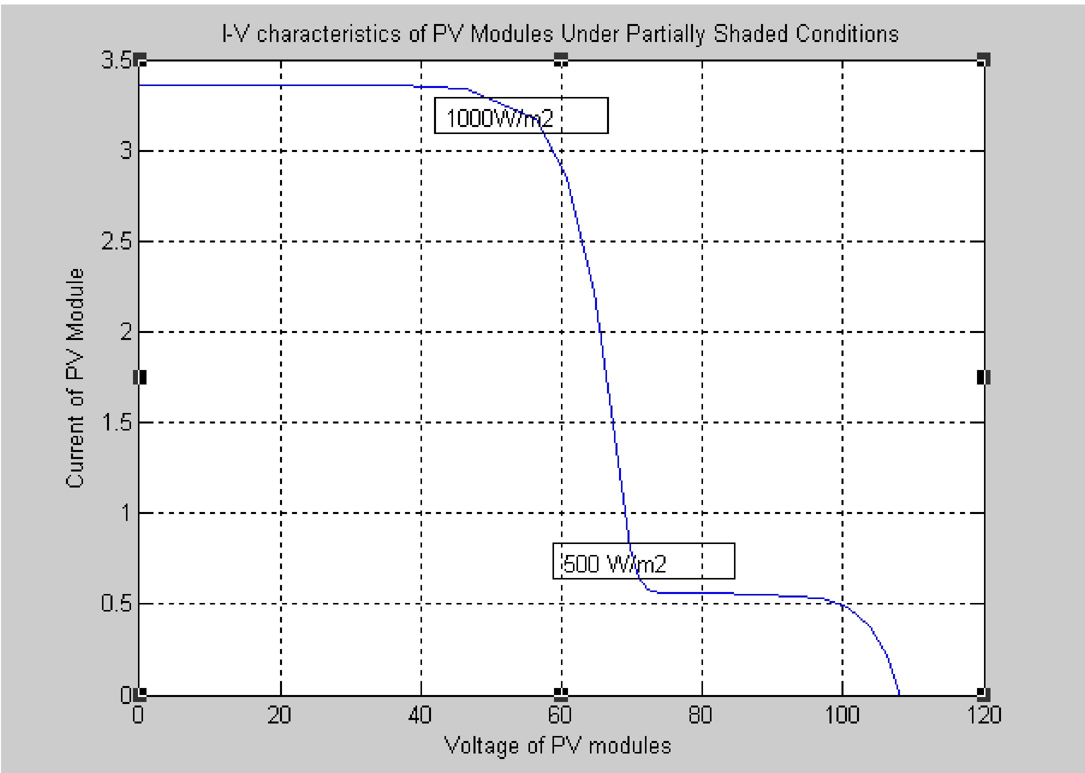

Figure 7 I-V characteristics under partially shaded conditions

In figure 8 we can see the P-V characteristics of PV Array under Partially Shaded condition. The First curve shown that the solar insolation of first module is 1000w/m^2 and second module is 500W/m^2.

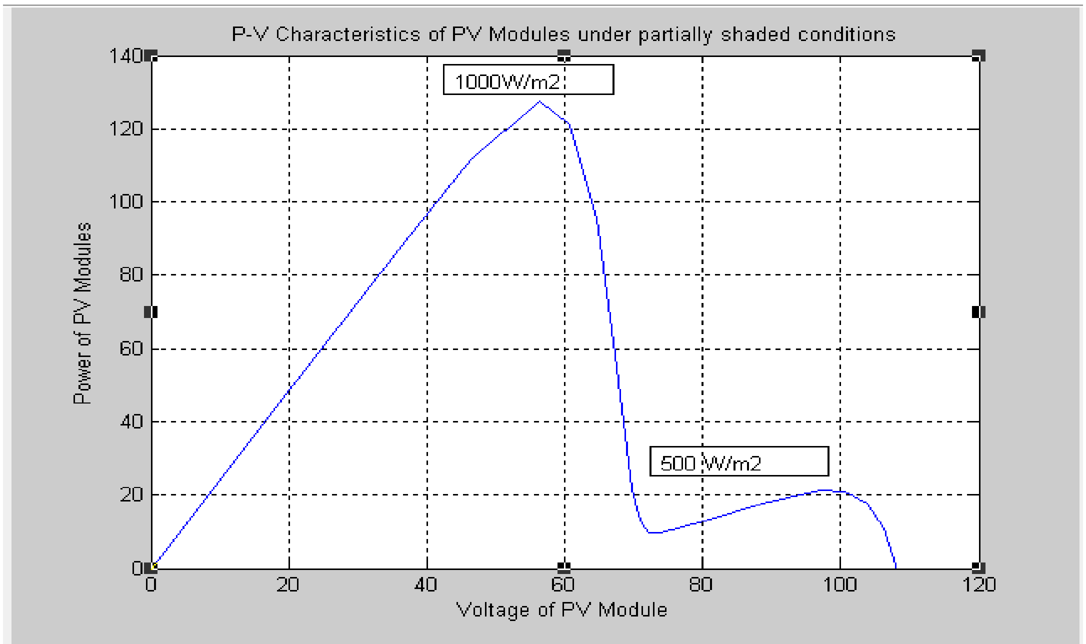

Figure 8 P-V characteristics under partially Shaded conditions

VI.CONCLUSION

Under partially shaded conditions the characteristics of PV modules become more complex and have multiple peaks. From the results, it is clear that the substantial power loss due to non uniform illumination of a series string. Matlab/simulink software has been developed the simulated circuit under variable climate and nature conditions, in particular under the effect of partial shading. To conclude that the increase partial shading in PV module, output power decreases.

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BIOGRAPHY

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