Performance Analysis of Partial Shading on Solar Photovoltaic System under Aluminium Reflectors

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ABSTRACT- The Solar Photovoltaic (PV) energy generation is rapidly increasing power in renewable energy systems and it is clean and cheap power. Photovoltaic (PV) system faces many problems in producing maximum power. One of the reasons was partial shading on the solar panels. The shading on the solar panels mainly occurs due to clouds, tall buildings, dust, trees...etc. This effect can vary the result current (Imp), maximum power (Pmax) and solar irradiation (W/m$^{2)}$ parameters should be reduced in Photovoltaic (PV) system .So in this research by providing aluminum reflectors on solar array system to observing shading effecting parameters performance. I.e, Current (Imp) 21.84%, Maximum power (Pmax) 22.34% and solar irradiation (W/m^2) 5.29% are increasing and overall solar array system performance has been increased under shading conditions using aluminum reflectors.

Keywords— Solar Irradiation, Reflectors, Partial Shading, Solar Panels

I. INTRODUCTION

Conventional methods of generating energy require a fuel to be consumed, and once it's gone you can never get it back unless you are prepared to expend more energy than the fuel contains, which kind of defeats the purpose Renewable energy is mostly based on the one energy source, the sun. solar photovoltaic system is one of major production in renewable energy generations and has many advantages like pollution free ,sustainable…etc,Therefore their installed capacity is increasing every year [1], But solar panels face different type of problems like Climatic stress(Solar irradiation, Dust, shading ,Temperature changes), Materials failures…etc. Shading effect is the one of cause to produce hot spots in the solar panels and reducing efficiency [2].

In this paper discussion about partial shading of solar photovoltaic system under solar reflectors is done. The previous various researches are done in solar photovoltaic panels under partial shading conditions [3-13],their main observations are , shading has more effect on current of PV than generated voltage and photovoltaic systems with small modules sizes (dimensions) are less affected by shading than the systems with larger modules sizes[14]and effected on maximum power available on photovoltaic panels [15] . Due to these reasons efficiency of photovoltaic panels decreases. This paper aims at developing more power using reflectors to harvest more of the incident solar irradiance and direct sunlight to PV modules, increases the electricity produced from a given area of PV panels and we intend to PV modules, increases the electricity produced from a given area of PV panels and we intend to. Observe power output variations under partial shading conditions with different irradiance and temperature values.

II. METHODOLOGY AND EXPERIMENTAL SETUP

In this experiment conducted date was 24-11-2019 and Fig 14- 13, 12-11, 10-9, 8-7, 6-5, 4-3, 2-1 conducted respectively order on time of 9 to 2 pm.

II- A SOLAR PANELS

The experimental setup of solar array system partial shading analysis with reflectors as shown in figure-A. Polycrystalline Solar panels and reflectors are placed on designed iron stand and reflectors designed dimensions are equal to exactly solar panel dimensions.

Fig A. Experimental Setup of Partial Shading Solar Array with reflectors

The solar PV array system consists of a 2*50=100Wp solar panels and its parameters details are shown in Table.

Table. I. Solar Panel Parameters

Parameters Name	Parameters Value
Open Circuit Voltage (Voc)	21 Volts
Short Circuit Current (Isc)	3.15 Amperes
Ideal Factor	1.5
Temperature	25□C
Irradiance	1000 W/M^2

The single solar panel consists of 36 cells (9*4),4 strings and each 2 strings have a one bypass diode connected .In this research solar PV panel strings are connected in series because of more number of parallel connected strings are not much affected by shading conditions according to previous research [16] and various papers are showed work [9-16],so

This research strings are connected in series taken.

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II-B REFLECTORS

Solar reflectors concentrates the light that will be exposed to the solar panel and which would increases the power output [17-18] by providing reflectors on solar panel in previous research aluminium foil reflector increase power output around 31.5 % of polycrystalline solar panel [19] .Reflector data shown below table for arrangement of experimental setup

TABLE 2. REFLECTOR DETAILS

Reflector	Quantity	Dimensions(Length*Width)
Aluminum foil	2	530mm*660mm

III-C SHADING PATTERNS

In this experimental setup used 7 random shading patterns for analyzing various parameters on with and without reflectors. For identification each shading pattern are drawn 2 times i.e. without (right side) and with (left side) reflectors in each shading patterns.

Fig.1, fig.2 represents the shading pattern-1 with 12 cells shaded and 60 cells un shaded solar array without and with reflectors respectively. Fig.3, fig.4 represents the shading pattern-2 with 16 cells shaded and 56 cells un shaded solar array without and with reflectors respectively. Fig.5, Fig.6. Represents the shading pattern-3 with 11 cells shaded and 61cells un shaded solar array without and with reflectors solar array respectively. Fig.7, fig. 8 represents the shading pattern-4 with 24 cells shaded and 48 cells un shaded solar array without and with reflectors respectively. Fig.9, fig.10 represents the shading pattern-5 with 32 cells shaded and 40 cells un shaded solar array without and with reflectors respectively. Fig.11, Fig.12 Represents the shading pattern-6 with 56 cells shaded and 16 cells un shaded solar array without and with reflectors respectively. Fig.13, Fig.14 represents the shading pattern-7 with 54 cells shaded and 18 cells un shaded solar array without and with reflectors respectively.

3. RESULTS AND DISCUSSION

By conducting experimental with different shading patterns voltage, current, solar irradiation, power output observed with as shown in Table 3.0, Table4.0.

Fig. 16 shows the output current variations for the all 7 shading patterns. Under fig 16 results graphs, Fig 1-2 is 16.66% shading and Imp has 3.30% improved from with reflector compared to without reflector. ,fig 3-4 is22.2% shading and Imp has 4.21% improved from with reflector compared to without reflector, Fig 5-6 is 15.22% shading and Imp has 12.42% improved from with reflector compared to without reflector, Fig 7-8 is 33.33% shading and has Imp 5.38% improved from with reflector compared to without reflector, Fig 9-10 is 44.44% shading and has Imp 21.84% improved from with reflector compared to without reflector , Fig 11-12 is 77.77% shading and Imp has 5.47% improved from with reflector compared to without reflector , Fig 13-14 is 75% shading and Imp has 19.51% improved from with reflector to without reflector. In the above observations lowest percentage increasing of current (Imp) is 3.30% and highest increasing is 21.84 % .This shows the current values are increased very and under full shading conditions the maximum amount current is increased.

Fig. 17 shows the maximum power (Pmax) variations for the all 7 shading patterns. Under fig 17 results graphs ,Fig 1-2 is maximum power (Pmax) has 4.12% improved from with reflector compared to without reflector., fig 3-4 is maximum power (Pmax) has 5.68% improved from with reflector to without reflector , Fig 5-6 is maximum power (Pmax) has 7.45% improved from with reflector compared to without reflector , Fig 7-8 is maximum power (Pmax) has 7.72% improved from with reflector compared to without reflector , Fig 9-10 is maximum power (Pmax) has 22.34% improved from with reflector compared to without reflector , Fig 11-12 is maximum power (Pmax) has 7.09% improved from withreflector compared to without reflector , Fig 13-14 is maximum power (Pmax) has 3.14% improved from with reflector to without reflector.

Fig. 18 shows the output voltage variations for the all 7 shading patterns . Under fig 18 results graphs ,Fig 1-2 is voltage (Vmp) has 0.44% improved from with reflector compared to without reflector. ,fig 3-4 is voltage (Vmp) has 0.62% improved from with reflector compared to without reflector , Fig 5-6 is voltage (Vmp) has 1.41% improved from with reflector compared to without reflector , Fig 7-8 is voltage (Vmp) has 0.782% improved from with reflector compared to without reflector , Fig 9-10 voltage (Vmp) has 0.917% improved from with reflector compared to without reflector , Fig 11-12 is voltage (Vmp) has 1.61% improved from with reflector to without reflector , Fig 13-14 is voltage (Vmp) has 2.43 % improved from with reflector compared to without reflector. Its observed that the variation of output voltage (Vmp) increased below 2.5% i.e. shading effected on output voltage variations are very less or negligible.

Fig 19-20 shows the solar irradiation for all 7 shading patterns without and with reflectors. In this section can analyses 2 ways i.e. un shaded cells and shaded cells. Un shaded cells solar irradiation increasing without to with reflectors fig1-2 ,3-4 ,5-6 ,7-8 ,9-10 ,11-12 ,13-14 are 6.54% ,7.4% ,6.3% ,5.19% ,3.80% ,3.11% ,1.86% respectively. Shaded cells solar irradiation has increasing without to with reflectors fig1-2 ,3-4 ,5-6 ,7-8 ,9-10 ,11-12 ,13-14 are 2.03% ,5.26% ,1.58% ,3.68% ,5.29% ,4.21% ,2.38% respectively .Its observed that lower percentage of shading has higher solar irradiation and collecting possible .Un shaded cells observing 5.29% highest on pattern -5 and lowest 1.586%on pattern -3.

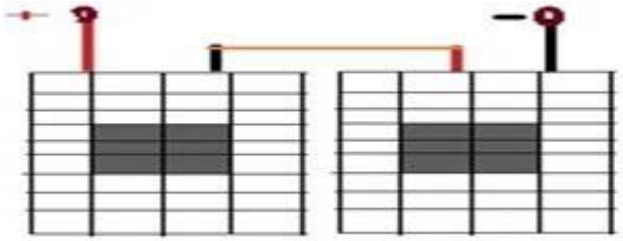

Fig 1

Fig.1. solar array 12 cells shaded, 60 cells un shaded without reflector

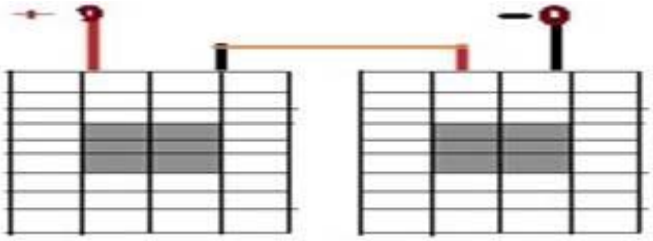

Fig 2

Fig.2 solar array 12 cells shaded, 60 cells un shaded with reflector.

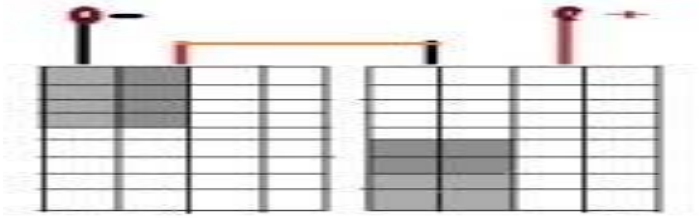

Fig 3

Fig.3. Solar array 16cells shaded, 56 cells un shaded without reflector with reflector

shading pattern-2

Fig 4

Fig .4. solar array 16 cells shaded, 56cells un shaded

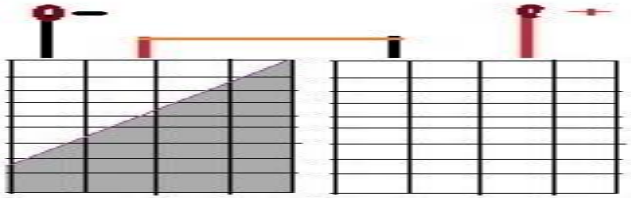

Fig 5

Fig.5.Solar array 11 cells shaded, 61 cells un shaded without reflector

Shading Pattern-3

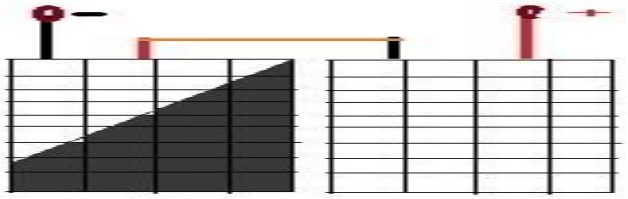

Fig 6

Fig.6. Solar array 11cells shaded, 61 cells un shaded with reflector

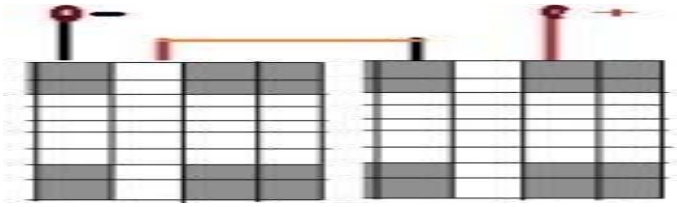

Fig 7

Fig.7 .Solar array 24 cells shaded, 48cells un shaded without reflector

Shading Pattern-4

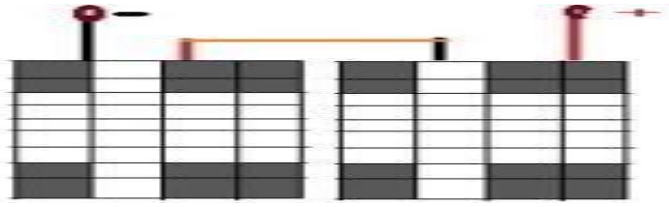

Fig 8

Fig.8. Solar array 24 cells shaded, 48 cells un shaded with reflector

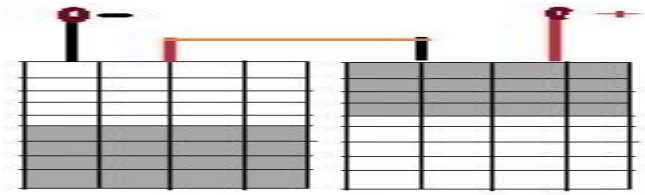

Fig.9

Fig. 9. Solar array 32cells shaded, 40cells un shaded without reflector

Shading Pattern-5

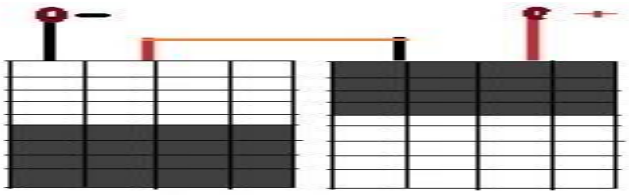

Fig.10

Fig.10. Solar array 32 cells shaded, 40 cells un shaded with reflector

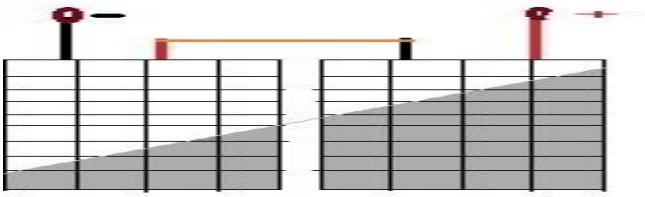

Fig.11 Shading Pattern-6

Fig.11.Solar array 56 cells shaded 16cells un shaded without reflector

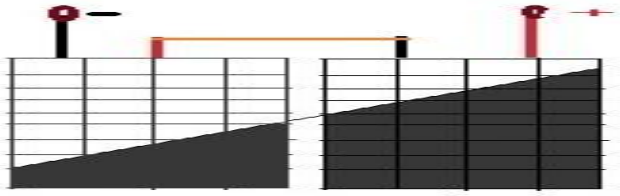

Fig.12

Fig.12. Solar array 56 cells shaded, 16 cells un shaded with reflector.

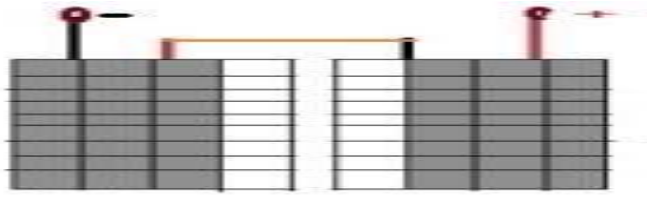

Fig.13 Shading Pattern-7

Fig.13. Solar array 54 cells shaded, 18 cells un shaded without reflector,

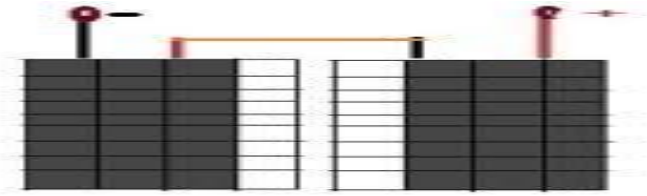

Fig.14

Fig.14. Solar array 54 cells shaded, 18 cells un shaded with reflector

Table 3.0 experimental performance parameters for 7 shading patterns without reflector

S.No	Solar Irradiance ($W/M^{2)}$		Voc (V)	Isc (A)	Vmp (V)	Imp (A)	Pmax (W)
	Un shaded cells	Shaded cells					
1	856	786	40.56	2.31	40.12	2.12	85.05
2	796	722	40.21	2.12	39.1	1.90	74.29
3	746	694	40.36	1.96	40.25	1.73	69.63
4	693	652	38.33	1.76	37.13	1.3	48.269
5	657	623	39.25	0.92	39.16	0.76	29.76
6	610	570	39.13	0.86	36.13	0.73	26.37
7	590	546	38.16	0.53	31.13	0.41	12.76

Table 4.0 experimental performance parameters for 7 shading patterns with reflector

S.No	Solar Irradiance ($W/M^{2)}$		Voc (V)	Isc (A)	Vmp (V)	Imp (A)	Pmax (W)
	Un shaded cells	Shaded cells					
1	912	802	40.74	2.39	40.41	2.19	88.56
2	855	760	40.46	2.21	39.4	1.98	78.51
3	793	705	40.936	1.96	40.31	1.945	78.42
4	729	676	38.63	1.81	37.92	1.37	52
5	682	656	39.61	0.931	39.33	0.926	36.41
6	629	594	39.76	0.87	36.33	0.77	28.247
7	601	559	37.23	0.538	31.46	0.418	13.175

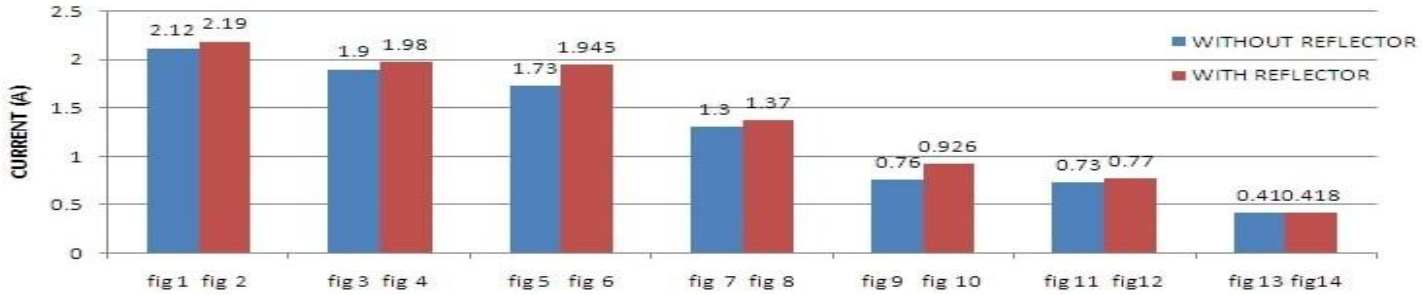

Fig.16. maximum current peak (Imp) with and without reflector

Fig. 17. Maximum power (w) with and without reflector

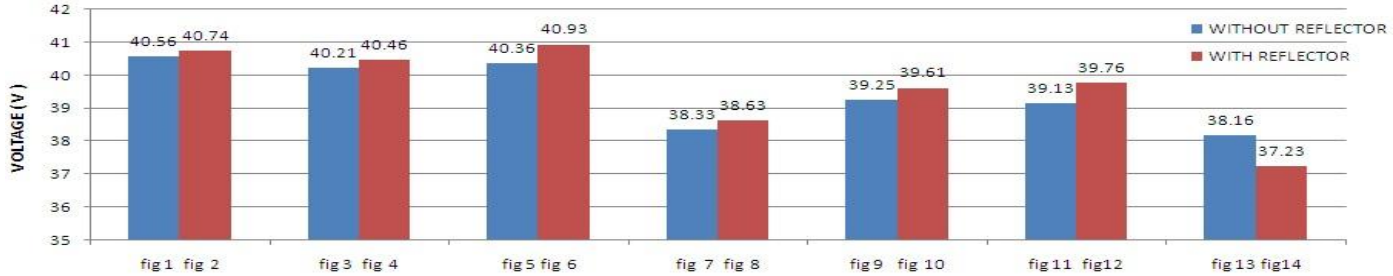

Fig.18. Maximum peak voltage (Vmp) with and without reflector

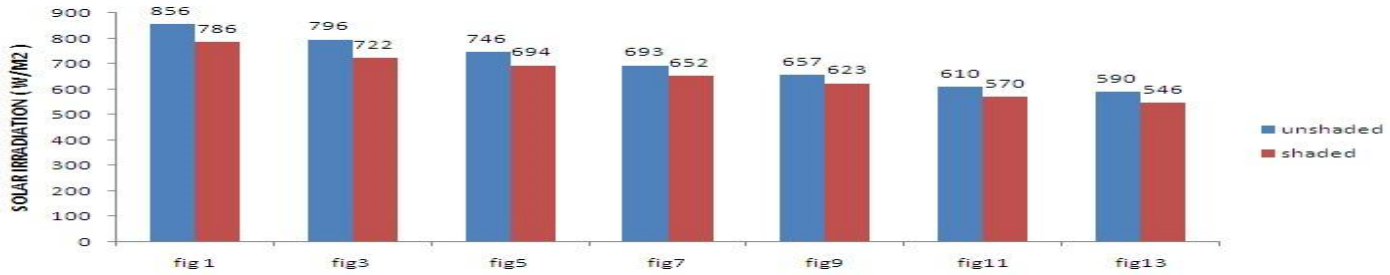

Fig.19. solar irradiation (W/m^2) without reflector

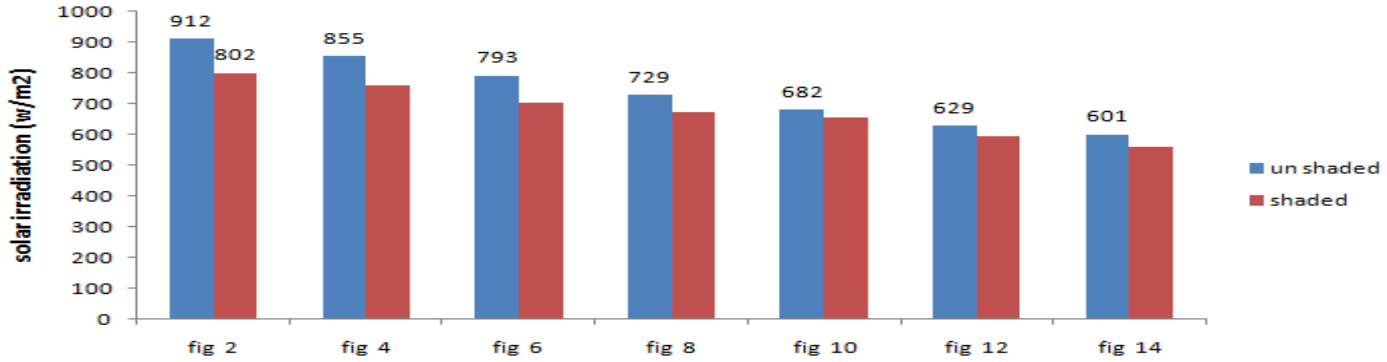

Fig. 20. solar irradiation (W/m^2) with reflector

CONCLUSION

In this expermental setup was obsrved various parametrs voltage (Vmp) and current (Imp), maximum power (Pmax) and solar irradiation (W/m^2) with and without reflectors. By using reflectors, solar irradiation (W/m^2) increasing 5.29%, output voltage (Vmp) increases 2.5%, their is very less percentage increases compared to other parameters and it's conclude that this parameter less effected on shading, Output current (Imp) is increased 21.84% and maximum power (Pmax) is increased 22.34%.The current (Imp), solar irradiation(W/m^2) ,maximum power (Pmax*)* are mostly effected by shading. So on this research suggesting that by providing reflector we can produce improving power output on solar array systems under shading conditions**.**

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