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RESEARCH ARTICLE OPEN ACCESS

SIMULATION OF A STAND-ALONE SYSTEM BY USING DIFFERENT SOLAR CELL TECHNOLOGIES USING THE PVSYST SOFTWARE

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ABSTRACT

Modeling and simulation of photovoltaic (PV) systems represents an essential task for the integration of PV panels in current power applications. At the present time, there are sizing tools of photovoltaic systems available on the market, taking into account the proposed energy consumption, site localization and system cost. this paper aims to simulation of a stand-alone system for two types: fixed system and non-fixed system in Alkhums city _ Libya using the PVsyst software. The sizing and simulations developed using PV modules based on two different technologies: Monocrystalline and polycrystalline silicon, Results show that the non-fixed system is more efficient than fixed system and the Monocrystalline silicon is more efficient than polycrystalline silicon where the solar fraction was 0.981,performance ratio was 0.653 and energy supplied to the user was 1259.8 kWh/year.

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INTRODUCTION

In recent years, demands have been rising for new energy sources and new techniques have been investigated for that. Such new energy resources must be abundant in quantity, free of pollution, economical and must be able to meet society's demands. Conceivable new energy resources are solar energy, wind energy, tidal energy, etc (Submitted, 2015). A new independent alternative source of energy such as solar is available in abundance because of its salient features like it supports distributed generation, needs minimum maintenance, payback period is small etc (Affandi, 2013)..Libya is located in the north of Africa between 20^0 to 32^0 north latitude and 9.5^0 to 25^0 east longitude with an area of about 1.775 MKm^2 of which only 12% is usable for agriculture, forest and pastures, the remaining 88% is desert. the big areas from the 88% can be used for the world, it is about 2200KWH/m^2 annually on horizontal surface, it varies from 3KWH/m^2/day in winter to 8KWH/m^2/day in summer months solar energy collection.

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Libya is one of the developing countries in which photovoltaic system was first put into work in 1976 to supply electricity for a Cathodic protection station. Since then; the use of photovoltaic systems is widely used in size and applications as standalone systems (Al-Jadi, 2005) Photovoltaic energy is the conversion of sunlight into electricity through- a photovoltaic (PV) cell, commonly called a solar cell. A photovoltaic cell is a non-mechanical device usually made from silicon alloys. Sunlight is composed of photons, or particles of solar energy. These photons contain various amounts of energy corresponding to the different wavelengths of the solar spectrum. When, photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity (Hornak, 1978) Solar modules are the heart of the system and are usually called the power generators. One must have also mounting structures to which PV modules are fixed and directed towards the sun (Jestr, 1980). A solar cell is nothing but a electrical device that directly converts the light energy to electrical energy through the process of photovoltaic effect. Basically the component of this solar cell is silicon. There are three common types of panel available on the market and they are:

- **Monocrystalline Panels**: The dark black color solar panels are known as Monocrystalline solar panels. Monocrystalline panels get their name from the fact that the silicon wafer used to make them is cut from a single crystal or 'boule' of silicon. Silicon is grown in a laboratory to achieve a high degree of purity and is then sliced very thinly to make wafers. The best efficiency is 21.5% until now released by the Sun Power a leading solar manufacturer company (Hornak, 1978).
- **Polycrystalline Panels:** The light or dark blue color solar panels are known as Polycrystalline Panels. It is also known as poly silicon (p-Si) and multi-crystalline silicon (mc-Si). These cells are cut from an ingot of melted and re-crystallized silicon. Raw silicon is melted and poured into a square mold, which is cooled and cut into perfectly square wafers. The efficiency of polycrystalline solar panels is usually 13-17% (Hornak, 1978).
- **Thin Film Panels (Amorphous Silicon):** Thin film, or amorphous, silicon cells are made up of silicon atoms in a thin layer rather than a crystal structure. Amorphous silicon can absorb light more readily than crystalline silicon, so the cells can be thinner. For this reason, amorphous silicon is also known as 'thin film' photovoltaic (PV) technology. The efficiency of Thin Film is very low, usually around 7-13% (Hornak, 1978). In this research it used only Monocrystalline and Polycrystalline Panels.

PV_{SYS} SOFTWARE: PVsyst V7.1 is a PC software package for the study, It is one of the most comprehensive programs used for sizing and simulations of various PV systems. The software manages various types of photovoltaic system analysis like stand-alone PV systems, grid connected of hybrid systems. PV_{SYS} uses meteorological data from international databases as well as detailed information about the component technical specifications (Solar Edge, 2016).

METHODOLOGY

It has chosen the PV_{SYS} software application for comparing various solar cell technologies that could power a photovoltaic lighting system. In order to obtain conclusive results, we varied only the solar cell technologies, and tilt angle and azimuth angle but the other components of the system remained unchanged. The sizing for this type of system will be as a stand-alone fixed system and stand-alone non-fixed system, meaning that connection to the local energy grid is not required.

Most of this type of systems require means for energy storage, therefore our system will use a solar battery. The PV application must be dimensioned to fully charge the batteries when exposed to maximum intensity for the given application. To avoid the possibility of damaging the system because of solar radiation fluctuations or battery overload, the system will be equipped with a charge controller. The PV system is intended to provide two days autonomy, in order to compensate for days with high cloudiness. This feature will result in a slightly oversized PV generator and battery. The types of PV technologies used in the simulations are Monocrystalline silicon and polycrystalline silicon solar cells. In order to choose the most suited solar battery for the system, important factors are considered, like daily energy consumption (3.522 kWh/day), number of days for system autonomy (2 days), battery voltage (12 V) and discharge coefficient (0.4).PV module used for the analysis is Solar Semiconductor. Table I shows the Main technical characteristics of Solar Semiconductor.

Table 1. The Main technical characteristics of Solar Semiconductor [PVsys software]

Technical characteristics	SSI-BIPV-150m
Nominal Power	150 w
Open circuit Voltage	24.40 V
Maximum voltage power point	19.70 V
Maximum power point	150.2 w
Maximum power point current	7.61 A
Short circuit current	8.23 A
Sizes	1653*983*32 mm
Weight	28 kg

Taking this result in consideration, for all the different types of PV technologies used in the simulations.
The methodology for this study given in tow steps:

Methodology for stand-alone fixed system

- Chose PV module (polycrystalline or Monocrystalline)keep it to true south
- Set tilt angle = 0.0 degreeand azimuth angle = 30 degree
- Set IAM (Incidence Angle Modifier) loss = 0.
- Tabulate the results.

Methodology for stand-alone non-fixed system.

1.Chose PV module (polycrystalline or Monocrystalline)
2.Set module to tilt angle and azimuth angle
3.Set IAM (Incidence Angle Modifier) loss = 0.
4.Tabulate the results.

SIMOLATION RESULTS AND DISCUSSION

Alkhums's longitude is 14.2639 degrees and latitude is 32.6504 degrees. In the present study, the meteorological data is acquired from Meteonorm version 7.2, a comprehensive climatological database for solar energy applications. Fig (1) illustrates the sun path diagram for the location of Alkhums city.

This shape expresses the apparent path of the sun facing the system, where it shows the outer path is the maximum path of the sun reaches in the summer and the inner path expresses the winter path of the sun and between them falls with the rest of the year. The organization is installed in an open space.

Table II shows the horizontal Global irradiance of Al khums city (monthly and year).Global Irradiance is the amount of energy reaching the earth on a horizontal surface (tilt angle = 0, azimuth angle = 0)

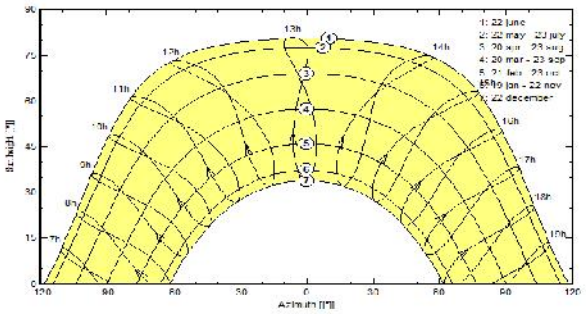

Figure (1) Sun path diagram for the location of Alkhums city_Libya [PVsys software, Meteonorm 7.2]

Table II Horizontal global irradiance of Al khums city

Month	Horizontal global Irradiance kWh/m^2.mth
January	100.9
February	116.7
March	168.1
April	199
May	230.5
June	234.3
July	245.8
august	221.8
September	177
October	141
November	109.2
December	90.4
Year	2034.6

Case 1: Study of stand-alone fixed system.

The design is created by selecting the area in which off grid PV plant is to be installed. For fixed system the optimum tilt angle is 30degree and the azimuth angle is 0 degree for Al khums. Then following inputs are provided:

Set the location longitude is 14.2639 degrees and latitude is 32.6504 degrees.

- Azimuth angle =0 degrees
- Tilt angle = 30 degrees
- PV module of150 Watt
- String length = 1,

By used Polycrystalline: Taking this result in consideration, for all the different types of PV technologies used in the simulations, it has considered a Solar Semiconductor battery of 12 V/239 Ah. Table III represents the numerical simulation results for the fixed system using Polycrystalline silicon modules, while Fig(2) shows the system performance ratio and solar fraction. The simulation results of the photovoltaic system using Polycrystalline silicon shows that for January, March, November and December months, the system fails to provide 38.71 kWh\year of energy needed.

Table III Monthly numerical simulation results for PV fixed system using Polycrystalline silicon modules

Month	E miss kWh	E User kWh	E load kWh	Solfrac
January	12.85	96.3	109.2	0.882
February	0.00	98.6	98.6	1.00
March	5.93	103.3	109.2	0.946
April	0.00	105.7	105.7	1.00
May	0.00	109.2	109.2	1.00
June	0.00	105.7	105.7	1.00
July	0.00	109.2	109.2	1.00
august	0.00	109.2	109.2	1.00
September	0.00	105.7	105.7	1.00
October	0.00	109.2	109.2	1.00
November	5.36	100.3	105.7	0.949
December	14.56	94.6	109.2	0.867
Year	38.71	1247.0	1285.7	0.970

Legends: E miss missing energy0.6095
E User energy supplied to the user0.971
E load energy need to the user
Solfrac solar fraction (E User/ E load)

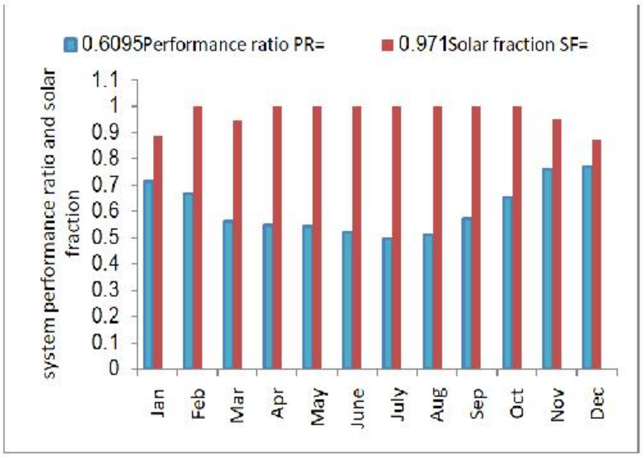

Figure 2. For fixed system used Polycrystalline silicon modules.

By used Monocrystalline: Table IVrepresents the numerical simulation results for the fixed system using Monocrystalline silicon modules, while Fig (3) shows the system performance ratio and solar fraction.Results using polycrystalline silicon, as well as the Monocrystalline silicon indicate that in January, November and December, the system cannot fulfill thetotal system energy needs, by a quantity of 36.69 kWh\year.

Table IV Monthly numerical simulation results for PV fixed system using Monocrystalline silicon modules

Month	E miss kWh	E User kWh	E load kWh	Solfrac
January	12.06	97.1	109.2	0.892
February	0.00	98.6	98.6	1.00
March	5.84	103.4	109.2	0.946
April	0.00	105.7	105.7	1.00
May	0.00	109.2	109.2	1.00
June	0.00	105.7	105.7	1.00
July	0.00	109.2	109.2	1.00
august	0.00	109.2	109.2	1.00
September	0.00	105.7	105.7	1.00
October	0.00	109.2	109.2	1.00
November	5.24	100.4	105.7	0.95
December	13.55	95.6	109.2	0.876
Year	36.69	1249.0	1285.7	0.971

Legends:
E miss missing energy0.6013
E User energy supplied to the user **0.971**
E load energy need to the user
Solfrac solar fraction (E User/ E load)

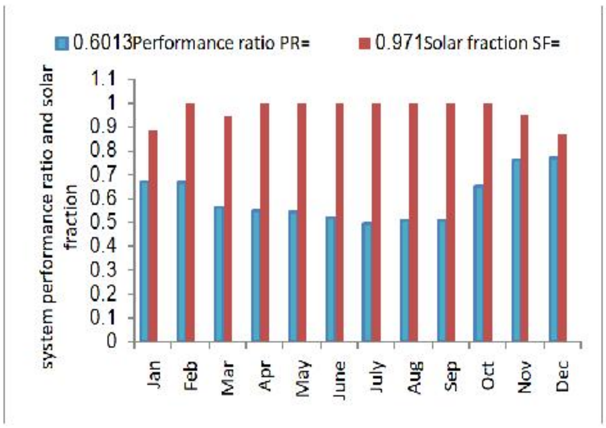

Figure 3. Performance ratio and solar fraction for fixed system used Monocrystalline silicon modules

Case 2: Study of stand-alone non-fixed system.

For a non-fixed system, the tilt angle and azimuth angle change from month to month. Table V shows the optimum tilt angle and azimuth angle for a non-fixed system (Jumaa, 2020).

Table V Month-wise Tilt and azimuth Angle for Al khums

Month	Tilt angle	Azimuth Angle
January	60^0	0.0^0
February	50^0	0.0^0
March	40^0	10^0
April	20^0	10^0
May	10^0	30^0
June	0.0^0	320^0
July	0.0^0	30^0
August	20^0	0.0^0
September	30^0	0.0^0
October	50^0	0.0^0
November	60^0	0.0^0
December	60^0	0.0^0

All the inputs in design are same as before in**case 1**only the tilt angle and the azimuth angle is it changes from month to month according to table V Then following inputs are provided:

- Set the location longitude is 14.2639 degrees and latitude is 32.6504 degrees.
- Tilt angle = from table (V) for each month
- Azimuth angle = from table (V) for each month
- PV module of 150 Watt
- String length = 1,

By used Polycrystalline: Table VI represents the numerical simulation results for the fixed system using Polycrystalline silicon modules, while Fig (4) shows the system performance ratio and solar fraction.

The simulation results of the photovoltaic system using Polycrystalline siliconshows that for January,March, November and December months, the system failsto provide 25.98 kWh\year of energy needed.

Table VI Monthly numerical simulation results for PV fixed system using Polycrystallinesilicon modules

Month	E miss kWh	E User kWh	E load kWh	Solfrac
January	10.10	99.1	109.2	0.908
February	0.00	98.6	98.6	1.00
March	5.85	103.3	109.2	0.946
April	0.00	105.7	105.7	1.00
May	0.00	109.2	109.2	1.00
June	0.00	105.7	105.7	1.00
July	0.00	109.2	109.2	1.00
august	0.00	109.2	109.2	1.00
September	0.00	105.7	105.7	1.00
October	0.00	109.2	109.2	1.00
November	4.44	101.2	105.7	0.958
December	5.59	103.6	109.2	0.949
Year	25.98	1259.7	1285.7	0.980

Legends:
E miss missing energy
E User energy supplied to the user
E load energy need to the user
Solfrac solar fraction (E User/ E load)

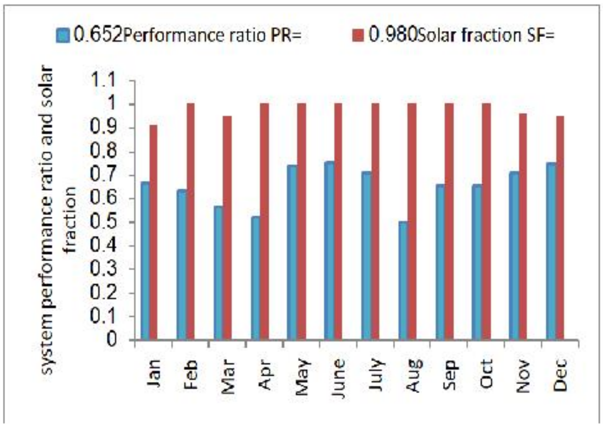

Figure (4) performance ratio and solar fraction for non-fixed system used Polycrystalline silicon modules

By used Monocrystalline: Table VIrepresents the numerical simulation results for the fixed system using Monocrystalline silicon modules, while Fig (5) shows the system performance ratio and solar fraction.Results using polycrystalline silicon, as well as the Monocrystalline silicon indicate that in January, November and December, the system cannot fulfill thetotal system energy needs, by a quantity of 24.286 kWh\year.

Table VII Monthly numerical simulation results for PV fixed system using Monocrystalline silicon modules

Month	E miss kWh	E User kWh	E load kWh	Solfrac
January	9.99	99.2	109.2	0.908
February	0.00	98.6	98.6	1.00
March	5.87	103.3	109.2	0.946
April	0.00	105.7	105.7	1.00
May	0.00	109.2	109.2	1.00
June	0.00	105.7	105.7	1.00
July	0.00	109.2	109.2	1.00
august	0.00	109.2	109.2	1.00
September	0.00	105.7	105.7	1.00
October	0.00	109.2	109.2	1.00
November	4.34	101.2	105.7	0.958
December	4.286	103.6	109.2	0.949
Year	24.486	1259.8	1285.7	0.980

Legends:
E miss missing energy
E load energy need to the user
Solfrac solar fraction (E User/ E load)
E User energy supplied to the user

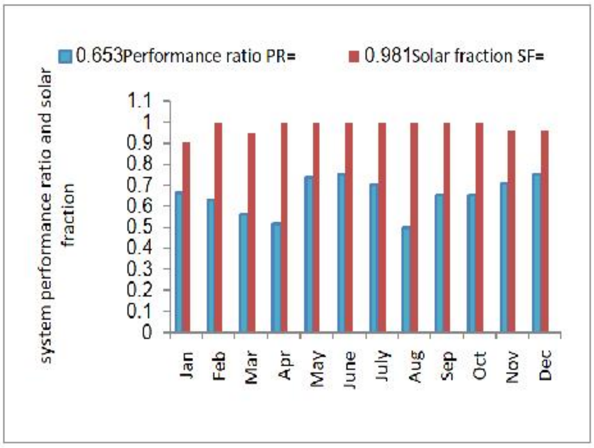

Figure 5. Performance ratio and solar fraction for non-fixed system used Monocrystalline silicon modules

Taking into account the obtained results in this study the Monocrystalline silicon offers the best yield. This is highlighted by the annual solar fraction between the energy supplied and the energy needed of the system. However, which is the highest of the analyzed situations. During the simulations, the modules used are almost identical in means of power and voltage, the main differences are the type of cells used. The simulation program estimates the module losses reported to the power tolerance, namely to a value of half of the inferior tolerance. This value is given by the manufacturers. During simulations, because of different manufacturers and power tolerance values, it could explain the fact that the non-fixed system is more efficient than fixed system and the Monocrystalline silicon is more efficient than polycrystalline silicon. A solar fraction value is less than one in the winter season, due to the clouds blocking the sun‘s rays, and this deficiency can be compensated by adding a number of batteries to the system or installing larger capacity batteries.

CONCLUSION

Sizing and simulations of a photovoltaic system before installation are a very important step. Critical information could result in finding unknown errors in the system or, why not, enhancing the system overall yield. This paper shows the results of systems using various solar cell technologies but with almost identical BOS components For the analyzed systems, The simulation Results show that the non-fixed system is more efficient than fixed system and the Monocrystal line silicon is more efficient than polycrystalline silicon where the solar fraction was 0.980,performance ratio was 0.653and energy supplied to the user is 1259.8 kWh/year.

REFERENCES

Affandi, R., M. Ruddin, A. Ghani, and C. K. Gan, “A Review of Concentrating Solar Power (CSP) In Malaysian Environment,” *Int. J. Eng. Adv. Technol.*, no. 2, pp. 378–382, 2013.

Al-Jadi, I. M. S. I. M. A. EKhlat, and Krema, N. M. 2005. “Photovoltaic in Libya applications, and evaluation,” *Proc. Int. Renew. Energy Dev. Ctries.*, pp. 1–11.

Hornak J. P. and Knight, K. 1978. “Solar energy system retrofit.,” *HPAC Heating, Piping, Air Cond.*, vol. 50, no. 1, pp. 87–89.

J estr,” vol. 6, no. 1, pp. 87–90, 1980.

Jumaa M. and Shukri, A. 2020. “Effect of Tilt Angle and Azimuth Angle on The Global Irradiance Using The PVsyst Software for Alkhums-Libya,” *Albahit J. Appl. Sci.*, vol. 1, no. 1, pp. 60–64.

Solar Edge, 2016. “Application Note - How to Simulate a SolarEdge PV System in PVsyst,” no. November, pp. 1–13.

Submitted T. and Science, I. 2015. “Modelling of an Efficient Dynamic Smart Solar Photovoltaic Power Grid System Balogun Emmanuel Babajide,” no. September.

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