Study the Effect of Partial Shading in Solar Photovoltaic System

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ABSTRACT

Non Renewable energy sources are diminishing day by day. It is very essential to extract energy from renewable energy sources such as solar, wind, fuel cells etc. Among those renewable energy sources, solar energy system is predominating now days. Solar system ensures high-quality and trustworthy supply of renewable energy. Solar photovoltaic energy conversion has gained much attention nowadays. The performance of solar photovoltaic system mainly depends on the solar radiation falling on the panel surface. Shading across the panel surface is the main cause for the degradation of its performance. The partial shading phenomena reduce life as well as efficiency of solar panel. This paper is deal with the study of partial shading on PV panel. In this paper experiment of partial shading on PV panel will be carried out and also comparisons of the IV characteristics and Efficiency with shading & without shading of PV panel will be presented. Finally the various reasons of partial shading are discussed and remedial solutions to avoid partial shading are going to present.

Key words: PV Panel, partial shading, I-V characteristics.

I. INTRODUCTION

Now a day's electric power is required in a wide range of applications. The usage of electric power has become an integral part of human being and the generation of electric power depends on renewable and non-renewable energy sources. Renewable energy technology is getting much more attention in both academic and industrial sector. There are different kinds of renewable energy sources, such as wind, hydro, geothermal, biomass and solar Among these renewable sources in that Solar energy is the energy which comes directly from the sun in the form of light and heat that is converted in the useful form with the help of variety of technologies, such as solar heating, photovoltaic, solar thermal energy, etc.[1] In the application of Solar panel, nowadays the efficiency of solar panel is reducing due to natural shading caused by construction or trees, weather change, presence of clouds. The purpose of this paper is to illustrate the effects of partial shading on PV panel characteristics, this is done by conducting experiment on without shading, 25%, 50%, 75% and 100% shading.[2]

II. About Solar Cell:

Solar cell is a semiconductor device which directly converts sunlight into electricity by photovoltaic effect. Hence, they are also called photovoltaic cell. A typical commercial silicon solar cell is shown in figure.[3]

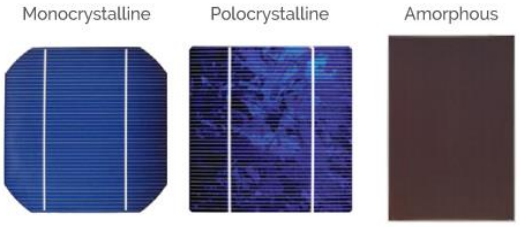

Fig.1: solar cell

III. Working of solar cell:

The sun light falling on the earth is basically the bundles of photons or bundles of small energy. Each photon in a bundle has a finite amount of energy in solar spectrum there are many photons of different energy. For generation of electricity, photons must be absorbed by semiconductor material. Free electron-hole pairs are generated. Electrons are considered as negative charge and hole are considered as positive charge. When solar cells connected to a load, electrons and holes near the junction are separated from each other. The holes are collected at positive terminal (anode) and electrons at negative terminal (cathode). Due to the difference between the electric potentials at the terminals we get terminals we get voltage at the terminals. [4] –[7]

IV. I-V characteristics of a solar cell:

The generality commonly used circuit model to characterize the electric action of a photovoltaic cell is the sole diode model as illustrated in Figure. [8]-[11]

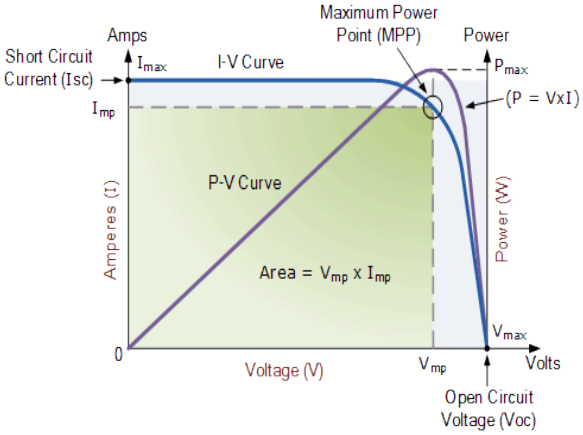

Fig.2: I-V Characteristics of solar cell

V. Partial shading effect on solar cells:

Solar panel work best when there is no shade cast upon them. In fact, a shadow cast on even just part of one solar panel in solar array can potentially compromise the output of the whole system. It is not always viable to have steady lighting of PV panel whole of the time in order of shadows caused by construction or arbor, weather change, presence of clouds and every day sun angle changing as illustrate in Figure. Power damage happens from shadow, as well current mismatch within a PV string and voltage mismatch among parallel. [12]-[14]

Fig.3: example for partial shading of solar panel

VI. Experimental Analysis:

A. Circuit Diagram

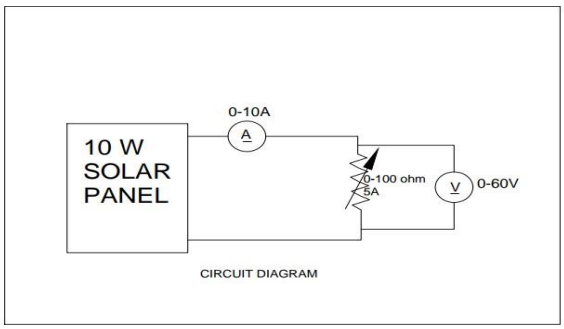

Fig.4: circuit Diagram

B. Procedure:

Connections are made as per circuit diagram. Keep the rheostat in minimum position. By varying the rheostat slowly note down the ammeter and voltmeter readings of without shading of PV panel. Now shading the PV panel by 25%, 50%, 75%, 100% and repeat the above procedure & note down the ammeter and voltmeter reading. Calculate the power by using formula P=V*I. Plot the I-V Characteristics.

C. Tabular column and its I-V Characteristics:

Table no.1: Without Shading

Without Shading			
SL NO	**Current in amps**	**Voltage in volts**	**Power= V*I in w**
01	0.44	**380mv**	**0.167**
02	**0.4**	**12.3**	**4.92**
03	**0.24**	**17**	**4.08**
04	**0.13**	**17.5**	**2.275**
05	**0.1**	**17.7**	**1.17**

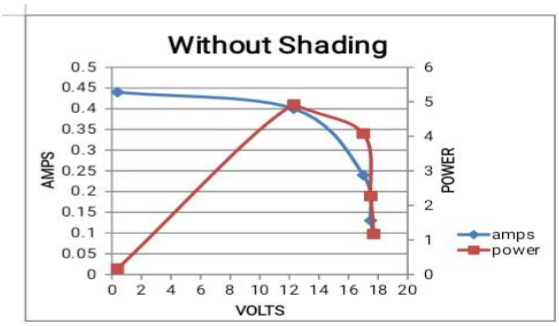

Fig.5: I-V characteristics of PV panel without shading condition. In this maximum power is 2.275W and the current is 0.13A as it is an expected value under without shading condition of 10W solar panel.

Table no.2: With 25% Shading

25% Shading			
SL NO	**Current in amps**	**Voltage in volts**	**Power= V*I in w**
01	0.17	**0.200**	**0.167**
02	**0.14**	**7.2**	**4.92**
03	**0.13**	**7.4**	**4.08**
04	**0.11**	**16.5**	**2.275**
05	**0.09**	**17**	**1.17**

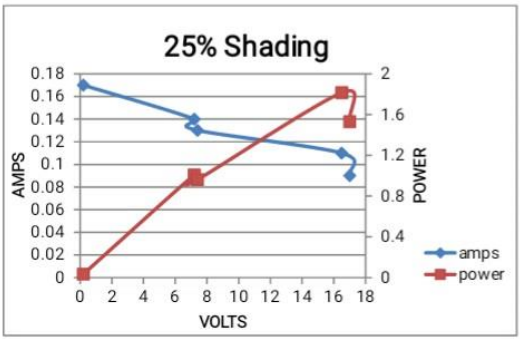

Fig.6: I-V characteristics of PV panel under 25% partial shading condition.in this the maximum power is 1.815W and the current is 0.11A compared to without shading the power is reduced as well as current.

Table no.3: With 50% Shading

50% Shading			
SL NO	**Current in amps**	**Voltage in volts**	**Power= V*I in w**
01	0.13	**0.182**	**0.023**
02	**0.11**	**5.1**	**0.561**
03	**0.1**	**10.3**	**1.03**
04	**0.09**	**14.6**	**1.314**
05	**0.08**	**15.6**	**1.248**

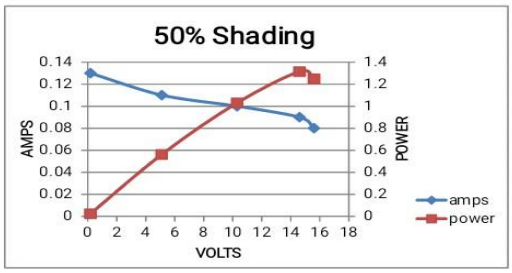

Fig.7: I-V characteristics of PV panel under 50% partial shading condition. In this the maximum power is 1.314W and the current is 0.09A it is almost 50% of maximum output power.

Table no.4: With 75% Shading

75% Shading			
SL NO	**Current in amps**	**Voltage in volts**	**Power= V*I in w**
01	0.08	**0.051**	**0.0040**
02	**0.08**	**5**	**0.4**
03	**0.07**	**7.2**	**0.504**
04	**0.06**	**10**	**0.6**
05	**0.05**	**13**	**0.65**

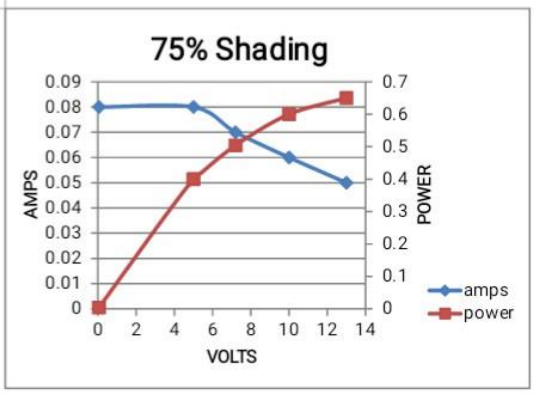

Fig.8: I-V characteristics of PV panel under 75% partial shading condition. the maximum power is 0.65W and the current is 0.05A again both the power and current is reduced.

Table no.5: With 100% Shading

100% Shading			
SL NO	**Current in amps**	**Voltage in volts**	**Power= V*I in w**
01	0.08	**0.085**	**0.0068**
02	**0.06**	**4**	**0.24**
03	**0.05**	**7**	**0.35**
04	**0.05**	**8**	**0.4**
05	**0.04**	**11.5**	**0.46**

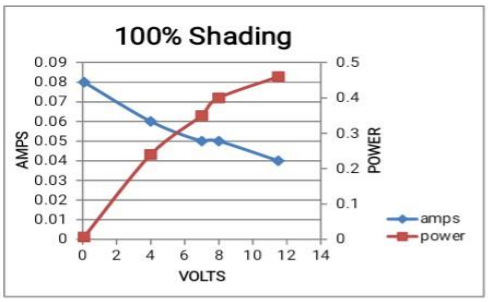

Fig.9: I-V characteristics of PV panel under 100% partial shading condition. the maximum power is 0.46W and the current is 0.04A by comparing this with without shading condition it is almost negligible amount of power is obtained from the solar panel.

VII. Result & Discussion:

In order to understand the effect of partial shading on PV panel, a comparison of current, voltage and power was made under without shading, 25% shading, 50% shading, 75% shading, 100% shading. All the results are shown in graphical forms. The above figure shows the comparative waveforms of current, voltage & power for different shadings. Under without shading condition we obtained maximum output power as seen from I-V characteristics, at under 25% shading maximum output power is low as compared to without shading condition, under 50% shading

maximum output power is half of without shading condition, and finally under 100% shading the maximum output power is negligibly low.

Conclusion:

In this paper, experimental based study is done for partial shading conditions on PV panel. Photovoltaic systems are highly susceptible to partial shading. The maximum power of a photovoltaic system can reduce drastically when partial shading takes place. The maximum power of a partially shaded photovoltaic system decreases at a constant rate as the shading heaviness increases. Without shading maximum power is obtained from PV panel, but under the shading of 25% to 100% the output power gradually decreases and the power under 100% shading is very less compare to without shading. It is seen by experimenting and comparing all the I-V characteristics of solar panel. To overcome this partial shading effect 1) Bypass Diode is connected across the PV array to minimize this effect. 2) Maximum power point tracking (MPPT) is installed. 3) the installer should be aware of tall buildings, trees etc., to ensure that it should not shade the PV panel.

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