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Experimental Study of Shading Effect on PV Module and Improvement in Power Using Diode on Series & Parallel PV Module

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Abstract: ***In this paper the experimental study provides first one is, the effect of shading on PV module and second one is, to enhance the power of series and parallel connection of photovoltaic module under shading condition using diode and this diode can be worked as a bypass diode under the series connection of PV module and also worked as a blocking mode under the parallel connection of photovoltaic module. this experimental study evaluates the higher power of photovoltaic module under the shading condition of 1-solar cell, 2-solar cell, 4-solar cell , 9-solar cell and full cover of photovoltaic module cell and also evaluates the power of PV module under the partial shading condition Of 9-solar cell cover above the one feet from the photovoltaic module, these all module or cell shading can remove the power due to shading and these all shading effect can be removed by using diode and improve the power of solar photovoltaic module, result indicates that the power improves approximately between 20%- 30% of solar photovoltaic system under shading condition***

Keywords: Photovoltaic module, full experimental setup, partial or hard shading, series and parallel connection, solar flux meter.

1. Introduction

Recently mass production of electricity and generation of electricity is increasing by solar photovoltaic system due to first one is it does not produce any pollution like CO_2,CO,HC,NO2 etc and second one is it does not require fossil fuels. The most important of solar photovoltaic module and system, it is renewable energy [1].the solar photovoltaic cell or module is directly converted sun's radiation into electrical energy and the conversion process of solar photovoltaic cell or module depends upon photovoltaic effect. the efficiency of solar photovoltaic system depends upon its materials like mono crystalline, poly crystalline, amorphous solar cell materials and the efficiency of mono crystalline silicon solar cell laboratory about 24% and commercial mono crystalline silicon solar cell has the efficiency 15%, the efficiency of polycrystalline silicon solar cell has 12% and the efficiency of the amorphous solar cell has 5% [2]. In this work have two panel which are connected in series and parallel, series connection for the voltage and parallel connection for the current. Solar cell or module produce current that is depend upon solar radiations that fall on the solar photovoltaic cell or module's surface but in some case this radiation is blocked due to shading and reduce the power because blocking of solar radiations due to shading condition. In these days the leading design level of solar photovoltaic module, then in this cases it is really difficulties to avoid the hard shading and partial shading of the solar photovoltaic module due to trees, birds, clouds, neighbor house in all the season. The solar photovoltaic module it is complex to study about the effect of shading on solar PV module and .its testing is also costly, taking more time, and depends upon the weather condition. In this work the array made of two modules in this study.

Table 1: module specification

Material	poly crystalline silicon
Rated maximum power (Pmpp)	40W
Open circuit voltage (V_{oc})	21.90V
Short circuit current (I_{sc})	2.45A
Rated voltage (V_{mpp})	17.40V
Rated current (I_{mpp})	2.30A
Isolation/radiation	1000W/m^2
Module temperature	25◦ C
Air mass(AM)	1.5
Area (each)	0.2m^2

2. Experimental Apparatus

In this study, there are different types of equipment used in this experiment which are mentioned and defined in the below.

2.1 Photovoltaic Module

In this study there are two modules used, which are consist of poly crystalline silicon material. The specification of these modules shown in Table-1 and these two modules stand on the iron frame stand.

2.2 Power controller unit (PCU)

The power controller unit is used in this study and it has different measuring equipment, measuring equipments are ammeter, voltmeter, diode, battery, inverter, charge controller, pot meter, temperature measuring equipments and dc load etc. these all measuring equipments fabricating in this power controller unit for the measurement of current, voltage, thermometer, pot meter (0 to 200Ω) etc.

2.3 Shading sheets

The shading sheets are used in this experimental study and it is in different-different from for the different cell shading sheets like single cell shading sheets, double cell shading sheets, four cell shading sheets, nine cell shading sheets and full single module shading sheets and these shading sheets consist of Bakelite materials, which is called plastic shading sheets and it is very hard shading sheets, which blocks the all radiation, and these radiation comes from the sun in the form of diffuse radiation, beam radiation, global radiation.

3. Experimental Studies

In the study of experimental set up about shading effect of solar photovoltaic module or system and improvement of power performance of solar photovoltaic module using bypass diode and using blocking diode under the shading condition. The power of solar photovoltaic module and shading effect of solar photovoltaic system are evaluated by the measure of their P-V and I-V curve. For this experiment, we have used various equipment which are mentioned above in the experimental apparatus and we have done this experiment on the poly crystalline solar module and the incident solar power radiation approximately $1200\pm40W/m^2$.the variation of radiation due to non uniform over an area.

The experimental study about, shading effect and power performance on solar photovoltaic module and for this study or experiment, these photovoltaic modules are connected in series and parallel and showing different- different P-V and I-V curve.

First, we can see that the variation of shading effect in series connection of two photovoltaic module without using bypass diode for any module and for the shading we have used the plastic sheets of Bakelite materials for the shading and it is very hard plastic sheets and after shading 9-cell power goes to zero in series connection, these variation shown in the figure. Second, we can also see that the variation of P-V and I-V curve for the different-different shading conditions. For this variation of shading, we have used shading plastic cover for different-different cell of the PV module like 1-cell, 2-cell, 4-cell and 9-cell cover for the photovoltaic module and the variation of P-V and I-V curve due to shading effect on the solar photovoltaic module shown in the fig 2 and fig 3.

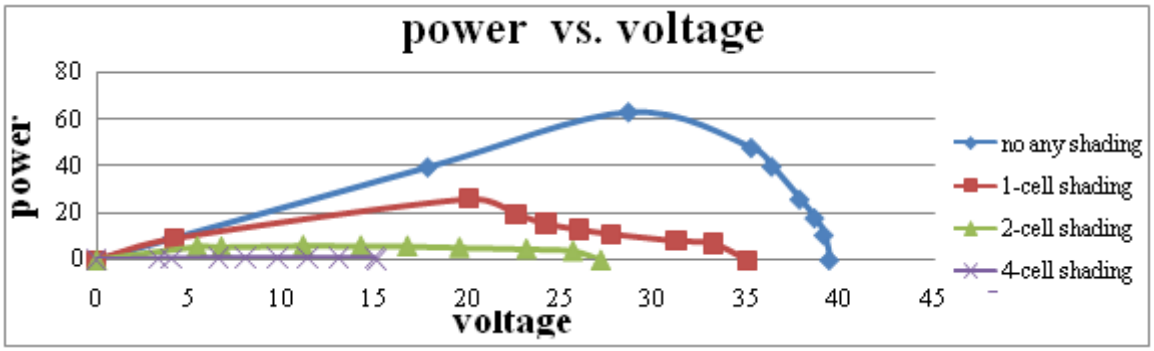

Figure 2: P-V curve of series connection module without using diode and shading effect for different condition.

Fig.3 I-V curve of series connection of module without using diode and shading effect for different condition

After the shading effect we can improve the power performance of solar photovoltaic module or system in the series connection using bypass diode where shading plastic sheets or shade is presenting and we have also done this experiment under shading condition. The series connection of module under shading condition we have used bypass diode for the improvement of power performance, which is shown in the P-V and I-V curve in fig 4 and fig 5.

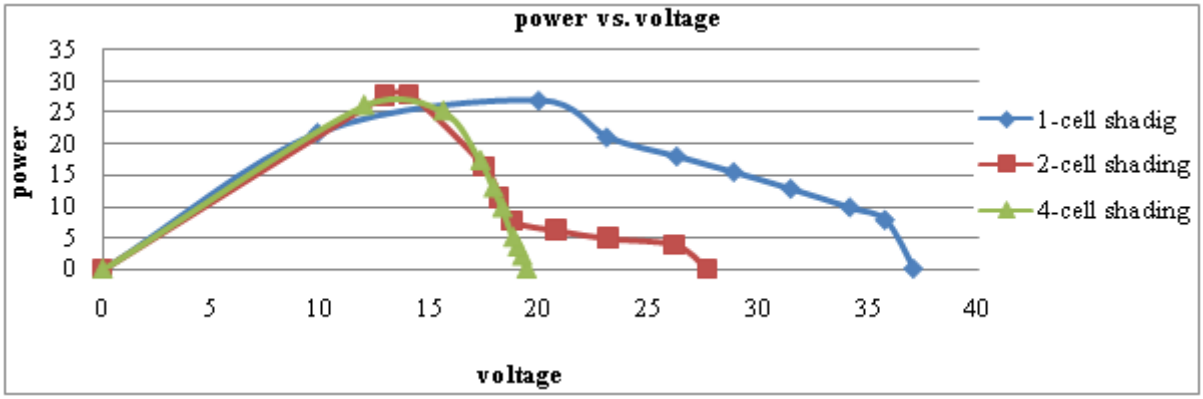

Figure 4: P-V curve of series connection of module with using bypass diode under shading condition

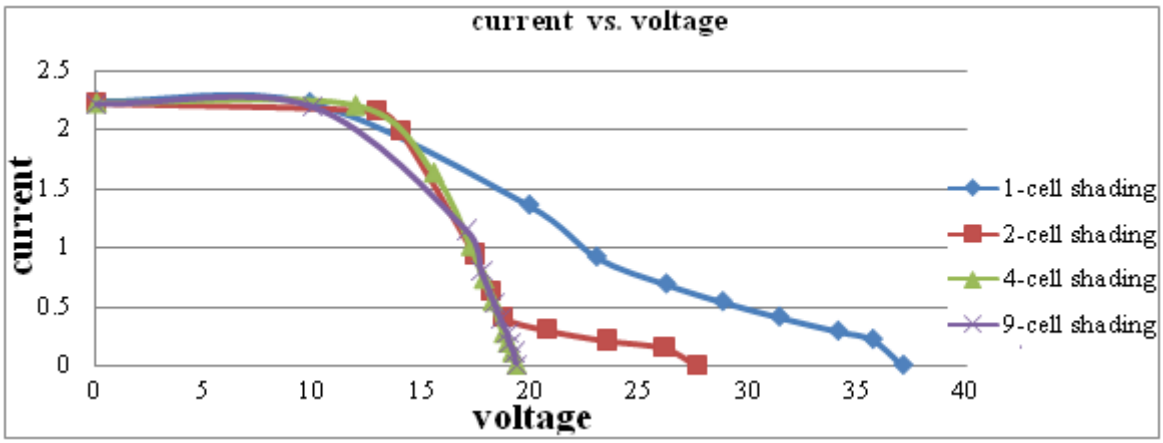

Figure 5: I-V curve of series connection of module with using bypass diode under shading condition

We have seen that the under the 9-cell shading in series connection of both module without using diode the power was zero but with using diode under the 9-cell shading condition the power was not zero because one module continually produce power, which has not any shaded condition. Second, the parallel connection of PV module mainly improve the current but under the shading condition the current may be circulate and it may be damaged made hot spot on the cell and module, it may be damaged the cell or module. Under the shading condition of parallel connection we have used different-different plastic sheets for the 1-cell, 2-cell, and 9-cell for the shading. In the parallel connection, the power does not goes to zero because if we will shade the first panel from plastic sheets then second panel will continuously produce current because it has no any shading but current may be circulated from second panel to first panel due current variation high to low but power does not goes to zero. The P-V and I-V curve of parallel connection of PV module shown in fig 6 and fig 7.

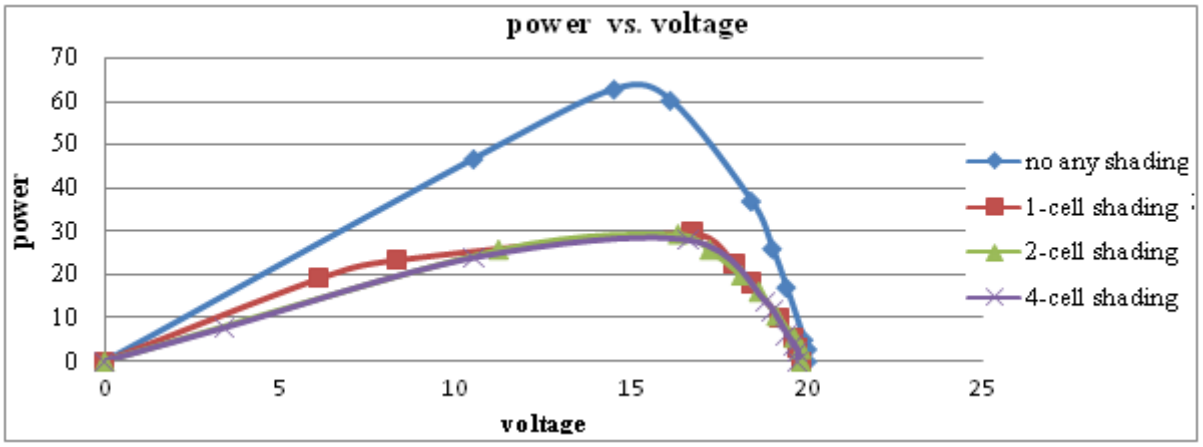

Figure 6: P-V curve of parallel connection of PV module

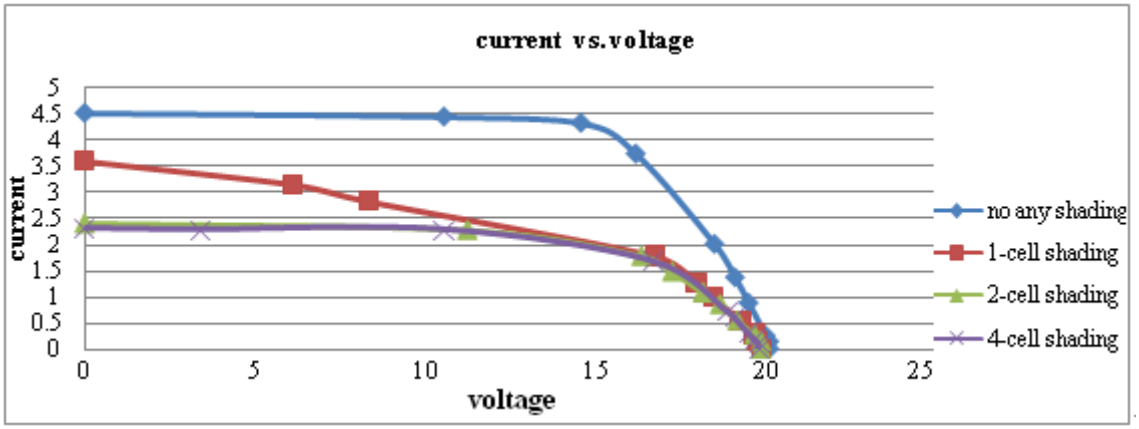

Figure 7: I-V curve of parallel connection of PV module

We have seen that in the parallel connection power does not zero under the 9-cell shading condition because when we shade 9-cell of one panel then other continua sally produce power but it has some draw back because current may be circulated due to variation of current from second panel to first panel due to shading effect and it may be damaged the panels and cells. These variations of current from second

panel to first panel can be reduced by using blocking diode to each panel.

Now, under the series connection of the module we can also see that the P-V and I-V curve but in this connection the shading effect we have taken shading sheets above the one foot from panels and under the 9-cell shading the power is not zero due to diffuse radiations and these diffuse radiations to help for power improvement under the shading condition above the one foot from panel in series connection and this shading we can say that soft shading. The P-V and I-V curve of series connection under the shading 9-cell, above one foot from the panel shown in the fig 8 and 9

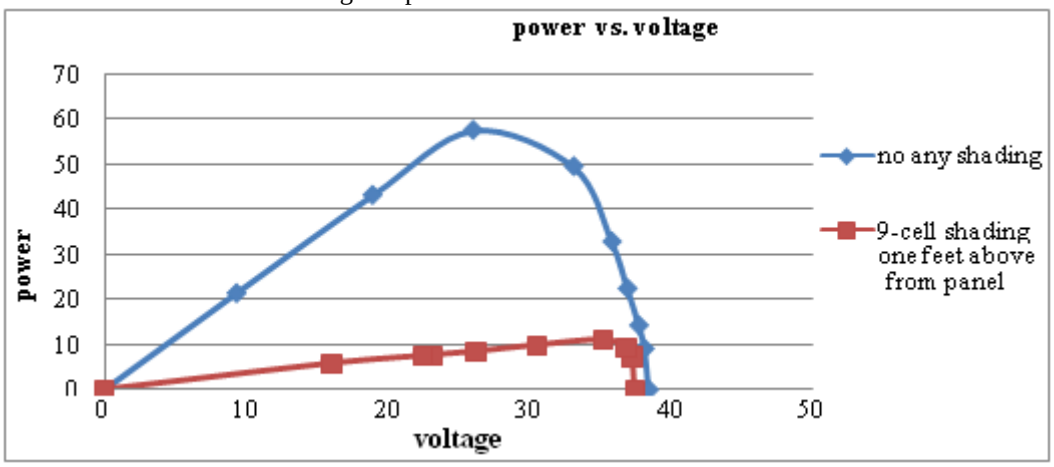

Figure 8: P-V curve of series connection under shading from one foot above form panel

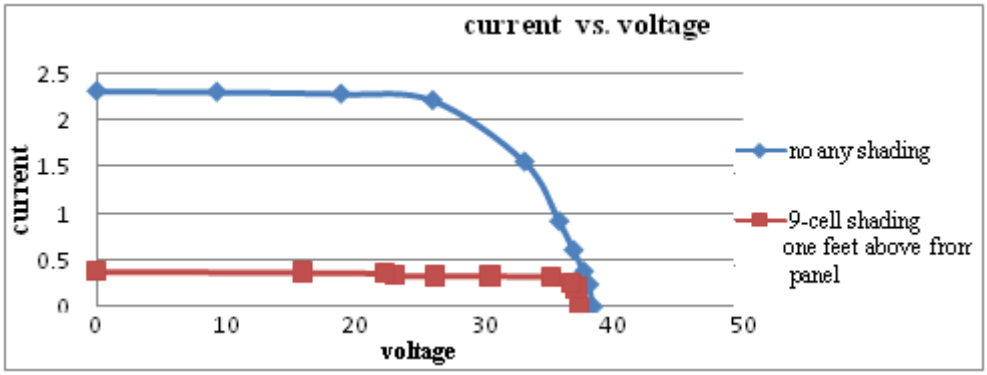

Figure 9: I-V curve of series connection under shading from one foot from panel

4. Result

We have done this experiment and found the effect of shading on PV panel, first we have seen that without shading of PV panel given power 78.29% and shade can remove power and it depends upon the different cell shading like 1-cell, 2-cell, 4-cell shading can be reduced power 45.29%, 70.659%, 76.39 % and 9-cell shading reduce power 77.96% all most equal 100% in series connection and when we have used bypass diode then it can improve in power under cell shading like 1-cell, 2-cell, and 4-cell 44.46%, 43.465%, 45.565% in series connection and in parallel connection without shading of PV panel given power 78.10% but under shading 1-cell, 2-cell and 4-cell can be reduced power 40.95%, 41.63, 43.1% and when we have used blocking diode then it block the circulating current in the parallel connection. We have also done this experiment under partial 9-cell shading condition one foot above from the panel and it reduces power 64.02% compared to hard shading due to diffuse radiation in series connection. So, it is found that the parallel connection is the best for power under shading condition then series connection except from circulating current.

5. Conclusion

This experimental study presented the effect of shading of P-V and I-V curve on solar PV module and also clarified the fundamental mechanism of reduction in output power under shading condition in series and parallel connection. It is cleared that the reduction of power depends upon shaded area or cell of solar PV panel and this investigation was illustrated by experimental data. In this paper, series connection and parallel connection power is compared to under the different hard shading condition and partial shading condition and also presented the improvement in power under shading condition using bypass diode in series connection and blocking diode for circulating current in parallel connection. It is helped that this paper will be used to solar PV system, to minimize the power losses and effect of shading on solar PV system for the new students and for the researchers.

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