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Performance Analysis of 68 W Flexible Solar PV

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Abstract—*There is a need to overcome the energy crisis to provide a good standard of living for the people. So the renewable energy sources are used extensively to harness energy from natural sources like solar and wind. Much attention is given to harnessing of solar energy as wind energy is mostly available in coastal regions. The growth and development in solar PV technology is increasing rapidly due to technological improvement, cost reductions in materials and government support for renewable energy based electricity production. The solar panels are installed near the buildings to harness energy from the sun. There are several types of solar panels available. This paper introduces theamorphous thin film flexible PV. A performance analysis is done on the panel calculating its efficiency.*

Keywords*: -Photovoltaic, millimeter, kilogram, watt*

1. INTRODUCTION

The growth and development in solar PV technology is increasing rapidly due to technological improvement, cost reductions in materials and government support for renewable energy based electricity production [1]. The solar panels are installed to harness energy from the sun. Generally the panels are installed on the rooftop of the buildings either grid connected or standalone. Nowadays with the advancement in technology, several new types of solar panels are introduced in the market. They are flexible PV, transparent PV, dye sensitized solar cell etc. The flexible PV can be rolled and can be installed on any surface either linear or curved. This has made installation easier. The modules were fabricated from high-efficiency, multiple-junction a-Si alloy solar cell [2].There are several companies manufacturing flexible PV like UNISOLAR, Microlink etc. [3].

1.1 Performance analysis

The analysis usually includes the efficiency of the solar panel that it can reach during its operation. The efficiency of the solar panel is given as:-

$$\eta_{pv} = \frac{P_m}{E_x A_c}$$

Where η_{pv} is the efficiency of the solar PV

P_m is the maximum power point power given by

$$P_m = V_{oc} I_{sc}$$

Where V_{oc} is the open circuit voltage and I_{sc} is the short circuit current.

E_x is the input light irradiance

A_c is the surface area of the solar PV [4]

1.2 Instrument Used

The following instruments were used:-

- Flexible Solar PV:-it is a product of UNISOLAR Company. The following specifications are available for this PV:-
  - Rated power:- 68W,
  - Voltage (V_{oc}) : -23.1V,
  - Current (I_{sc}):- 5.1A,
  - Dimensions:- 2849 x 394 x 4 mm,
  - Weight:- 3.9Kg

- Solar Power meter:-it was used to determine the irradiance which is the amount of light falling on the surface of the PV. This gives the input power per unit area for the panel, which on multiplying with area of the panel will give the input power.
- Voltmeter:-this instrument was used to measure the open circuit voltage (V_{oc}). It has a range of 0-100V. Fig. 4 shows voltmeter.
- Ammeter:-this instrument was used to measure the short circuit current (I_{sc}). It has a range of 0-2.5A. Fig. 1 shows ammeter.
- Rheostat:-this instrument was used as a variable resistance in the setup. Fig. 2 shows rheostat.
- Environment Meter:-this instrument was used to measure the relative humidity and wind speed. It is an Extech instrument with model no. 45170. Fig. 6 shows the meter.
- Infrared thermometer:-this instrument was used to measure the module temperature .It has the range of 0-1mW and output wavelength of 630- 670 nm. Fig. (3) shows the thermometer.
- Multimeter:-this instrument was used to measure the voltage and current at the output of the module. It has the range of 0-1000V and 0-10A. Fig. (5) shows the Multimeter.

Fig. 1: Ammeter

Fig. 2: Rheostat

Fig.3Infrared thermometer

Fig. 4: Voltmeter

Fig. 5: Multimeter

Fig. 6: Environment Meter

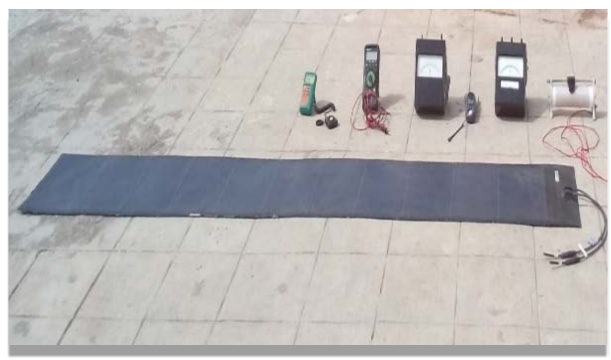

Fig. 7: Setup of the experiment (rooftop)

Fig. 8: Flexible PV (façade position)

2. METHODOLOGY

The panel is placed at two different positions one is at façade and other is rooftop. The flexible PV is kept at an angle of 23 degrees with reference to the northern hemisphere for rooftop placements so that the panel always faces the sun.

For façade placements. The panel can be placed on the window or door at a vertical position. The panel is connected to a rheostat having variable resistance across which the voltage reading is taken by a voltmeter and current reading is taken by an ammeter. This will give an open circuit voltage and short circuit current as output, which in turn give the output power. The input is taken as the amount of light falling on the panel surface. It is measured by the solar power meter which gives the irradiance when multiplied with the surface area gives the input power. The efficiency is given as the ratio of output power to the input power. The efficiency is determined for both façade and rooftop. Then a comparison is made between the rooftop PV and façade PV to determine which has greater efficiency.

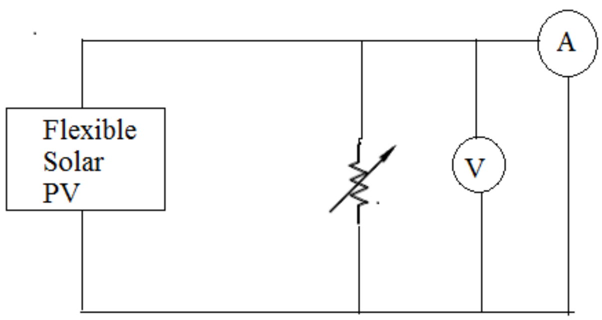

Fig. 9: Circuit Diagram

3. CALCULATION

The efficiency of the flexible PV for façade and rooftop positions are calculated below:-

Table 1: Facade flexible PV

Time	$A_{temp.}$	W_{Speed}	$S_{Intensity}$	$M_{temp.}$	Voc	Isc	V_M	I_M	η
9:00 AM	30.1	0.1	625	33	19.37	1.21	36	1.9	3.34
10:00 AM	35.2	0.2	645	36	20.25	1.62	37	1.7	4.53
11:00 AM	40.2	0.2	957	58	20.4	3	36	2.2	5.69
12:00 AM	42.9	0.1	992	60	19.83	3.23	36	1.92	5.75
1:00 PM	44.2	0.2	981	61	18.12	3.45	37	2	5.67
2:00 PM	45	0.2	977	64	18.13	3.49	30	1.72	5.77
3:00 PM	41	0.3	733	52	17.21	2.52	33	2.4	5.27
4:00 PM	43	0.1	499	45	15.23	1.88	35	2.4	5.11
5:00 PM	29.2	0.1	298	30	18.34	0.52	19	0.9	2.85

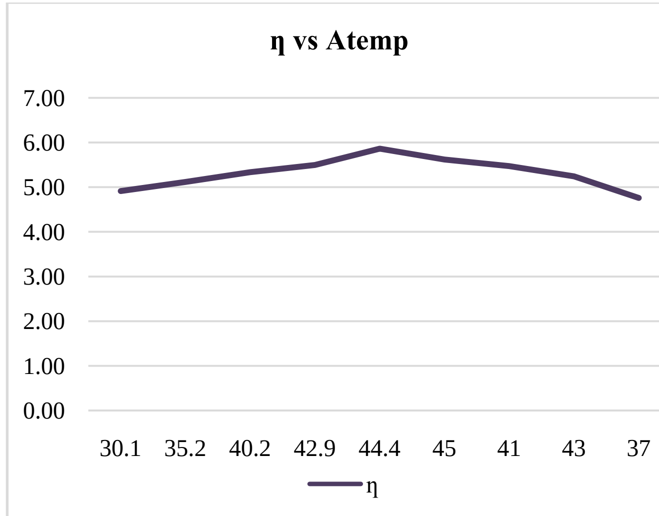

Fig. 10: η and ambient temperature

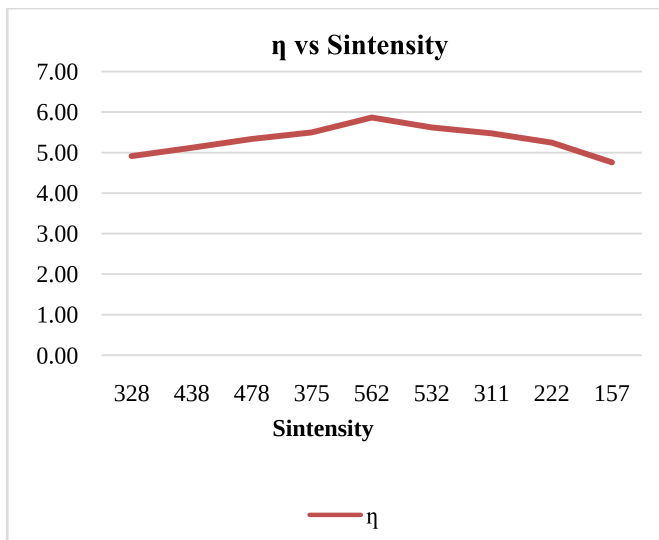

Fig. 11: η and solar intensity

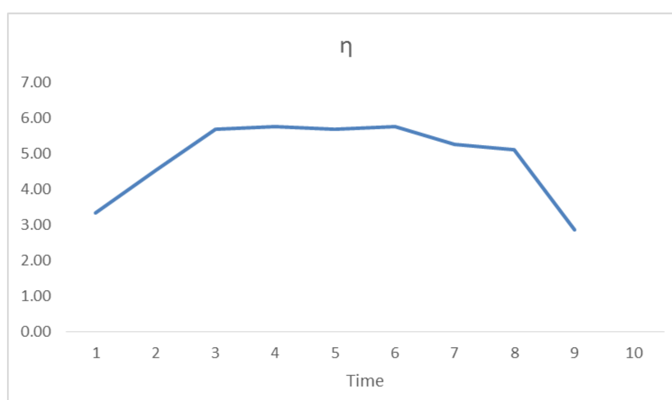

Fig. 12: η and time

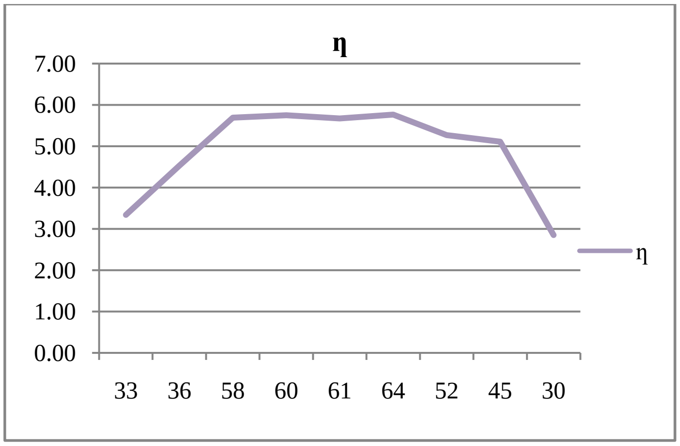

Fig.13: η and module temperature

Table 2:- Rooftop flexible PV

TIME	A_{temp}	Wspeed	S_{intens}	$M_{temp.}$	V_{oc}	I_{sc}	V_m	I_m	η
9:00 AM	30.1	0.1	328	31	17.23	1.05	34	0.8	4.91
10:00 AM	35.2	0.3	438	35	19.21	1.31	35	0.7	5.12
11:00 AM	40.2	0.2	478	40	17.05	1.68	30	1.4	5.34
12:00 AM	42.9	0.1	375	44	18.23	1.27	35	2.2	5.50
1:00 PM	44.4	0.2	562	48	19.27	1.92	20	1.5	5.86
2:00 PM	45	0.2	532	46	19.07	1.76	30	1.5	5.62
3:00 PM	41	0.1	311	45	17.53	1.09	27	1.4	5.47
4:00 PM	43	0.3	222	34.2	14.21	0.92	29	2.2	5.24
5:00 PM	37	0.1	157	32	12.34	0.68	12	1.5	4.76

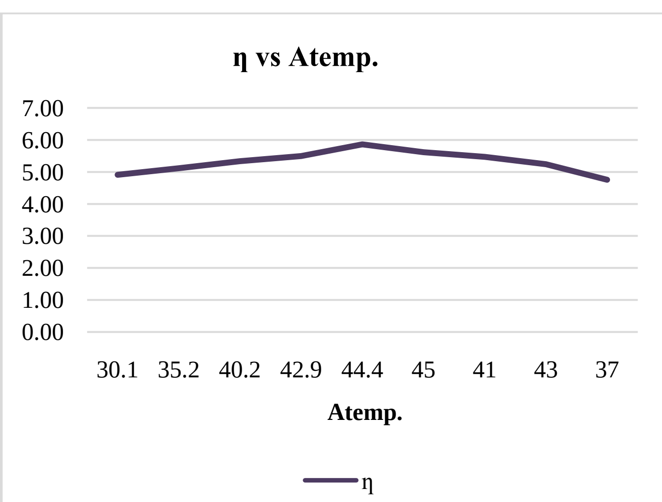

Fig. 14: η and ambient temperature

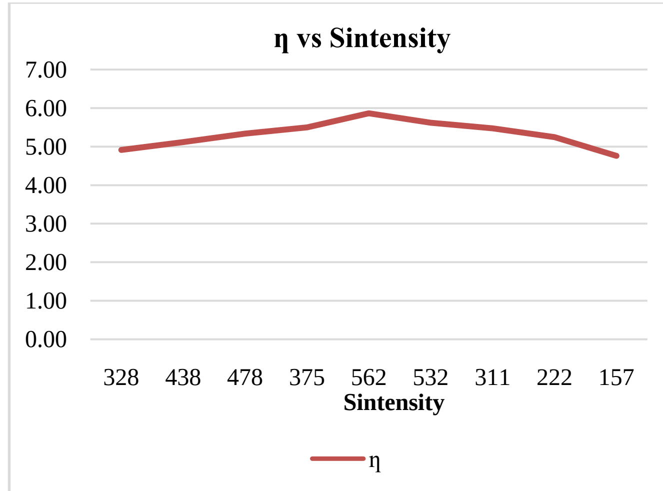

Fig. 15: η and solar intensity

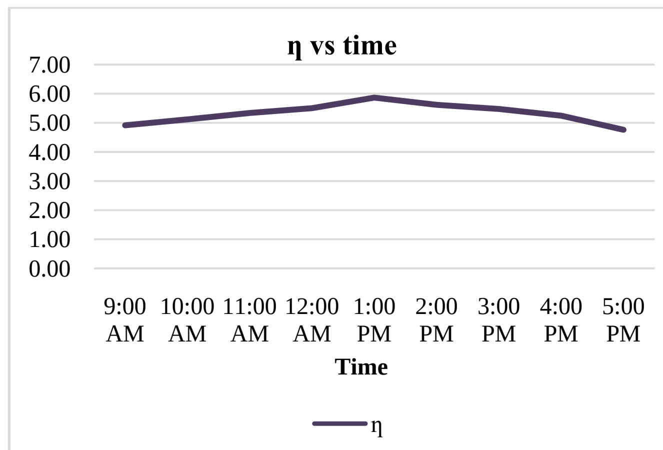

Fig. 16: η vs time

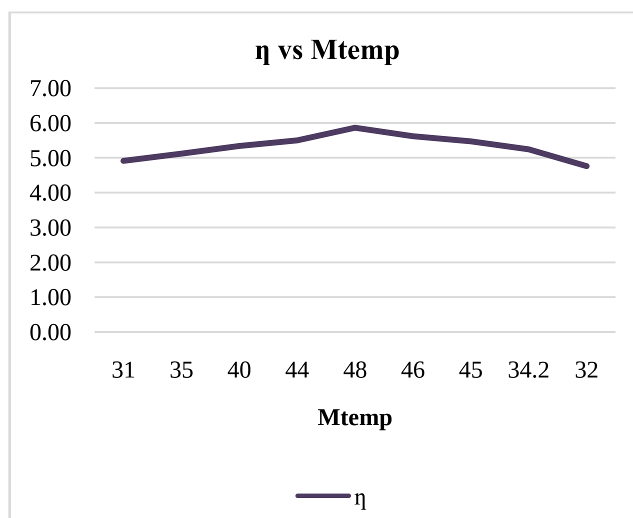

Fig. 17: η vs module temperature

4. CONCLUSION

The overall efficiency of the flexible PV for the rooftop position is 4.89 and for the façade position is 5.31. The calculated result proves that the flexible PV is best suited for façade position.

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