An Analysis on Solar Panel under Fluctuating Circumstances of Shading

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Abstract- *Sun is a biggest star in which the energy is generated by the nuclear fusion process of hydrogen nuclei into helium. Sunlight is the electromagnetic radiation produced from the sun. About 8 to 9 minutes is taken for the sunlight to reach the earth surface. Sunlight can be continuously utilized as the energy source by the development of solar panel. In this research article, the investigation begins with the single solar panel individually and the combined performance of the solar panel was examined under the different shading conditions. The investigation on the solar panel provides the information of voltage and current in the effect of shading. The results showed that the voltage and current decreased gradually as the effect of shading increases.*

Keywords- Energy Source, Solar panel, Sunlight, Sun and Shading

I. INTRODUCTION

Sun is a burning star for more than 4 billion years and it is responsible for all the energy available on earth. The sun fills the earth atmosphere with a constant energy supply of 1.37 KW/m^2 [1]. The peak intensity of sunlight at the surface of the earth is about 1 KW/m^2[2]. Although the seasonal radiation variations caused by the tilt of the earth with respect to the sun. The winter sun will daily provide less than 20% of the summer sun's energy at some locations because it is lower in the sky and the days are shorter [7].

Solar energy is abundant and direct supply of sunlight can be converted to heat and electricity. The direct use of solar energy can be utilized broadly in three ways namely passive, active and photovoltaic. In this research article, the photovoltaic or the commonly known solar panel will be discussed. Photovoltaic technology is the modernized method to convert the solar energy into electricity [4]. Photovoltaic technology employs the PV cells or also called as solar cells. Solar cells or PV cells are made of silicon and other materials, which produces the electricity by the striking of sunlight on cells leads to the movement of electrons [3].

PV cell technologies are usually classified into three generations, depending on the basic material used and the level of commercial maturity [6]. First-generation PV systems (fully commercial) use the wafer-based crystalline silicon (c-Si) technology, either single crystalline (sc-Si) or multi-crystalline (mc-Si). Second-generation PV systems (early market deployment) are based on thin-film PV technologies and generally include three main families: Amorphous (a-Si) and micromorph silicon (a-Si/µc-Si) Cadmium-Telluride (CdTe) and Copper- Indium-Selenide (CIS) and Copper-Indium-Gallium-Diselenide (CIGS). Third-generation PV systems include technologies, such as concentrating PV (CPV) and organic PV cells that are still under demonstration or have not yet been widely commercialized, as well as novel concepts under development [5].

II. MATERIALS AND METHODOLOGY

A. Materials Required

The required materials for the experimental investigation are solar module, Halogen lamp and Multi-meter. The specifications of the PV panel were clearly mentioned in the Table 1. A halogen lamp, also known as a tungsten halogen is an incandescent lamp consisting of a tungsten filament sealed into a compact transparent envelope that is filled with a mixture of an inert gas and a small amount of a halogen.

Table 1. Specification of PV panel

Company	**Ecosense INSIGHT SOLAR**
Model No.	ELDORA 40P
Cell material	Polycrystalline silicon
Artificial Source of Radiation	Halogen - with regulator
V_{oc}	21.90V
I_{sc}	2.45A
Rated voltage	17.40V
Rated current	2.30 A
P_{max}	40W
Radiation used	1000 W/m^2
Cell temperature	25 °C

Fig. 1. Ecosence INSIGHT Solar systems.

Fig. 1. shows the Insight solar system which has two solar panels and the control module. The solar panels uses the halogen lamps for the radiation and the power generated from PV panels are connected to the controller, which controls and converts the power as needed.

B. Experimental Methodology

The experiment was conducted on the solar panel, in which the panel was made up of Polycrystalline silicon material. The dimensions of the solar panels were 660 × 460 mm of two insight solar panels, which uses halogen lamp as light source. The Multi-meter is connected to the solar module output for the result analysis.

Effect of solar panel in varying conditions of load and radiation

In order to measure the voltage and current of left and right PV panel, the solar panel were subjected to various conditions such as varying radiation and adding load. The voltage and current values of PV panels of left and right were measured with and without load besides the radiation of 48 W/m^2 and 200 W/m^2. The temperature of the PV panel was observed to be 29 ˚C.

The power was calculated from the observed values of current and voltage. The formula used to calculate power was

$P = I \times V$
Where,
P is Power in Watts
I is Current in Ampere and
V is Voltage in Volts.

Effect of shading on left and right solar panel

The shading experiment was carried out on the left and right PV panel individually and the corresponding voltage and current were measured. The temperature and radiation of the PV panel was kept at 29 ˚C and 120 W/m^2. The effect of the left panel was noted without and with load at varying shading conditions namely no shading, 25 %, 50 %, 75 % and 100 %shading. The effect of shading in the right PV panel was examined in the similar way as left PV panel. The power values were calculated corresponding to the measured voltage and current.

III. RESULTS AND DISCUSSION

A. Effect of solar panel in varying conditions of load and radiation

The current and voltage values of the investigated left and right solar panel were tabulated in table 2 and 3. The varying conditions of left and right PV panel gives the range of current and voltage values that the solar panel is capable. The effect of solar panel individually left and right panel were tested in order to get their initial power conditions. The maximum power, voltage and current conditions of solar panel was listed in the specification but the voltage and current at specific point was determined experimental in this area of research.

Table 2. Effect of left PV panel in varying conditions of load and radiation

PV panel conditions	Voltage (V)	Current (mA)	Power (mW)
Without radiation and without load	7.3	0.76	5.55
Without radiation and with load	7.3	0.75	5.48
With 48 W/m^2 radiation and with load	18.2	64	1164.8
With 200 W/m^2 radiation and with load	20.1	182	3658.2

Table 3. Effect of right PV panel in varying conditions of load and radiation

PV panel conditions	Voltage (V)	Current (mA)	Power (mW)
Without radiation and without load	6	0.61	3.66
Without radiation and with load	6	0.67	4.02
With 48 W/m^2 radiation and with load	17	32	544
With 200 W/m^2 radiation and with load	19.8	160	3168

B. Effect of shading on left and right solar panel

The left and right solar panel was examined on different shading percentage besides varying load and the respective current and voltage were tabulated in table 4 to 7. The power was calculated by multiplying the current and voltage. The open circuit voltage (V_{OC}) and short circuit current (I_{OC}) were tabulated in the table 4 and 6 where the left and right solar panel were tested without load conditions.

Table 4. Effect of shading on left PV panel without load conditions

Percentage shading (%)	Voltage (V)	Current (mA)	Power (mW)
No shading	19.6	175	3430
25	18.8	20	376
50	18	16	288
75	17.4	12	208.8
100	16	11	176

Table 5. Effect of shading on left PV panel with load conditions

Percentage shading (%)	Voltage (V)	Current (mA)	Power (mW)
No shading	19.6	177	3469.2
25	18.6	22	409.2
50	18.1	16	289.6
75	16.8	13.6	228.48
100	15	12	180

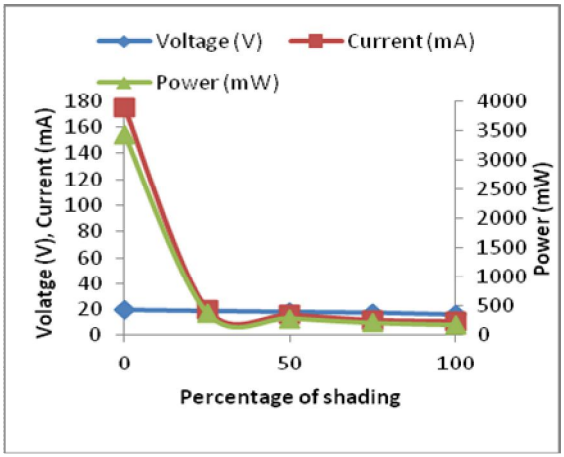

Fig.2. Effect of shading on left PV panel without load conditions

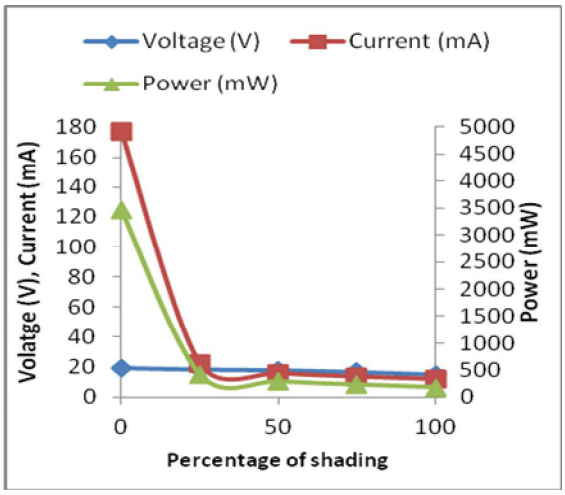

Fig.3. Effect of shading on left PV panel with load conditions

Fig. 2 and 3 gives the plot of percentage of shading on abscissa and other parameters are plotted in other axis. The graph of without and with load conditions of left PV panel is almost same due to the low load value condition applied in the closed circuit. If the high load is place in the closed circuit, there will be a noticeable variation in the voltage and current.

Table 6. Effect of shading on right PV panel without load conditions

Percentage shading (%)	Voltage (V)	Current (mA)	Power (mW)
No shading	19.15	160	3064
25	18	25	450
50	17.3	13	224.9
75	16	10	160
100	14	7	98

Table 7. Effect of shading on right PV panel with load conditions

Percentage shading (%)	Voltage (V)	Current (mA)	Power (mW)
No shading	19.1	159	3036.9
25	18	25	450
50	17	15.4	261.8
75	14.6	10.3	150.38
100	14.1	9	126.9

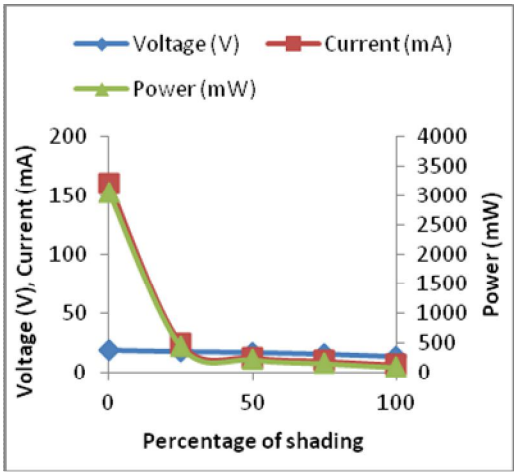

Fig. 4. Effect of shading on right PV panel without load conditions

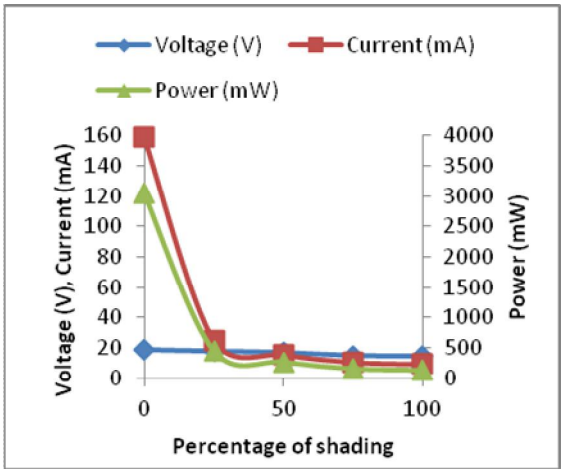

Fig. 5. Effect of shading on right PV panel with load conditions

Fig. 4 and 5 gives the plot of percentage of shading on abscissa and other parameters are plotted in other axis. The graph of without and with load conditions of right PV panel is almost same due to the low load value condition applied in the closed circuit. If the high load is place in the closed circuit, there will be a noticeable variation in the voltage and current.

When the Fig. from 2 to 5 compared the left and right panel performance were seemed to be the same even without and with load conditions.

IV. CONCLUSION

Currently the non-renewable energy resources are the major energy source of our country. Due to this scenario, there is a constant depletion of the non-renewable energy. In order to find the alternative form of energy, the renewable energy plays a vital role in satisfying the demand that arises in the future. The solar energy is one of the key renewable energy and there are many research advances in order to improve the outcome of solar panels.

The left and right solar panel was subjected to shading in the without and with load conditions. The performances of right and left solar panel were observed to be same even under the shading conditions.

The solar panel output is severely affected by shading. When the shading region increases, the panel output decreases. If the load is increased along with the shading region, the module output was found to be slightly decreasing compared to without load in the shading region.

The study on solar panel can be improved by connecting the solar panel in series and parallel connections. When PV panels are connected in series the voltage is more than in parallel, similarly when PV panels are connected in parallel the current is more than in series while increasing the radiation.

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