

Investigation of SPV Power Plant With Dual Axis Sun Tracker

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Abstract

This paper describes an approach to the design and implementation of sun tracker stand in PV system making 120 Volt string. For the strength analysis against wind pressure the PV system with tracker stand has been implemented in solid work software SP-13. Another part of this paper is the comparison of power drawn from The PV system with tracker and without a tracker. The data received in real experimental setup. We analyzed that the efficiency of PV systems can be increased by 42 % compared to the static PV system by implementing the tracker techniques in the PV System.

Keywords: photo voltaic system, dual axis sun tracker system, control circuit, solid work

I. INTRODUCTION

Photovoltaic Technology is an attractive source of energy among the present renewable energy sources because It can produce electrical power without harming the environment and ease of installation. But the characteristics of PV cells depends on environmental conditions, mainly irradiance and temperature. It has been observed that the change in the irradiance value mainly affects the output current of PV system while the temperature changes mainly affect the PV system output Voltage and the power- voltage curve of a PV cell has a convex shape [1-3]. Walker proposed a MATLAB based model of PV module for the study of environmental effect on energy by PV System [4]. Now a day many research are going on in this field. How to increase the efficiency of solar photo voltaic power plant. The PV Power plant should be designed to produce maximum output power for any temperature and solar irradiance value at all time. The

implementation of dual axis sun tracker in the PV power plant is a key step to maximize an efficiency of solar photo voltaic power plant and decreases the cost of PV systems.

This paper is organized as follows. Section II details

the PV array description. Section III presents the solar tracking system. Section IV deals with the wind generation concept. Section V details the Simulation Results of solar Tracker stand having 120 V string, done in solid work software Sp-13 for strength Analysis.

II. PV ARRAY DESCRIPTION

The current generated from the PV cell is directly proportional to solar radiations [3]. As the solar irradiance increases the value of the current increases. The V-I characteristics of the PV cell mainly depends on irradiance and temperature. To study the effect of both parameters on the cell characteristics PV module has been implemented

in MATLAB software. The variation of the saturation current as a function of temperature is described by [6].

TABLE 1: SPECIFICATIONS OF SOLAR PHOTOVOLTAIC MODULES

Configuration	Single Glass Laminated Type With 72 Cells (12 × 6) In Series
Overall Size	1595 (± 3) × 790 (± 2) × 50 (± 1) MM
Weight	15 Kg. (Typical)
Module Frame	Anodized Aluminum
Typical Electrical Characteristics of L24150 type module (170Wp)	
Open Circuit Voltage (V_{oc})	42.0 V
Short Circuit Current (I_{sc})	4.86 A
Operating Voltage	35 V
Max Power Output	170.0 W ± 3%

The Specification of Solar photovoltaic module use in the experimental setup, is shown in table 1.

PV array simulation was done in MATLAB software. The following results were obtained. Fig 1 shows the V-I characteristics of 170 watt PV array at the irradiance value 1000 W/m^2 . The P-V characteristic of this module is shown in Fig 2. The value of the voltage at which the power is maximum is denoted by V_m , It is the maximum voltage of PV module. The variation of SPV voltage with respect to time is shown in Fig 3.

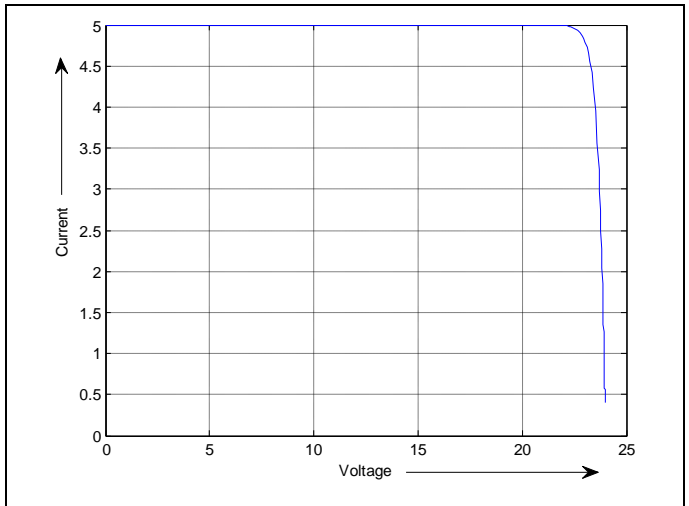


FIG 1: VOLTAGE VS CURRENT (SEC).

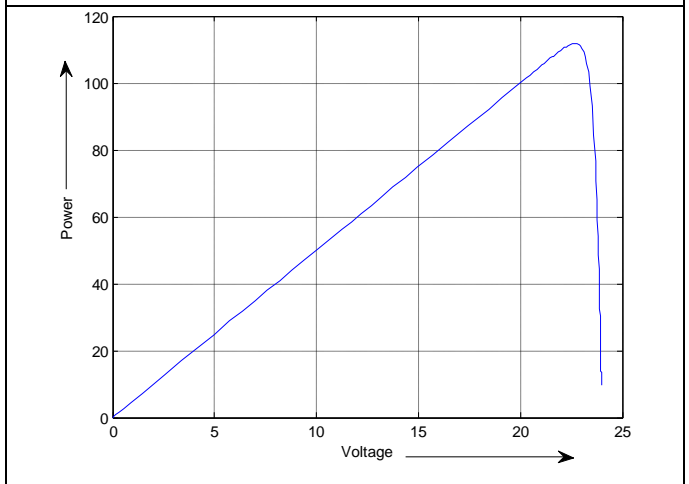


FIG 2: VOLTAGE VS POWER.

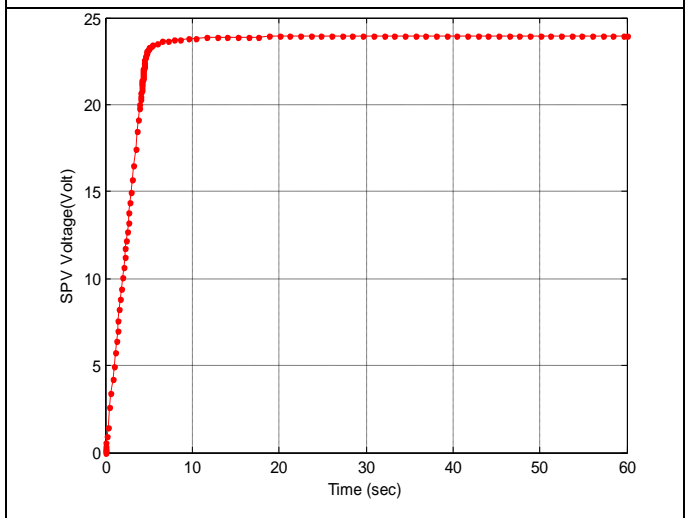


Fig 3: SPV Voltage Vs time (Sec).

III. SOLAR TRACKING PV SYSTEM

The designed solar tracker stand for 120 V string is shown in Fig 4. The PV system, making 850 W, the shown five panels in Fig 4, is connected in series for producing 120 V. The rated value of each panel is 170 W. The detailed specification has been shown in table 1.



FIG 4: ACTUAL SOLAR TRACKING SYSTEM (170X5 WATT)

As shown in Fig 4. The Solar tracker PV system consists of PV Panels, Spring system for balancing the load, worm gear system and two 24 V, DC motors for dual axis freedom of rotation. In this designing we used the angles of MS steel material to make it cost effective. In the experimental setup, for the Analysis of Improved efficiency both solar Tracking PV system as well as Static PV system are connected to DC bulb load, each bulb have the rating 12 V, 90 W. These bulbs were connected in series to make 120 Volt. The value of current and voltage was measured by Ampere-meter and Voltmeter. The ammeter was connected in series with the load and a voltmeter in parallel across the DC bulb load.

IV. WIND GENERATION CONCEPT

Uneven heating and the rotation of the earth results a global wind pattern in which the warm air rises near the equator, and the surface air moves toward the equator to replace the rising air. The flow of wind between the equator and about

30° north and south latitudes moves east to west. That's why in many countries the wind speed in the west has generally higher than in the east.

The experiment was done in Agra. According to the Geographical information, it is situated at latitude 27.17667 and longitude 78.008. The monthly average wind speed is shown in Fig 5. The maximum value of wind flow in Agra is 4.35 m/s in the month of June [5].

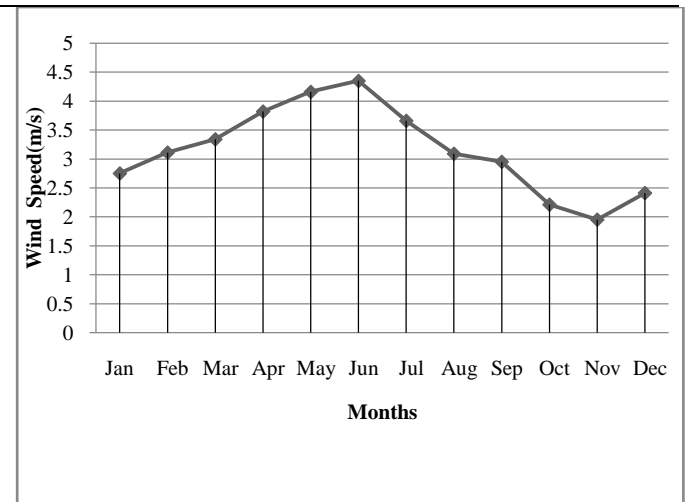


FIG 5 AVERAGE SPEED OF WIND IN AGRA (m/s)

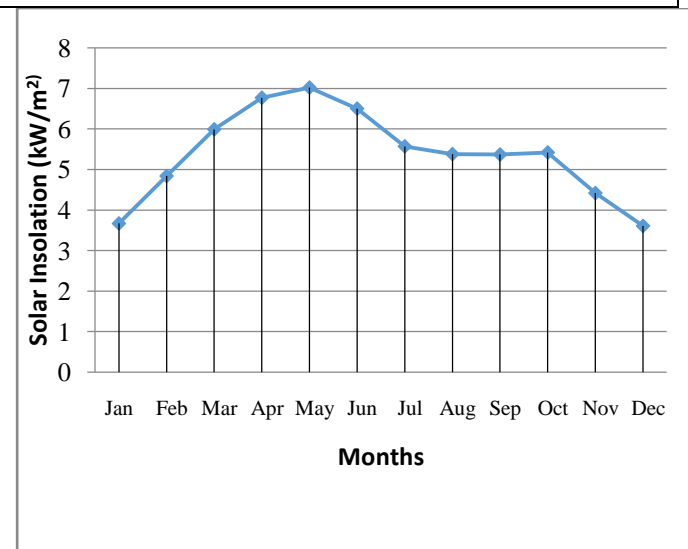


FIG 6 MONTHLY AVERAGE VALUE OF SOLAR INSOLATION IN AGRA.

The average value of solar radiations in each month is shown in Fig 6. The maximum value of irradiance in Agra occurs in the month of May [5].

V. SIMULATION RESULTS AND DISCUSSION

Fig 7 shows the designed structure in solid work software SP-13. In which the FE modeling, analysis has been implemented. For performing the analysis, created meshing was the 29-Jacobian point.

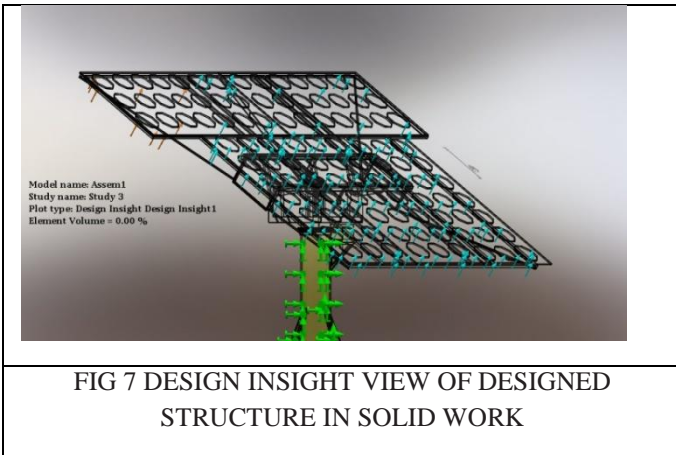


FIG 7 DESIGN INSIGHT VIEW OF DESIGNED STRUCTURE IN SOLID WORK

For the analysis strength analysis of solar tracker stand different pressure level was applied perpendicular to panel frame structure as shown in Fig 8. Observed that the stress value at different nodes to check the stresses values and find the material used in real tracker stand have good strength against the applied wind pressure.

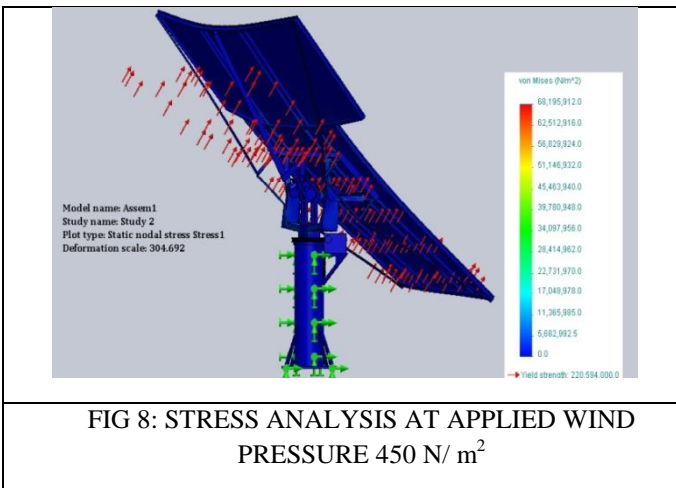


FIG 8: STRESS ANALYSIS AT APPLIED WIND PRESSURE 450 N/ m²

The value obtained at the selected node on different pressure level is mentioned in table 2. The stresses values are less than the yield strength of used materials.

TABLE 2 STRESS VALUES AT DIFFERENT NODES ON DIFFERENT PRESSURE LEVEL

S.No	350N/m ²	400N/ m ²	450N/ m ²	500N/ m ²
1	0.0001047	0.0002107	0.0002373	0.0002637
2	0.00009594	0.0001931	0.0002176	0.0002417
3	0.00008722	0.0001756	0.0001978	0.0002197
4	0.0000785	0.000158	0.000178	0.0001978
5	0.00006978	0.0001404	0.0001582	0.0001758
6	0.00006105	0.0001229	0.0001384	0.0001538
7	0.00005233	0.0001053	0.0001187	0.0001318
8	0.00004361	0.0000877	0.0000988	0.0001099
9	0.00003489	0.0000702	0.0000791	0.0000879
10	0.00002617	0.0000526	0.0000593	0.0000659
11	0.00001744	0.0000351	0.0000395	0.0000439
12	0.00000872	0.0000175	0.0000197	0.0000219

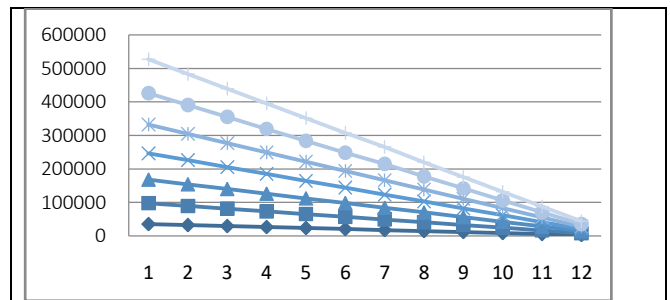


FIG 9 VARIATIONS OF STRESSES AT SELECTED NODE ON INCREASED PRESSURE LEVEL.

As the applied pressure increases the stresses at the selected node increases but the value of FOS is

6.67. It can be concluded that the solar tracker stand have good strength against the applied wind pressure 650 N/m^2 . It is the critical wind pressure may occur in India due to wind speed in stormy weather.

colors and the displacement values at different pressure values are shown in table 3.

VI. EXPERIMENTAL RESULTS

These data were taken in the month of August-13, 2019. Table.4 represents the recorded data of fixed PV system and Tracking PV System.

Table 4: Fixed system and Tracking System

TIME	Static PV System		Tracking PV System			
	Voltagge (V)	Current (Amp)	Power(watt)	Voltagge (V)	Current (Amp)	Power (watt)
7.00am	0 . 8 1 6	1	0.816	0.941	0.2	0.1882
7.30am	1 . 1 8 0	2	2.36	1.350	1	1.35
7.45am	1 . 1 6 8	2 . 5	2.92	2.040	1	2.04
8.00am	2 . 2 0 0	3	6.6	1.189	1	1.189
8.15am	3 . 4 8 5	4	13.94	1.010	2	2.02
8.30am	4 . 7 5 0	5 . 5	26.125	6.60	3	19.8
8.40am	7 . 3 5	6 . 5	47.775	14.50	10.5	152.25
8.55am	9 . 1 8	7 . 0	64.26	16.02	11	176.22
9.05am	1 0 . 4 1	7 . 5 2	78.2832	16.82	11.40	191.748
9.20am	1 2 . 5 1	8 . 4 0	105.084	17.87	11.70	209.079
9.36am	1 4 . 4 8	9 . 1 0	131.768	18.95	12.0	227.4
9.50am	1 6 . 2 1	9 . 6	155.616	19.80	12.40	245.52
10.05am	1 8 . 3 5	1 0 . 4	190.84	19.93	12.50	249.125
10.20am	1 9 . 2 8	1 0 . 6	204.368	20.12	12.50	251.5
10.40am	2 1 . 7 0	1 1 . 4	247.38	20.80	12.60	262.08
10.54am	2 2 . 4 5	1 1 . 6	260.42	21.02	12.60	264.852
11.10am	2 3 . 2 2	1 1 . 9	276.318	21.04	12.75	268.26
11.25am	2 3 . 4 5	1 2 . 0	281.4	20.85	12.90	268.965
11.45am	2 3 . 8 7	1 2 . 0	286.44	20.69	12.75	263.7975
12.00am	2 3 . 8 6	1 2 . 0	286.32	20.23	12.50	252.875
12.15am	2 3 . 9 1	1 2 . 1	289.311	19.53	12.50	244.125
12.40pm	2 3 . 0 4	1 2 . 1	278.784	20.34	12.45	253.233
1.00pm	2 3 . 9 1	1 2 . 1	289.311	20.35	12.40	252.216
1.10pm	2 3 . 9 0	1 2 . 1	289.19	20.45	12.50	255.625
1:25pm	2 3 . 8 1	1 2 . 0	285.72	20.71	12.50	258.875

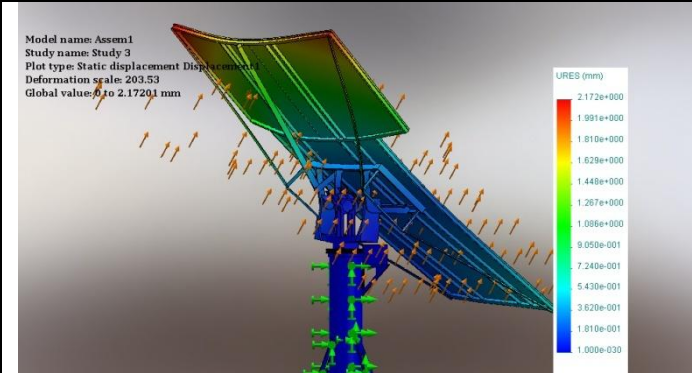


FIG 10: DISPLACEMENT VIEW OF STAND AT WIND PRESSURE 650 N/m^2

TABLE3 DISPLACEMENT AT DIFFERENT NODES ON DIFFERENT PRESSURE LEVEL

S.No	Applied Pressure in N/m^2						
	350 N/m^2	400 N/m^2	450 N/m^2	500 N/m^2	550 N/m^2	600 N/m^2	650 N/m^2
1	2.483	2.833	3.189	3.543	3.896	4.254	4.604
2	2.276	2.597	2.932	3.248	3.571	3.899	4.221
3	2.069	2.361	2.658	2.953	3.247	3.545	3.837
4	1.862	2.124	2.392	2.658	2.922	3.19	3.453
5	1.655	1.888	2.126	2.362	2.597	2.836	3.07
6	1.449	1.652	1.86	2.067	2.273	2.481	2.686
7	1.42	1.416	1.595	1.772	1.948	2.127	2.302
8	1.035	1.18	1.329	1.476	1.623	1.772	1.919
9	0.827 7	0.944 2	1.063	1.181	1.299	1.418	1.535
10	0.620 8	0.709 2	0.797 3	0.885 9	0.974	1.063	1.151
11	0.413 9	0.472 1	0.531 5	0.590 6	0.649 3	0.709	0.767 4
12	0.206 9	0.236 1	0.265 8	0.295 3	0.324 7	0.354 5	0.383 7

Simulation result on applied pressure 650 N/m^2 shows that maximum displacement occurs at the end of supporting frame of panels indicated by red

1:44pm	2 2 . 9 0	1 2 . 0	274.8	20.37	12.60	256.662
1:55pm	2 2 . 8 3	1 1 . 9	271.677	20.03	12.60	252.378
2:10pm	2 1 . 5 1	1 1 . 7	251.667	19.87	12.50	248.375
2:25pm	2 0 . 7 0	1 1 . 5	238.05	17.85	12.00	214.2
2:35pm	2 1 . 2 2	1 1 . 4	241.908	19.04	12.10	230.384
2:50pm	1 8 . 7 0	1 0 . 9	203.83	17.26	11.80	203.668
3:00pm	1 7 . 9 0	1 0 . 5	187.95	17.06	11.50	196.19
3:05pm	1 5 . 6 5	1 0	156.5	14.66	11.00	161.26
3:21pm	1 4 . 9 8	9 . 6	143.808	14.16	10.90	154.344
3:44pm	1 0 . 2 2	7 . 5	76.65	10.07	9.00	90.63
4:00pm	9 . 7 0	7 . 5	72.75	10.38	9.00	93.42
4:22pm	6 . 9 0	6 . 5	44.85	7.93	8	63.44
4:35pm	5 . 6 4	6 . 1	34.404	6.62	7.5	49.65
4:40pm	5 . 0 5	6	30.3	5.26	7	36.82

Figure 11 And 12 Shows The Comparative Results Of Spv Power Getting From Spv Power Plant From With And Without Tracking Concept

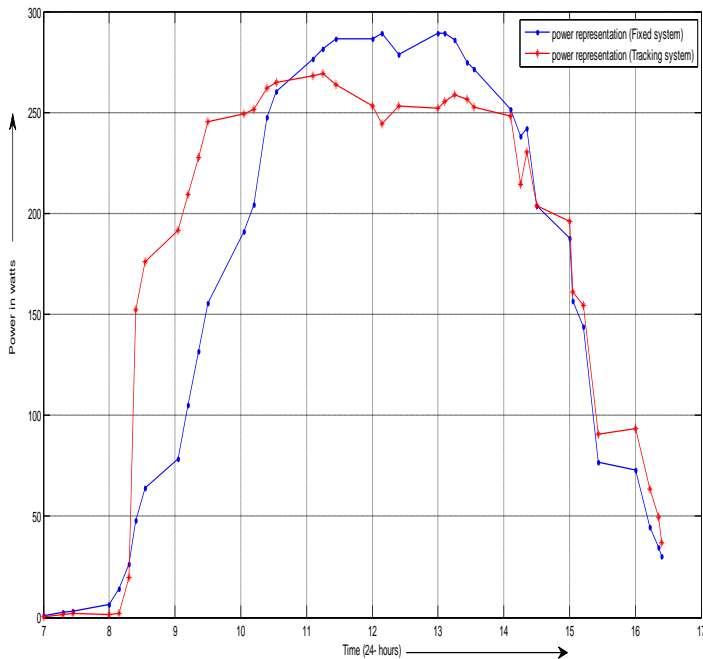


Figure 11. Graphical Representation of Power

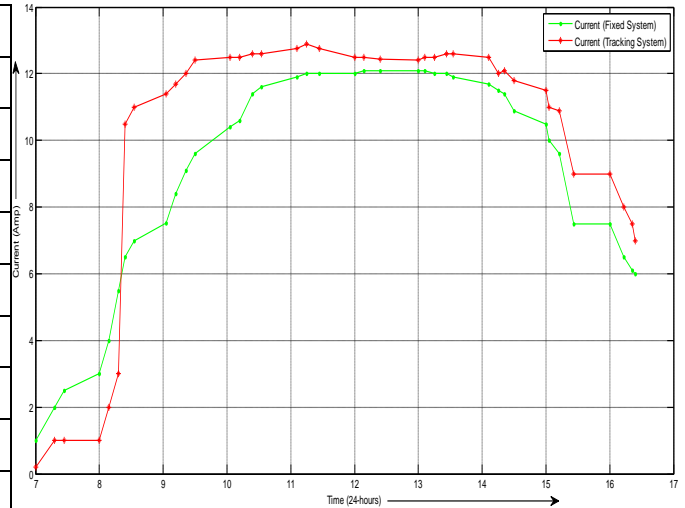


Figure.12 Graphical Representation of Current

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