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Performance analysis of 75 W Transparent PV Panels

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Abstract—*In this era of energy crisis, the use of renewable energy sources has increased to reduce the expenditure of countries in harnessing conventional energy sources like coal and petroleum. There are several new technologies came into existence. One such is transparent PV panel. The transparent PV panel helps in harnessing both solar energy and daylight that will not only generate electricity but also reduce consumption during peak load. In this paper the performance analysis has been done on transparent PV to calculate the efficiency of the transparent PV panel so as to determine how better is the working of the transparent PV as a rooftop panel.*

Keywords: *Photovoltaic, millimeter, kilogram, watt*

1. INTRODUCTION

The world is going through an energy crisis. The recent science and technology development are mostly dealing with alternative energy source to combat the increasing energy demand. The countries have their major revenues spend on supplying and harnessing energy sources [1]. So to avoid this, the use of renewables has increased substantially, especially solar energy. The solar panels are installed everywhere for harnessing solar energy. New technologies are also introduced regarding installation of solar PV. One such method involves "building integrated PV". The buildings usually install either rooftop solar PV or transparent PV integrated with doors and windows. The transparent PV panels are usually installed either on windows or doors to harness both solar energy and daylight. This will not only supply electricity at peak hours, but also will reduce artificial light expenditures. A transparent photovoltaic (PV) is a building component generating electricity via PV modules and allowing daylight to enter into the interior spaces [2]. The transparent PV panel is made of amorphous Silicon [3] and has a transparency level of 20%.

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 Instruments used

The following instruments were used:-

- Transparent PV: -The transparent PV used is made of hydrogenated silicon and is monocrystalline in nature [3]. It has 20% transparency and is used as building integrated. It has following specification:-
  - Power rating =75 W
  - Open circuit voltage(V_{oc}) = 21.8 V
  - Short circuit current(I_{sc}) = 4.79 A
- Solar power meter: -this instrument was used to measure the irradiance (KW/m^2). Irradiance is the amount of sunlight falling on the surface of the solar panel. This serves as the input power to the solar panel.
- Voltmeter: -this instrument was used to measure the open circuit voltage (V_{oc}). It has a range of 0-100V.
- Ammeter: -this instrument was used to measure the short circuit current (I_{sc}). It has a range of 0-2.5A.
- Rheostat: - this instrument was used as a variable resistance in the setup.
- Environment Meter: - this instrument was used to measure the relative humidity and wind speed. It is an Extech instrument with model no. 45170.
- 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.
- Digital thermometer: - This instrumentwas used to measure the ambient temperature. It has a temperature range of -50'C to 300'C.
- 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. 1: Ammeter

Fig. 2: Rheostat

Fig. 3: Infrared Thermometer

Fig. 4: Voltmeter

Fig. 5: Multimeter

Fig. 6: Environment Meter

2. METHODOLOGY

2.1 Experiment setup

The transparent PV is kept at an angle of 23 degrees with reference to the northern hemisphere so that the panel always faces the sun. 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.

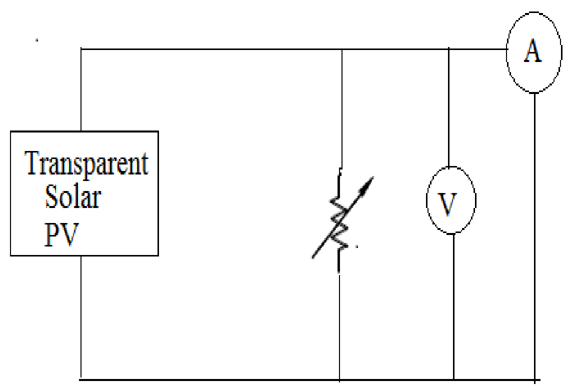

Fig. 7: Circuit Diagram

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. Then a comparison is made between the rooftop PV and façade PV to determine which has greater efficiency.

Fig. 8: Experiment setup

3. CALCULATION

The efficiency of the transparent PV for façade and rooftop position are calculated below:-

Table 1: Façade transparent PV

TIME	A Temp.	W Speed	S_{Intens}	M Temp.	V_{OC}	I_{SC}	V_M	I_M	η
9:00 AM	30.1	0.1	330	28	16.02	1.35	37	1.2	15.06
10:00 AM	35	0.3	521	34	19.63	1.82	38	1	15.75
11:00 AM	40.2	0.2	614	45	20.04	2.17	39	1.4	16.27
12:00 AM	42.9	0.1	456	49	16.23	2.05	30	2.3	16.76
1:00 PM	44.5	0.2	582	50	17.21	2.25	35	1.8	15.28
2:00 PM	45	0.2	568	52	19.72	2.12	30	1.5	16.91
3:00 PM	41	0.1	581	43	18.32	2.13	36	1.6	15.43
4:00 PM	43	0.1	392	40	19.39	0.96	39	1.5	10.91
5:00 PM	29.2	0.1	175	31	18.59	0.2	19	1.4	4.88

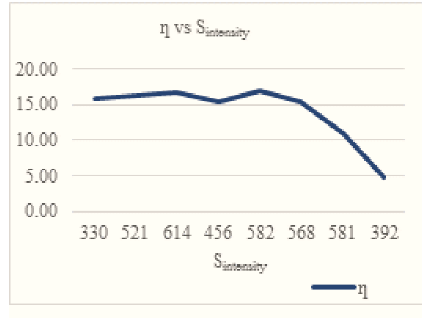

Fig. 9: η vs solar intensity

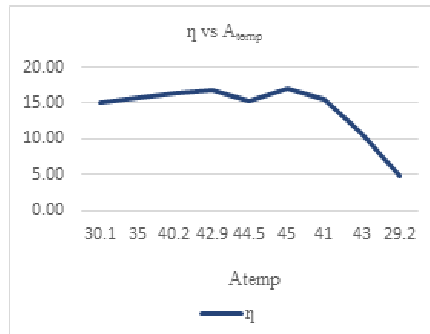

Fig. 10: η vs ambient temperature

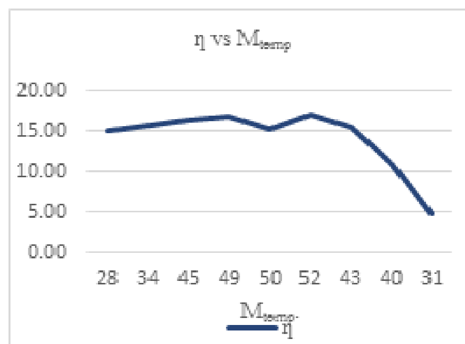

Fig. 11: η vs module temperature

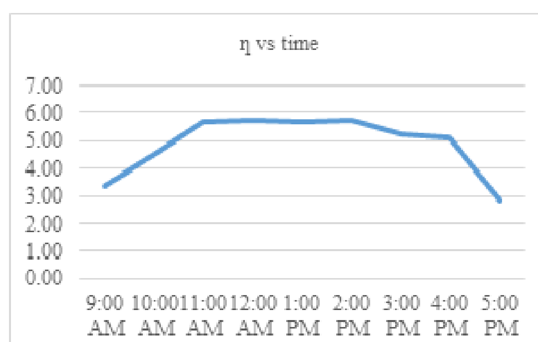

Fig. 12: η vs time

Table 2: Rooftop Transparent PV

TIME	A_{Temp}	W_{speed}	$S_{intensity}$	$M_{temp.}$	Voc	Isc	V_M	I_M	η
9:00 AM	30.1	0.1	610	31	20.02	2.21	35	2.32	16.66
10:00 AM	35.2	0.3	642	35	18.71	2.31	33	2	15.47
11:00 AM	40.2	0.2	945	54	19.38	3.59	34	2.5	16.91
12:00 AM	42.9	0.1	1001	59	18.21	3.9	35	2.2	16.30
1:00 PM	44.5	0.2	974	58	19.11	3.73	34	2.5	16.81
2:00 PM	45	0.2	978	57	19.79	3.59	37	2.5	16.69
3:00 PM	41	0.1	725	55	17.23	2.9	36	0.3	15.83
4:00 PM	43	0.1	538	42	19.37	1.63	15	1.8	13.48
5:00 PM	29	0.1	219	31	18.66	0.75	20	0.9	14.68

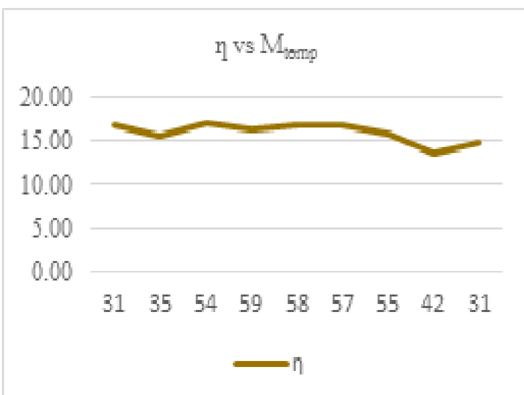

Fig. 13: η vs module temp.

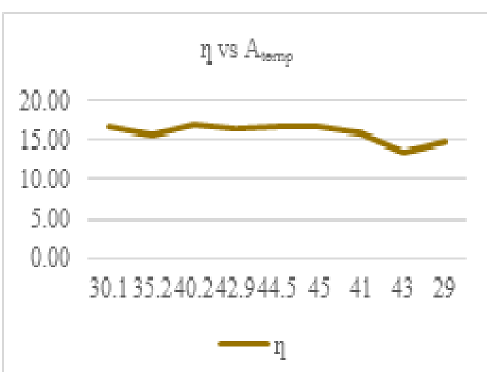

Fig. 14: η vs time

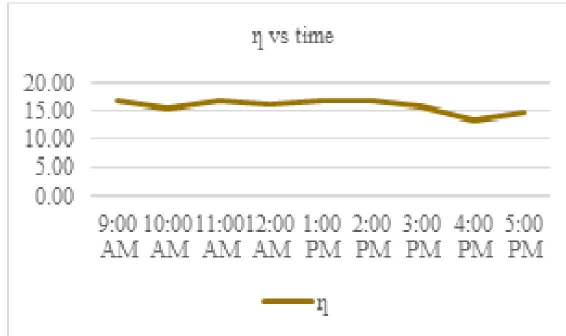

Fig.15η vs solar intensity

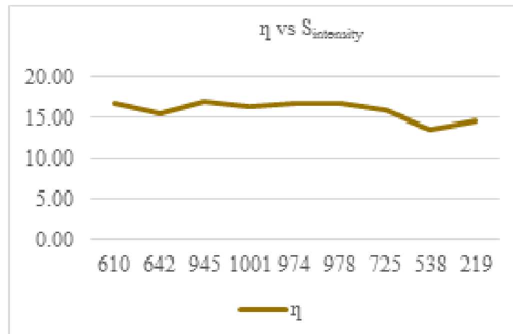

Fig. 16: η vs ambient temperature

4. CONCLUSION

The overall efficiency of the transparent PV for façade is 14.13and for rooftop is 15.87. Therefore the transparent PV is best for rooftop applications.

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