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Performance Comparison of Manual Single Axis Sun-Tracking Photovoltaic (PV) with Fixed System PV Panels in Jordan

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Abstract: This work aims to study the performance of standard fixed photovoltaic (PV) solar systems and compare it to single axis tracking photovoltaic solar system. The study has two parts: experimental part and simulation part. In the experimental analysis, two identical mounting grid connected PV systems 125kWp with same PV modules and inverters are installed under Jordan climate condition for ten months start from April to January. The PV panels are installed using either fixed mount with tilt angle 25 degree and single axis manual tracking (North - South tracking system). The measured data for these different mounting cases of PV system are analyzed and compared together. The data has been collected using data loggers every fifteen minutes, recorded then analyzed. The experimental result showed that the output power injected into grid increased in total by approximately 9.69% as compared with the fixed system of 25° tilted angle. Both Fixed and tracking PV systems are applied into PVSYS simulation tool to investigate the performance using solar radiation data for Amman, Jordan. the simulation tool showed that the power gained from single axis tracking system increased by 12.83%. The simulation results are compared with measured data which is approximately close to the result from experimental study. The percentage of difference between experimental output power and simulation result is very small, it doesn't exceed 0.440% using single axis tracking system. While the difference in fixed system is bigger, it is approximately 4.00%.

Keywords: Photovoltaic System (PV), Solar Tracker, Tilted Sun Tracker, Manual Single-Axis Sun Tracker

1. Introduction

Development of renewable energy resources is in exponentially raising. According to the price hike of the fossil fuels and rapidly increasing in energy demand. Fossil resources are about to run, without mentioning the pollution of these materials which causing global warming. On the other hand renewable resources are clean, green, continuous and safe.

Photovoltaic (PV) solar systems are becoming a major alternative green source of electricity production in Jordan. The geographical location for Jordan makes it one of the best areas in the world for PV systems, where we have more than three hundred sunny days with moderate temperature all along the year. This makes PV system more efficient in generating electric power. Indeed, the rapid increase in energy costs in Jordan makes it more and more feasible to implement such solutions.

The PV solar panel performance is sensitive to the density of light falling on it. It is well known that the earth has two types of movements. The first is around the sun which leads to changes in the sun angle in the horizon. This change causes the changes of seasons on earth. The second type of movement is rotating the earth around itself which manifest of sun movement from the east to west daily. The result of those two changes in sun location relative to the earth is changing the falling density of light on a fixed surface.

It is desired to collect maximum density of sun radiation all the times because the produced PV electricity increases with increasing light density. This can be achieved by implementing systems that allows the PV panel to continuously follow and track the sun. These systems are called tracking systems.

It is required to quantify the improvement in system performance to justify the cost increased due to using multi-axes tracking system.

Typically, two axes are required to track the sun: Vertical axis which is used to tilt and orients the angle of the PV panel toward the south (follow the seasonal movement from N-S) and horizontal axis which follows the sun from east to west (follow daily movement).

Tracking systems keep the PV panel facing the sun all the day and throughout the year. As a result, the amount of solar irradiation that captured by the panel's surface will be maximum which will lead to an increase in conversion efficiency of radiation to electricity. Thus the generated electricity yield is improved. Furthermore, the overall system investment cost should drop down. Also, this process should optimize land area usage for producing electricity compared to non-tracking systems.

2. Literature Review

2.1. Single Axis Tracking System

Solar trackers are utilized to keep the solar collector surface perpendicular to the Sun and allow collecting a higher amount of solar radiation than with a fixed module. There are two main types of trackers, single axis and dual-axis, which usually operate using either a passive or active mechanism.

In 1976, Zerlaut and Heiskell [1] built a sun tracker device to keep sun rays perpendicular to cell surface. The device employing a feedback-controlled mechanism and clock mechanism. The feedback controller used to distinguish between the sun and the bright cloud and follow the sun to control the orientation of apparatus daily and seasonally across the sky.

Theoretical comparison between a fixed PV system and east- west sun-tracker (E-W) was studied by Richard Neville [2] (1978); the amount of power generated by (E-W) tracker system is greater than a fixed system by (5-10) %.

Rizk and chaiko [3] (2008) designed and tested a sun tracker device using stepper motor and light sensor. They noticed that the efficiency for fixed panel was 39%, but using single axis (vertical axis) tracker system the efficiency was increased to 70%. The power generated was increased by 30% over the fixed panel.

Abadi I. et al [4] (2014) designed and modeled single axis solar tracking system, the system has a DC motor, LDR sensor and fuzzy logic controller implemented on ATMEGA 8353 microcontroller to keep the sun position perpendicular to the panel surface. The power generated by the single axis tracker system gained of 47% compared to the fixed system.

Hafez and et al (2015) [5], developed new design of solar single axis tracking system using stirling engine as a motor for the structure to study the panels performance in Giza, Egypt. The E-W axis system provided maximum output power compared to the fixed system.

Battu Deepa and M. Hemalatha (2015) [6], designed single axis solar structure system. The system used AT89S52 microcontroller to control the movement method and timer circuit to help the panel catching the sun rays in cloudy day to get maximum energy output. They noticed that the output efficiency was 16% for single axis system and 8% for fixed system and the timer circuit can add more steps for system to get more accurate system.

2.2. Dual Axes Tracking System

Murat Kacira et al (2004) [7] stated that the PV orientation and its tilt angle increased the performance of PV with increased the amount of solar energy. They built a mathematical design to determine the optimum angles in Sanliurfa, Turkey. The result showed that the optimum angle is 13° in June and 61° in December. Also 2-axis solar tracking gains 34.6% more amount of solar rotation compared to a fixed panels at 14° tilt angle on July.

Another paper prepared by Salah Abdallah [8] and Salem Nijimeh (2004). They designed and modeled an electromechanically 2-axis sun-tracking system. This study focused on codding and programming a logical open loop controller for sun movement across the sky all the day through the year. They found that 2-axis tracking system increased the PV performance with increased the amount of enTergy collected up to 41.34% compared with a fixed surface tilted at 32° in Jordan.

Cemil Sunger (2009) [9] implemented an electromechanical close loop sun-tracker system. The altitude and azimuth angles are calculated along one year in Northern hemisphere, Turkey. These angles used to control close loop PLC for tracking the sun on both axes. The data was recorded for both systems: fixed and double-axis tracking. The comparison between these systems showed that 42.6% more power was achieved in the double-axis sun-tracking system.

Zhimin Li et al (2010) [10] studied the radiation statues in China, he found that there are two areas according to the amount of solar radiation: poor solar and abundant solar. The south-north single-axis sun tracking system applied on those areas. The tilt angles adjusted four times in a year to enhance the PV performance. The increase in the solar gain was above 30% in the abundant solar area and less than 20% in the poor area.

William David (2011) [11] simulated and constructed fixed, manual azimuth tracking and manual dual-axis tracking surface in USA, the average irradiation increased in 2-axis tracking by 34% relative to the fixed surface and 29% in azimuth tracking system. The deviation error between simulated result and fixed real system is 5% and 1% for real manual azimuth tracking system.

In another study, Rutu and Ali (2012) [12] designed and installed two 7.9 KWP PV systems: fixed and double-axis tracking surface. The analyses have been done for climate conditions in Turkey. The annual power generated was 11.53 MWh for the 28° fixed tilt angle while the double-axis tracking system generated 15.07 MWh that means 30.79% more power is obtained in the double-axis tracking system.

An experimental PV study was done in Greece by John Kaldellis and Dimitrios zafirakis (2012) [13] to evaluate the PV performance of single-axis tracking system (south-north) during the summer period. He found that the optimum angle for almost the entire summer period is 15°.

George et al (2014) [14] studied the performance of two photovoltaic systems: one fixed and the daily single-axis solar tracking. He analyzed the data taken from the experimental off-grid PV systems in Italy. He noticed that the power production is greater during morning and evening (single-axis tracker) than the power production from fixed system.

Saban Yilmaz et al (2015) [15] carried out on extensive investigation of the power generated from PV panels and its performance. The study is based on a simulation tool and the data is statically analyzed.

Naseer et al (2015) [16] designed and simulated and modeled a PV system and RO models to develop the power consumption of water desalination in Dhahran, Saudi Arabia. The developed RO and PV are modeled individually. The result showed that the annual gain increased for single-axis tracker system by 43% and by 62% for double-axis tracker system.

Guillermo Quesada et al (2015) performed an experimental work to increase the efficiency of PV panels by increase the amount of solar irradiation. A solar tracking system changes the PV orientation hourly and seasonally for a grid-connected PV in Montreal, Canada. They found that zenith (horizontal tracking) for mostly cloudy day is not feasible in summer. [17]

A recent work was done by Hassan Fathabadi (2016); he proposed a high accurate closed loop sensorless dual-axis solar tracker. Closed loop got the actual direction of the sun at any time but the open loop used offline estimated data about the sun path so low efficiency. He compared the error in sensorless solar tracker and in both sensors based and he found that the error in sesnsorless by 0.11°. This study was worked in Athens, Greece. [18]

3. Common Specification of Two Systems

Two identical types of standard PV systems are conducted with capacity of 125kwp for each system. The two systems are grid connected systems with same solar modules and inverters. The PV panels are installed using either fixed mount with tilt angle 25 degree and single axis manual tracking (North - South tracking system). The performance of these different mounting cases of PV system is compared together. The systems were installed at Amman, Jordan in 2017. The data has been collected using data loggers every fifteen minutes, recorded then analyzed.

Each system used same PV modules 315 W/ 36.8 V and inverters 25kw. No batteries are used because it is grid connected system. The fixed system has been installed on tilt angle of 25 degree directed to the south. Because it is considered an optimum angle in Jordan according to the calculation of irradiation for Jordan.

In the other hand, the tracker system has moved manually, the step of the moving is every 5 degree into range start from 0 degree to 55 degree. It is moving vertically from north to south (tilted angle range is 0 degree-55 degree). The structure has been fabricated in easy way to change the angle, only you need to change the pin from hole to another one. Every hole presented a specific angle as shown in the below figure.

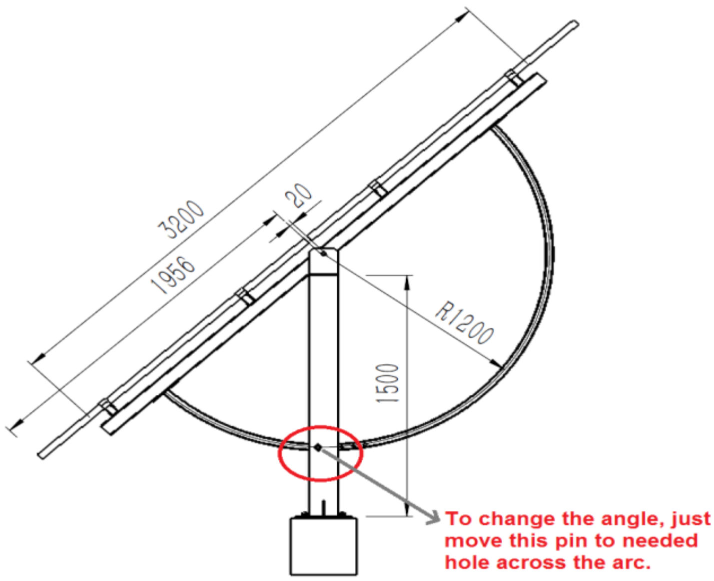

Figure 1. *Manual structure design [19].*

Tow system have been monitored using SMA Sunny Portal website. The inverter that used is from SMA Company, it has web connect device that help us to monitor the system whenever and wherever. It lets us see every inverter's production every 15 minutes, we can see the whole system production daily, monthly and yearly. Also, you can see every single inverter production. You can know the temperature and the weather status if it cloudy, sunny or whatever for your exact system location, in addition it shows the saving in CO_2 emission (amount of CO_2 can be avoided). The below figure represents the sunny portal website page.

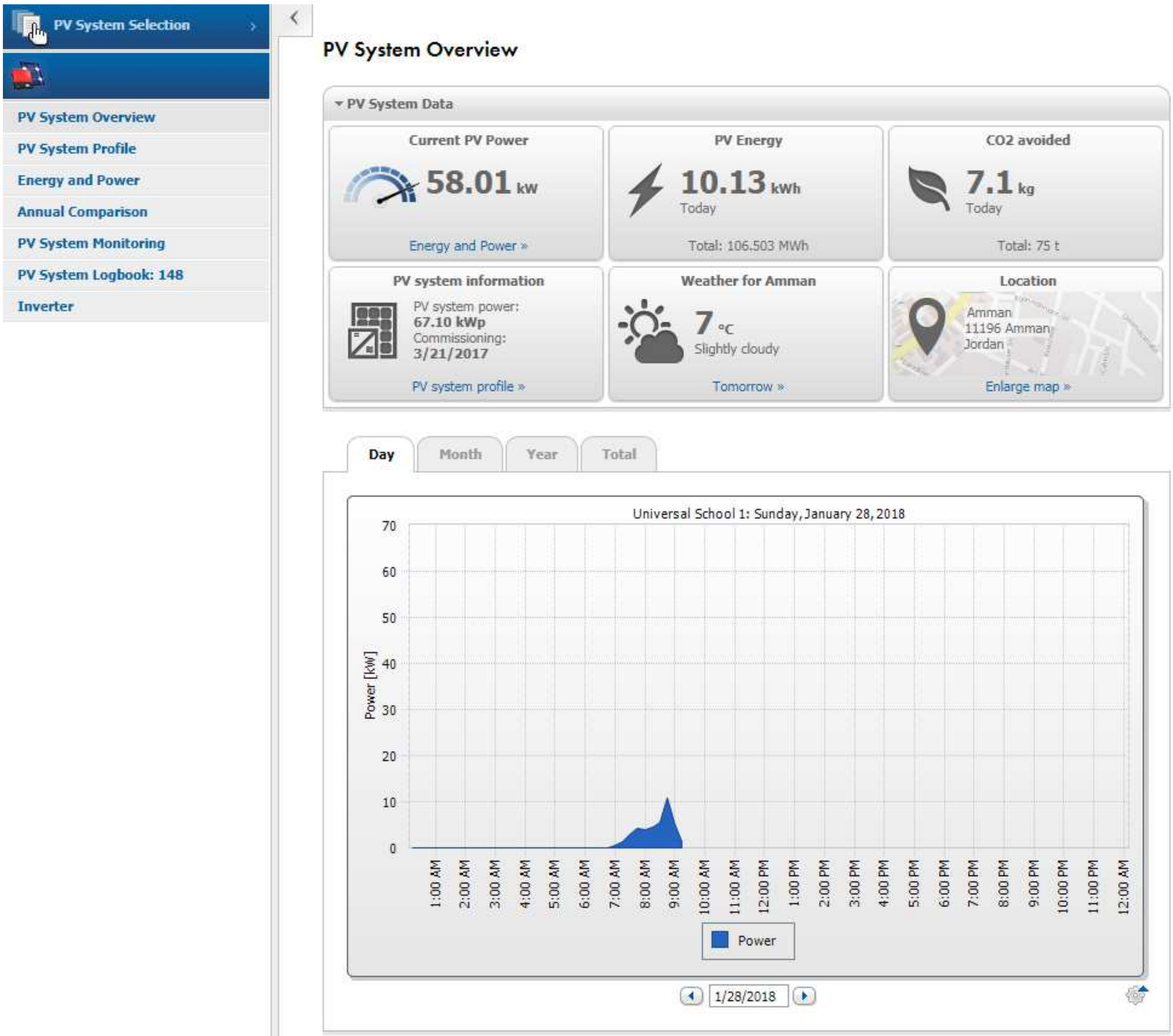

Figure 2. *SMA data logger [20].*

4. System Components

Tow systems used same modules, cables and inverters, table 4 represents the components of the fixed system and manual tracking system.

Table 1. *System components.*

Type	Manufacture	Specification	Source
PV module	Suntech	315 W	China
Inverter	SMA	25 KW + 15KW	Germany
DC Cable	Top Cable	4 mm^2	Spain
AC Cable	Cablco	16 mm^2	Jordan
M.C.B	Schneider	63 A	France
R.C.C.B	Schneider	63 A	France
Structure	AKCOME	Galvanized steel	China

4.1. PV Modules

The solar modules made in China, it is considered one of the top ten solar panels in the world. Type of solar modules used in both systems is polycrystalline module, the maximum output power is 315Wp. It composed of solar cells in parallel and series to obtain a desired optimum power. The amount of solar cells in crystalline solar module is 72 cells. The solar module provides an achieved performance of up to 16.2%.

The table below presents the electrical specification for the Suntech modules.

Table 2. *Panels specification.*

Specification	Panels / 315 W
P max	315.00 W
V oc	45.10 V
I sc	9.012 A
V mp	36.80 V
I mp	8.56 A
Efficiency	16.20%
Dimension	1956*992*40 mm
Weight	25.20 kg

Figure 3 shows the electrical characteristics of solar module (I-V Curve: curve of current-voltage) at different current - voltage ranges and different solar irradiation levels. The output current of a solar module efficiency directly relates to the amount of current and voltage produced from the incoming irradiation. The higher the irradiation caused higher current. Furthermore, the voltage slightly varies with varying irradiation.

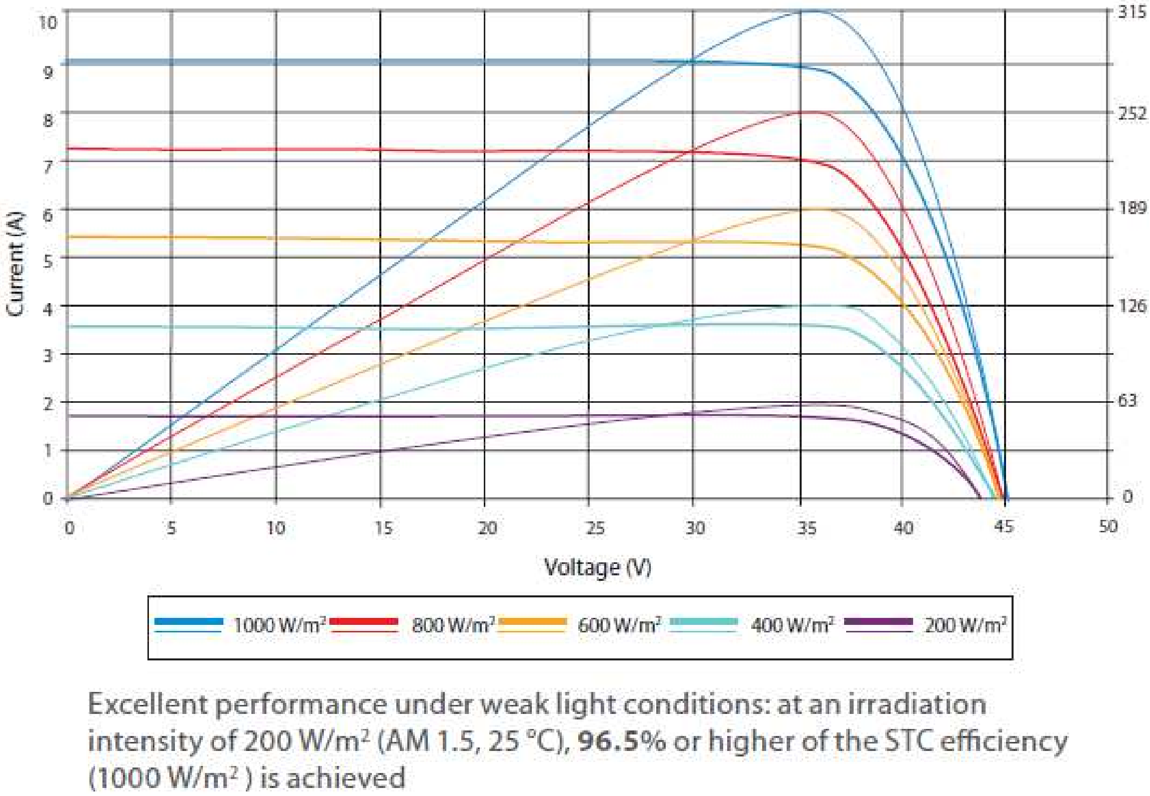

Figure 3. *I-V curve for Suntech panel [21].*

4.2. Inverters

SMA inverters are used with every system, SMA made in Germany. It is tier one in the world.

The size of each system is 125kW. So we selected five 25 kW power inverters. Table 3 shows the selected inverters specifications:

Table 3. *Inverter specification.*

Specification	Inverters / 25 kW
Number of inverter	5
Rated Output Power	25 kw
AC Nominal Voltage Range	160 V- 280 V
Rated Power Frequency	50 Hz/ 230 V
Efficiency	98.40%
Max. output current	29 A
Number of independent MMP inputs/ strings per MPP input	2/ A:3; B:3

4.3. Cables

4.3.1. DC Cable

According to the output current from PV modules we calculate the maximum DC current depends to the formula:

$$IDC = \frac{\text{Imax x Safety Factor x Ampicity correction factor}}{\text{Tem.Correction factor x Conductor Correction Factor}} \quad (1)$$

Table 4. *DC cable calculation.*

Item	Calculation Value
Imax (from panel)	9.012 A
Safety Factor	1.25
Ampicity correction factor	1.25
Conductor Correction Factor	1.000 (from figure 4)
T cell c	58
Tcell F	137
Tem.Correction factor	0.58 (from figure 5)
Idc cable	24.273
Result	4 mm^2 (from figure 6)

Figure 4 shows the adjustment factor depends on the number current carrying across the conductor, we used one conductor so the correction factor will be 1.00.

Number of Current-Carrying	Adjustment Factor
1–3 Conductors	1.00
4–6 Conductors	0.80
7–9 Conductors	0.70*
10–20 Conductors	0.50

Figure 4. *Conductor correction factor [22].*

Figure 5 shows the ambient temperature correction factor depends on the temperature which is equal 58 degree in Jordan. The correction factor will be 0.58.

Ambient Temperature °F	Ambient Temperature °C	Correction Factor 75°C Conductors	Correction Factor 90°C Conductors
70–77°F	21–25°C	1.05	1.04
78–86°F	26–30°C	1.00	1.00
87–95°F	31–35°C	0.94	0.96
96–104°F	36–40°C	0.88	0.91
105–113°F	41–45°C	0.82	0.87
114–122°F	46–-50°C	0.75	0.82
123–131°F	51–-55°C	0.67	0.76
132–140°F	56–60°C	0.58	0.71
141–158°F	61–70°C	0.33	0.58
159–176°F	71–80°C	0.00	0.41

Figure 5. *Ambient temperature correction [22].*

4.3.2. AC Cable

According to the output current from inverter we calculate the maximum AC current depends to the below formula:

$$IAC = \frac{\text{Imax output inveretr x Ampicity correction factor}}{\text{Tem.Correction factor}} \quad (2)$$

Table 5. *AC cable calculation.*

Item	Calculation Value
Imax (from inverter)	36.2 A
Ampicity correction factor	1.25
Tem.Correction factor	0.87
Iac cable=(Imax*Amp/tem.corr)	52 A
Result mm^2	10 mm^2
Length m	15
Voltage drop mV/A/m	4
Voltage drop V	3.96
Voltage drop%	0.99
Final Result	10 mm^2

Figure 7 shows the correction factor depends on the ambient temperature for Jordan, we used 45 degree so the correction factor will be 0.87..

Conductor Size (AWG)	60°C (140°F)	75°C (167°F)	90°C (194°F)
	Types UF	Types RHW, THHW, THWN, XHHW, USE	Types RHW-2, THHN, THHW, THWN-2, USE-2, XHHW, XHHW-2
14*	20	20	25
12*	25	25	30
10*	30	35	40
8	40	50	55
6	55	65	75
4	70	85	95
2	95	115	130
1	110	130	150
1/0	125	150	170
2/0	145	175	195
3/0	165	200	225

Figure 6. *DC cable size selection [22]*

Conductor	Reference method A of Table 4E1A - enclosed in conduit in thermally insulating wall etc				Reference method B of Table 4E1A - enclosed in conduit on a wall or in trunking etc			
	2 cables, single phase a.c. or d.c.		3 or 4 cables, three phase a.c.		2 cables, single phase a.c. or d.c.		3 or 4 cables, three phase a.c.	
C.S.A.	Current carrying capacity	Voltage drop	Current carrying capacity	Voltage drop	Current carrying capacity	Voltage drop	Current carrying capacity	Voltage drop
mm^2	A	mV/A/m	A	mV/A/m	A	mV/A/m	A	mV/A/m
1.0	14	46	13	40	17	46	15	40
1.5	19	31	17	27	23	31	20	27
2.5	26	19	23	16	31	19	28	16
4	35	12	31	10	42	12	37	10
6	45	7.9	40	6.8	54	7.9	48	6.8
10	61	4.7	54	4.0	75	4.7	66	4.0
16	81	2.9	73	2.5	100	2.9	88	2.5
25	106	1.85d 1.90a	95	1.65	133	1.85d 1.90a	117	1.65
35	131	1.35d 1.35a	117	1.15	164	1.35d 1.35a	144	1.15
50	158	0.99d 1.05a	141	0.90	198	0.99d 1.05a	175	0.90
70	200	0.68d 0.75a	179	0.65	253	0.68d 0.75a	222	0.65
95	241	0.49d 0.58a	216	0.50	306	0.49d 0.58a	269	0.50

Correction Factors

For Ambient Temperature

Ambient Temperature	25°C	30°C	35°C	40°C	45°C	50°C	55°C	60°C	65°C	70°C	75°C	80°C
Correction Factor	1.02	1.0	0.96	0.91	0.87	0.82	0.76	0.71	0.65	0.58	0.50	0.41

For Grouping Refer to Table 4C1 of BS 7671

Where a conductor operates at a temperature exceeding 70°C it shall be ascertained that the equipment connected to the conductor is suitable for the conductor operating temperature. [See Regulation 512.1.2 of BS 7671].

E. & O.E.

Figure 7. *AC current cable selection and temp. correction factor [23].*

5. Experimental Result

The experimental study was carried out in order to compare the performance of manual adjustable tilted angle tracking photovoltaic system in comparison with a fixed photovoltaic system of same conditions: same whether condition, same location, same solar irradiation with same time and same type of inverter, panels, cable and production device.

The experiment (of 125 KW) was performed at different months started on April, 2017 to January, 2018. The measurements were taken every 15 minutes.

Table 6 show the data collected by different system using SMA Sunny Portal Website.

The table shows power generated by each system, we started from April, 2017 to Jan, 2018. The percentage difference is calculated to make the comparison in easy way.

This experiment is done in Jordan, Amman, it showed the significant gain of electrical power output generating from fixed system, in comparison with manual single axis tracking system. The amount of power gained from fixed system is 200098.137 kwh, while manual single axis tracking system produced 221566.861kwh under same conditions, with increased approximately 9.69% of generating power.

Table 6. *Power generated by each system.*

Month	Power generated monthly				% of difference
	Manual single axis PV tracking system (tilted angle adjustable)		Fixed PV system (25 deg.)		
	Power generated	angle	Power generated	angle	
Apr. 2017	23256.573	25°	22942.583	25°	1.350112934
May, 2017	25198.1535	15°	23741.571	25°	5.780512846
Jun. 2017	28232.327	10°	22530.265	25°	20.19692532
Jul. 2017	26518.283	5°	21226.061	25°	19.95688032
Aug. 2017	26029.3787	15°	24341.465	25°	6.484648441
Sep. 2017	22566.706	25°	22331.578	25°	1.041924329
Oct. 2017	22329.534	35°	20806.958	25°	6.818664465
Nov. 2017	18605.915	40°	16834.829	25°	9.518940616
Dec. 2017	14609.739	45°	13037.998	25°	10.75817302
Jan. 2018	14220.252	50°	12304.829	25°	13.46968394
Total	221566.8612	-	200098.137	-	9.689501437

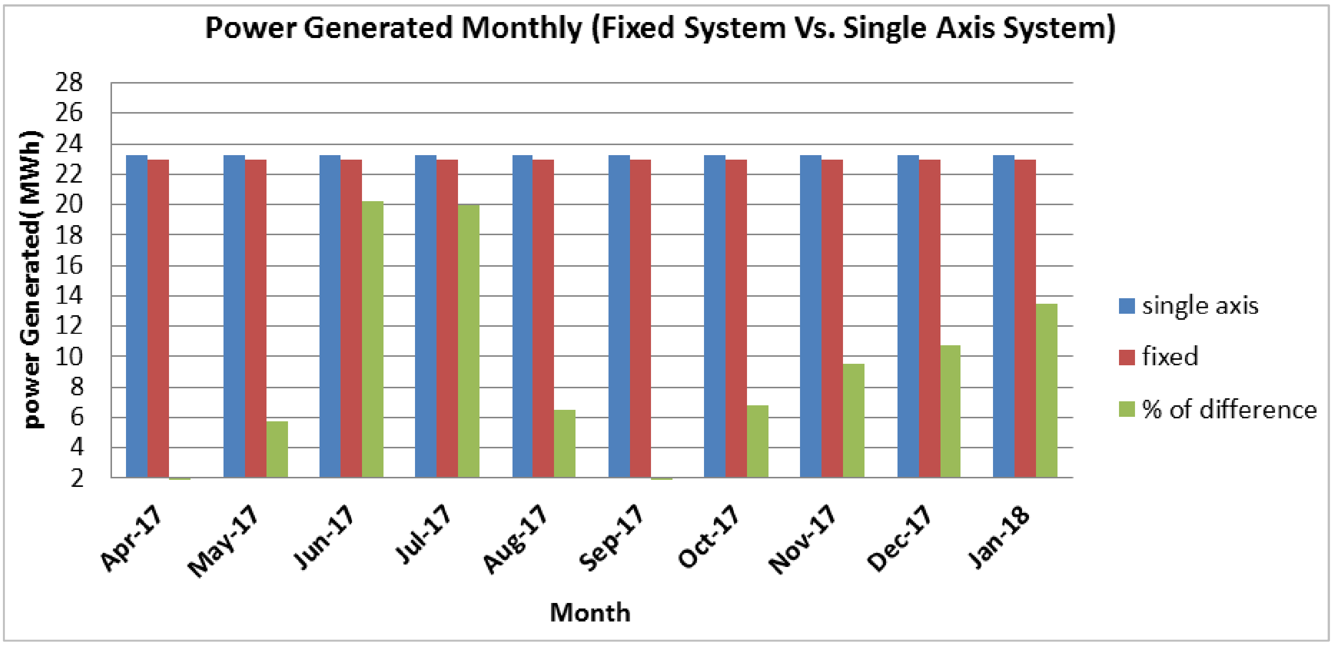

Figure 8. *Power generated monthly.*

6. Simulation Analysis

fixed system

Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	EffArrR %	Eff SysR %
January	93.0	7.00	128.2	124.4	14013	13253	14.09	13.32
February	103.0	8.00	128.2	124.7	13898	13158	13.97	13.23
March	155.0	10.30	175.8	170.9	18878	17902	13.83	13.12
April	191.0	14.60	196.5	190.8	20654	19584	13.54	12.84
May	232.0	18.20	219.3	212.4	22540	21358	13.25	12.55
June	255.0	20.90	230.1	222.4	23234	22040	13.01	12.34
July	261.0	22.90	239.9	232.6	24079	22844	12.93	12.27
August	235.0	23.00	233.9	226.9	23525	22319	12.96	12.30
September	199.0	21.60	222.0	216.0	22480	21376	13.05	12.41
October	161.1	18.20	205.2	199.6	21242	20178	13.34	12.67
November	115.0	13.40	162.1	157.5	17160	16301	13.64	12.96
December	88.0	8.70	126.0	122.4	13734	13026	14.04	13.32
Year	2088.1	15.61	2267.1	2200.5	235437	223338	13.38	12.69

Legends:
GlobHor Horizontal global irradiation
T Amb Ambient Temperature
GlobInc Global incident in coll. plane
GlobEff Effective Global, corr. for IAM and shadings
EArray Effective energy at the output of the array
E_Grid Energy injected into grid
EffArrR Effic. Eout array / rough area
EffSysR Effic. Eout system / rough area

Figure 9. *Simulation result of fixed system.*

Both systems are simulated using PVSYS tool, the power generated is shown in the below figure. the total power injected into grid for fixed system in same period of experimental study (Apr. 2017-Jan. 2018) is 192279 kwh, while the output power injected into grid for single axis tracking system is 220590kwh, with increased approximately 12.83% of injected power into grid.

single axis tracking system

Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	EffArrR %	Eff SysR %
January	93.0	7.00	156.7	154.1	17231	16342	14.17	13.44
February	103.0	8.00	147.3	144.6	16067	15252	14.05	13.34
March	155.0	10.30	198.5	194.6	21389	20318	13.88	13.19
April	191.0	14.60	217.9	213.1	23017	21900	13.61	12.95
May	232.0	18.20	232.7	226.5	24029	22839	13.30	12.64
June	255.0	20.90	244.0	236.9	24765	23545	13.08	12.43
July	261.0	22.90	257.5	250.4	25924	24648	12.97	12.33
August	235.0	23.00	261.2	255.3	26404	25135	13.02	12.40
September	199.0	21.60	257.8	253.1	26159	24893	13.07	12.44
October	161.1	18.20	253.0	249.1	26219	24935	13.35	12.70
November	115.0	13.40	201.0	197.9	21328	20273	13.67	13.00
December	88.0	8.70	154.7	152.2	16933	16080	14.10	13.39
Year	2088.1	15.61	2582.2	2527.8	269465	256160	13.45	12.78

Legends:
GlobHor Horizontal global irradiation
T Amb Ambient Temperature
GlobInc Global incident in coll. plane
GlobEff Effective Global, corr. for IAM and shadings
EArray Effective energy at the output of the array
E_Grid Energy injected into grid
EffArrR Effic. Eout array / rough area
EffSysR Effic. Eout system / rough area

Figure 10. *Simulation result of single axis tracking system.*

7. Conclusion

It can be concluded that the output power injected into grid increased in total monthly collected experimentally by approximately 9.69% as compared with the fixed system of 25̊ tilted angle. for ten months start from April to January under Jordan climate. on the other hand, the simulation tool showed that the power gained from single axis tracking system increased by 12.83%, which is approximately close to the result from experimental study.

The table below showed the comparison between experimental analysis and simulation analysis for both systems: single axis tracking system and fixed tilted angle 25̊. The percentage of difference between experimental output power and simulation result is very small, it doesn't exceed 0.440% using single axis tracking system. While the difference in fixed system is bigger, it is approximately 4.00%.

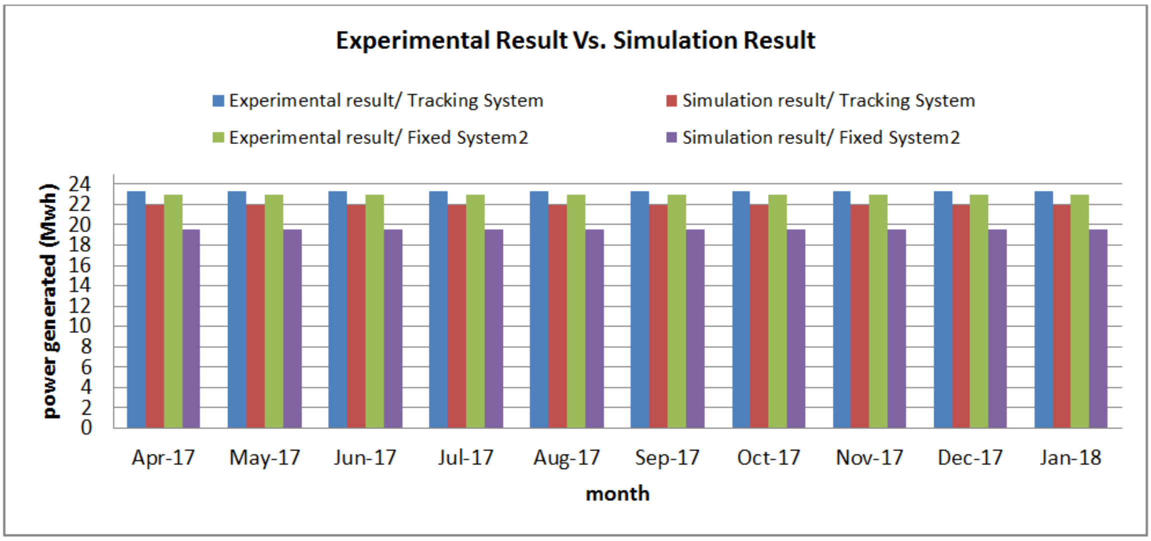

Figure 11. *Experimental result Vs. simulation result.*

Table 7. *Experimental result Vs. simulation result.*

Month	Power generated monthly					
	Manual single axis PV tracking system (tilted angle adjustable)			Fixed PV system (25 deg.)		
	Experimental result	Simulation result	% of difference	Experimental result	Simulation result	% of difference
Apr. 2017	23256.573	21900	5.83307351	22942.583	19584	14.63908
May, 2017	25198.1535	22839	9.36240626	23741.571	21358	10.039652
Jun. 2017	28232.327	23545	16.6026945	22530.265	22040	2.1760286
Jul. 2017	26518.283	24648	7.05280579	21226.061	22844	-7.6224176
Aug. 2017	26029.3787	25135	3.43603553	24341.465	22319	8.3087234
Sep. 2017	22566.706	24893	-10.3085227	22331.578	21376	4.2790438
Oct. 2017	22329.534	24935	-11.6682507	20806.958	20178	3.0228253
Nov. 2017	18605.915	20273	-8.95997321	16834.829	16301	3.1709796
Dec. 2017	14609.739	16080	-10.0635679	13037.998	13026	0.0920233
Jan. 2018	14220.252	16342	-14.9206076	12304.829	13253	-7.7056821
Total	221566.8612	220590	0.44088777	200098.137	192279	3.9076511

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