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Stand-Alone Solar Power System Design for a Clinic Centre Top Roof in AZ-Zawia City, Libya

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ABSTRACT

There are many motives for using solar energy in Libya country, one of which is that the climatic conditions are ideal and strong, and the other is that solar energy is environmentally benign. This paper simulates a stand-alone solar system for a health facility in the city of AZ-Zawia, Libya, using MATLAB programming depending on the area bar selected using a Homer programmer. Solar array sizing and system design calculations were integrated during the simulation procedure. Assuming that the average number of hours of sunshine in the city of AZ-Zawia is about 6.5 hours, the required capacity is about 5 kW, and the energy used per hour is approximately 32 kWh. In addition, system sizing components are calculated, such as the solar array, battery capacity charging and discharging times, charging controller, inverter characteristics, system wiring, circuit breaker features, and characteristics. Also, current I vs. voltage V and power P vs. the voltage V curves of the solar array are simulated. The power output of the designed system is simulated. The input voltage of the DC and current inverter as well as the output voltage of the DC and current inverter are obtained. The intended system consists of a 32 kW/day photovoltaic system with 36 batteries (12 V, 1403.5 Ah) and a 5 kW MPPT inverter. According to system ratings, this system can maintain cottage lighting and appliance loads. A simulation of the dynamic model of the system designed by MATLAB-Simulink was performed. According to the simulation results, the designed system can provide stable voltage and frequency for clinic center loads.

KEYWORDS: Stand-alone, Solar Irradiance, Solar System, Loads Classifications, System Sizing, Online Education, HOMER Program, MATLAB Simulink

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تصميم نظام طاقة شمسية مستقل لسطح علوي لمركز طبي في مدينة الزاوية، ليبيا

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الملخص:

هناك العديد من الدوافع لاستخدام الطاقة الشمسية في ليبيا، أحدها أن الظروف المناخية مثالية وقوية، والآخر أن الطاقة الشمسية صديقة للبيئة. يحاكي هذا البحث نظامًا شمسيًا مستقلاً على برنامج الماتلاب لمنشأة صحية في مدينة الزاوية، ليبيا، باستخدام برمجةاعتمادًا على شريط المساحة المحدد باستخدام مبرمج الهومر. تم دمج حسابات حجم المجموعة الشمسية وتصميم النظام أثناء إجراء المحاكاة. وبافتراض أن متوسط عدد ساعات سطوع الشمس في مدينة الزاوية حوالي 6.5 ساعة، فإن القدرة المطلوبة لتغذية هذه الأحمال تقريبا 5 كيلو واط، والطاقة المستخدمة في الساعة حوالي 32 كيلو واط ساعة. بالإضافة إلى ذلك، تم حساب مكونات حجم النظام، مثل المصفوفة الشمسية، وأوقات الشحن والتفريغ لسعة البطارية، ووحدة التحكم في الشحن، وخصائص العاكس، وأسلاك النظام، وميزات قاطع الدائرة، وخصائصها. أيضًا، تمت محاكاة منحنيات التيارمقابل الجهد الكهربي(**V**) و كذلك القدرة (**P**) مقابل الجهد الكهربي (**V**) للمصفوفة الشمسية. بالاضافة الي انه تم الحصول على جهد الإدخال للتيار المستمر والعاكس الحالي وجهد الخرج للتيار المستمر. يتكون النظام الشمسي المصمم من الواح كهروضوئية بقدرة 32 كيلووات/ يوم مع 36 بطارية (12 فولت، 1403.5 أمبير) وعاكس نوع بقدرة 5 كيلووات. وفقًا للنتائج المتحصل عليها اثناء تصميم ومحاكاة النظام، يمكن لهذا النظام الحفاظ على إضاءة المنزل وأحمال الأجهزة. من ناحية اخري، تم إجراء محاكاة للنموذج الديناميكي للنظام المصمم بواسطة برنامج المحاكاة الماتلاب. وفقا لنتائج المحاكاة، يمكن

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للنظام المصمم توفير الجهد والتردد المستقرين لأحمال المركز الطبي الذي تمت عليه هذه الدراسة.

الكلمات الدالة:

مستقل، الإشعاع الشمسي، النظام الشمسي، تصنيفات الأحمال، تحجيم النظام، التعليم عبر الإنترنت، برنامج هومر، المحاكاة ببرنامج الماتلاب

1. INTRODUCTION

What exactly is a solar PV system?

A solar photovoltaic system, often known as a solar power system, is a renewable energy system that converts sunlight into electricity using PV modules. The generated electricity can be stored or consumed immediately. In other words, solar cells can feed back into the grid, or combine with one or more other renewable energy sources. Solar PV systems are a very dependable and clean electricity source that may be used for various purposes, including residential, industrial, agricultural, livestock, etc. [1, 5].

Our solar system's vitality depends on the energy provided by the sun. The sun provides about a year's worth of energy to the world in just one hour [1]. Direct conversion of sunlight to electricity is referred to as photovoltaic. It is an appealing alternative to traditional electricity sources for a variety of reasons, one of these reasons is that it is safe, quiet, non-polluting, and renewable, in addition, it is capacity can be increased incrementally to match gradual load growth. Moreover, it is reliable with minimal failure rates and projected service lifetime [2, 3]. Furthermore, solar cells do not require any specific preparation to function, consequently, it has no moving parts and it is inconceivably solid, hence PV systems in many cases require a small area, so Photovoltaic systems can be plugged in nearly anywhere.

The sum of daylight coming to the soil changes depending on the time of day, season, area, and climate conditions. Irradiation is the total energy emitted by the sun on a daily or annual basis, and it reflects the power of the sun.

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Because of different geographical regions have different weather patterns; the selected area has a significant impact on photovoltaic system design from a variety of angles including panel orientation determining the number of days of autonomy when the sun does not shine in the sky [4].

The solar radiation, location, the PV panel's face angle, the kind of PV (monocrystalline, polycrystalline, micro amorphous silicon, etc.), and other factors all affect the efficiency and output power of PV [8]. PV system design and simulation can be useful in a variety of scientific studies. It can be useful to characterize the observation, forecast the behavior of the system, and then evaluate the accuracy of the model while keeping an eye on the physical system [9].

The purpose of this study is to design and describe the steps involved in designing and selecting equipment for a stand-alone solar system based on Watt-Hour demand for feeding the clinic center located in AZ-Zawia City, Libya with suitable voltage and frequency. A residence in AZ-Zawia City, Libya, with medium energy usage was chosen as a case study. This paper presents a stand-alone PV system design with an efficient battery-charging controller based on suitable design equations. AZ-Zawia city is an ideal location for soaking up the sun. As illustrated in figure (1), AZ-Zawia strip is located at 32° latitude and 11° degrees longitude according to the HOMER program, making it a sun-rich region with annual solar irradiation of roughly **5.32 KWh/m^2/d**. In addition, all required components for the design have been simulated using Mat-lap software. The first step in designing a PV system is to choose a suitable location for solar panels and other components such as batteries, charge controllers, and inverters. Otherwise, the result from the system will not have desired power output [10]. Since most renewable energy sources derive directly or indirectly from the Sun, it is possible that the Sun will provide all of our future energy demands. It gives off greater vitality. More energy per hour than the Earth consumes in a year; it is devoid of carbon gases, and very secure geopolitical conditions conflicts, and limitations. The volume of solar power on the Earth's surface is approximately 100,000 TW [11]. In this paper also, the PV-array design and the

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Voltage and current curve of the solar panel array characteristic will be simulated using MATLAB. Furthermore, the inverter used in the PV design for converting AC& DC voltages and currents characteristic to feed both types of loads will be simulated as well.

غراء الزاوية Garraa, QP7P+6H9, Ez-zauia, Libya (32°45.8'N , 12°44.2'E)

32° 55' 07.81" N 11° 26' 27.19" E

Zawia Libya

Fig.1 AZ- Zawia city strip on HOMMER programmer

In this paper also an introduction to solar PV systems is illustrated in section 1. The problem statement, methodology, and case study of this paper are included in sections 2, 3, and 4 respectively. The system configuration and the sizing of system wiring of the PV system are illustrated in sections 5 and 6 respectively. The proposed system sizing calculation, which includes the characteristics of the battery used, in addition to inverter type and PV inserted in this complex system. Moreover, the required hourly energy for the clinic center located in AZ-Zawia city is obtained in section 7. The last sections give the simulated results, conclusion, and the used references respectively.

2. PROBLEM STATEMENT

Due to the fact that the weather, amount of daylight, and power consumption change every 24 hours, standalone PV systems only produce intermittent DC electricity. This results in customers' inability to fulfill their needs for electricity at specific times. To make up for such issues when the power is conserved during peak generation periods, some equipment is required. Therefore, a power storage utility is needed to store excess electricity generated by consumers so that it can be used as needed [12]. Electric energy has

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become one of the most crucial requirements for humanity's demands in the modern world, and electricity demand has been significantly increasing. Due to a number of circumstances, Libya's electrical energy supplies have recently become exceedingly unreliable. One of these issues is the rise in unlawful loads due to some customers who are unlikely to want to pay fees for the electric energy they consume in their daily lives, in addition to the expiration of electric stations, which have become unable to feed the majority of electric loads such as houses, schools, universities, and other critical institutions that should operate without any interruptions. Instability in generating electric energy, on the other hand, can generate a variety of problems, including influencing consumer loads. Furthermore, the harmful gases produced by electric firms such as oil and gas stations, are also one of the difficulties that force customers to move to other forms of energy sources, in addition, these gas and oil stations have an adverse effect on humans and are driving global changes. As a result, a new technique known as solar photovoltaic technology systems should be adopted to deal with such massive challenges. Solar cell technology is a relatively new invention that has quickly become one of the most popular ways to generate clean, natural, effective, steady, and reliable energy.

3. METHODOLOGY

Before designing the required solar cell system, there are some steps that must be considered. One of these points is major system components which have to be chosen depending on the design type such as photovoltaic panel, charger controller, batteries, load types, inverter characteristics, and other auxiliary energy sources used for the design. After knowing all required components and their calculations, all required values can be entered in all blocks using MATLAB programming to simulate the results.

4. CASE STUDY

A Residence in Zawia City, Libya

According to the HOMER program, AZ-Zawia city, Libya is a very sun-rich place with annual solar irradiation of about 5.32 kWh/m^2per day due to its geographical location at 32° latitude and

12° longitude and the temperature of air is (20.29^{0}). As a result, solar energy systems in such area of the globe would be incredibly efficient as shown in figure (2).

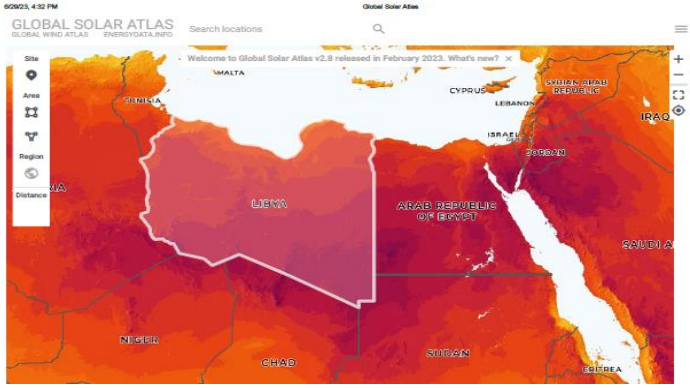

Fig.2 Global solar atlas map for irradiation measurements [7]

5. SYSTEM CONFIGURATIONS

Photovoltaic systems are categorized as standalone or utility-interactive depending on how the system components are connected to other power sources.

Figure (3) below illustrates a stand-alone PV solar system that is designed to function independently of the electric utility grid and is often constructed and sized to serve particular DC and/or AC electrical loads.

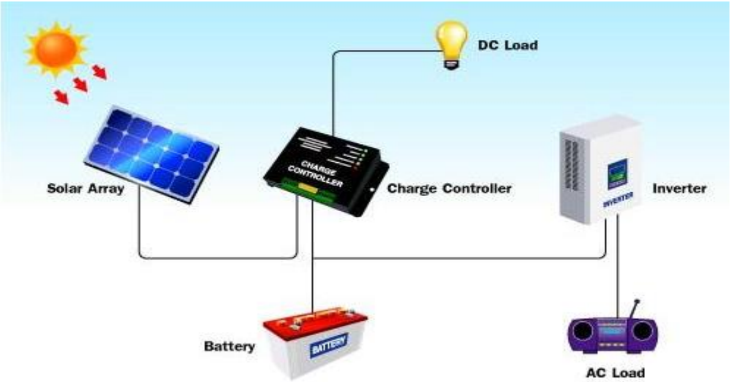

Fig.3 Stand-alone photovoltaic System Schematic Diagram [3, 6].

6. SIZING OF SYSTEM WIRING

Selecting the proper estimate and sort of wire will decrease the misfortunes over the wire due to the resistance upgrade to execution and unwavering quality of a photovoltaic framework. The DC wires between the photovoltaic modules and batteries through the voltage controller must withstand the extreme current created by these wires. Table (1) illustrates the power consumption required for the design of a stand-alone solar cell system.

Table 1. Required power consumption and hours used.

Individual loads	Qty.	W/load	KW.AC	Use h/d	KWh/d AC
Refrigerator	3	0.16	0.48	15	7.2
freezer	1	0.16	0.16	15	2.4
light detector	2	0.25	0.5	5	2.5
Computer	1	0.3	0.3	6	1.8
Ultrasound	1	0.25	0.25	6	1.5
suction machine	1	0.3	0.3	6	1.8
Blood pressure	1	0.05	0.05	6	0.3
Centrifuge	1	0.2	0.2	6	1.2
CBC device	1	0.3	0.3	6	1.8
sterilizer	1	0.2	0.2	6	1.2
water fridge	1	0.2	0.2	6	1.2
LED lamp	20	0.015	0.3	6	1.8
ECG: Electro-cardiograph	1	0.15	0.15	6	0.9
AC total connected Watts			3.39	**AC average daily load**	25.6
Total Average Energy Consumption 25.6KWh/day AC					

7. CALCULATIONS OF PROPOSED SYSTEM SIZING

7.1. Sizing of the Solar Array Calculations

The characteristic of the selected panel (PV module ASW-280M) is [5]:

- Manufacturer: American Solar Wholesale
- Model Number: ASW-280M

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- CSI Approved: Yes
- CSI Model Number: ASW-280M
- Description: 280W-Mono-crystalline Module
- Cell type: Mono-crystalline.
- Power at STC: 280W
- Power at PTC: 248.4W
- Open circuit voltage (V_{oc}): 43.99V.
- Short circuit current (I_{sc}): 8.14A.
- Maximum power voltage (V_{mp}): 37.01V.
- Maximum power current (I_{mp}): 7.57A.

  The daily energy requirement from the solar array can be determined using equation (1).

$$E_r = \frac{E}{\mu} = \frac{25600}{0.8} = 32\text{KW.h/day} \qquad (1)$$

Equation (2) below is used to obtain the peak power of the PV.

$$P_p = \frac{E_r}{T} = \frac{32}{6.5} = 4.92\text{KW} \qquad (2)$$

The total current needed can be calculated by using equation (3) below.

$$I_{DC} = \frac{P_p}{V_{DC}} = \frac{4923}{48} = 102 \text{ Amps} \qquad (3)$$

According to the necessity to meet the desired voltage and current, modules linked in series and parallel in line with:
To begin, consider the entire number of modules calculated using equation (4) as follows.

$$N_T = \frac{P_T/Pa}{P_{/Pa}} = \frac{5KW}{280W} = 18 \text{ panals} \qquad (4)$$

Second, the number of series modules is computed using equation (5) illustrated below.

$$N_s = \frac{V_{DC}}{V_r} = \frac{48}{31.8} = 2 \text{ panal} \qquad (5)$$

Finally, the total number of modules connected in parallel is calculated using equation (6) below.

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$$N_p = \frac{N_T}{N_s} = \frac{18}{2} = 9 \text{ panal} \qquad (6)$$

The PV array of the system consists of (9) strings in parallel and (2) strings connected in series.

The calculation of consumed energy daily is the multiplication of the number of used devices and the power of each device multiplied by the operated hours per day. Therefore, by combining the computed illustrated in table (1), the total energy consumed is(25.6KWh).

The efficiency of the system is 25% due to the losses resulting from the drop in voltage, high temperatures and the amount of light falling on the cells due to the direction of the cells and their lack of rotation with the solar beam and others. Therefore, the consumed energy per hour is(25.6KWh)(1.25), which resulting in(32KWh).

To find out the capacity by computing the average number of sunshine hours in our city is about (6.5)hours. Therefore, the required energy is(32KW/6.5 = 5KW).

7.2. Sizing Of Battery Bank Calculations

- Total average energy use is (32KWh)
- Days of autonomy or the no-sun days is determined to be 2 days. According to the selected battery (Solar RB 350 AH, 48V-DC).
- The amount of energy storage required is,

$$E_{rough} = 32000 \times 2 = 64KWh$$

- For Energy safety,

$$E_{safe} = \frac{64000}{0.95} = 67368.4 \text{ WH}$$

- The capacity of the battery bank required can be calculated using equation (7) written below.

$$C = \frac{E_{safe}}{V_b} = \frac{67368.4}{48} = 1403.5 \text{ A.h} \qquad (7)$$

- The total number of batteries conned in series N_{bs} is computed as in equation (8)

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$$N_{bs} = \frac{C}{C_b} = \frac{1403.5}{350} = 4 \text{ battery} \qquad (8)$$

Alternatively, by using another method illustrated as below:

- The number of batteries in series equals to
  (48V/12V per battery = 4 batteries)
- Then number of parallel paths is,
  $N_{bp} = (2808\text{A.h})/(350\text{A.h}) = 9$ battery
- The number of batteries needed is,

$N_{Bat}(9)(4) = 36$ battery connected as (9) parallel branches and (4) series batteries.

The process of discharging the electric charge from the batteries occurs during the hours of sunset, and when the charging current from the panels is insufficient to charge the batteries, a discharge condition arises, shortening the battery's life.

The number of hours without sunshine due to clouds, rain and dust is calculated, in which the dependence on the electrical energy stored in the battery bank will be from 5 to 7 days. However, the number of hours without sunshine is sometimes less than 2-3 days, depending on the environmental conditions of the area, which the solar system rely on. Depending on the electric grid panels that must give a current to the charging regulator should be 20% greater than the current required to charge the batteries by assuming the number of days without sunshine is 2. The voltage system (DC) that fits the solar PV is (48V), and the discharge (DOD) of depth (50%) and battery charge efficiency is (95%), in addition, the battery voltage is(12V), furthermore the capacity of the battery is(350Ah), consequently the battery capacity computed as:

Battery Capacity = (32000W.h /day*2day) / (0.95*0.5*48V)

$$\text{Battery Capacity} = 2808 \text{ A.H}$$

- The type of battery is Solar (RB) has a voltage of (12V) and capacity of (350A.h)
- The number of batteries connected in series is the voltage of the system over the voltage of each battery:

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$$\text{Number of batteries} = (48\text{V})/\left(\frac{12\text{V}}{\text{per}}\text{battery}\right)$$
$$\text{No. of batteries} = 4\ \text{battery}$$

The number of batteries connected in parallel = the capacity of battery bank over the battery capacity is$(2808\text{A.h})/(350\text{A.h}) = 9$ battery, consequently, the total number of the required batteries is$(9)(4) = 36$ battery.

- Time of charging and discharging batteries:

Table (1) drawn above illustrates the computed loads which can be operated at the same time assuming that 60% only of total load value operating, the total load energy of 60% is 0.6*3390 = 2034Watt-AC. The total power of the 60% of the total load is 0.6*25600 = 15360W.h–AC

- Time required for operating the loads, average discharge rate and charging current of battery are determined by equations (9&10&11) inserted as below.

Weighted average load work time= ∑ Energy ÷ ∑Power (9)

Weighted average load work time= 15360Wh/2034W
Weighted average load work time = 7.55 hours/day

Average Discharge Rate (h) = (Autonomy days* weighted average load work time)/ DOD (10)

Average Discharge Rate (h) = $((2\text{day})(7.55\text{h/day}))/(0.5)$
Average Discharge Rate (h) = 30.2h

The results above illustrated that the system is able to give about (30.2h) during operating (60%) of the total load, where the discharging ratio is the maximum current the battery can transfer, and it should be (10%) of the battery capacity, hence

Charging current of Battery = C x (10/100) (11)
Charging current of Battery = 0.1/h*350A.h = 35A

Fundamentally, the charging current ought more noteworthy than the charging current of the batteries. Hence, the expected current is (37A) with misfortunes of(40%).

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This implies that misfortunes will be included to the capacity of the battery, which can be calculated as (350)×(40/100) = 140, subsequently the modern charging time of battery = Battery Ah/Charging Current and time (T) = Ah/A = $(490\text{A.h})/(37\text{A})$ = 13.24 Hours, which is the entire time required for charging the battery totally. Moreover, the current of the framework is around (65A) is more prominent than the current required for charging the (35A) batteries and this is often the desired result for planning distant better, improved and a stronger PV-systems.

7.3. Sizing Of Voltage Controller Calculations & Sizing of Wires

The charge of the controller during gloomy or foggy days (Autumn/Winter/Spring), as well as low temperature circumstances, MPPT is most effective and best matches charge controller. MPPT is utilized to harvest the maximum available energy from the solar panel, which works best in cold weather. When the battery is deeply depleted, in addition MPPT, allows additional current (A) to be extracted for the battery to be charged, even though the battery charging condition is low. Any panel or series of panels' (V_{oc}) (Open Circuit Voltage) and (I_{sc}) (Short Circuit Current) cannot exceed the permitted limit for voltage and current entering both the charging regulator and the inverter. To avoid any charging regulator or inverter damage that is not covered by the guarantee. Using proper wiring for the panels, voltage (V_{oc} orV_{mpp}) can be controlled, so in current devices, it is frequently combined with the inverter. Essentially, selecting the right estimate and sort of wire will decrease the misfortunes over the wire due to the resistance improve the execution and unwavering quality of a photovoltaic framework. The DC wires between the photovoltaic modules and batteries through the voltage controller must with stand the greatest current created by these modules.

The short circuit current (I_{sc}) can be read on the specifications of the solar panel at the back of the panel by using the following steps:

- Multiplying the current of (I_{sc})by the number of parallel panels

• Multiplying by the safety factor to avoid the rise in current by 25%, and multiply that by the factor of 1.25. Consequently, the current of the charging regulator is $(9.45)(9)(1.25) = 107$ A, which is greater than the current of the panel system.

• Charging regulator voltage is computed as in equation (12) below.

$$\mathrm{Ch.reg.Volt} = (1.2)(\mathrm{V_{oc}})(\text{number of series plates}) \quad (12)$$

$$\mathrm{Ch.reg.Volt} = (1.2)(39)(2) = 93.6 \text{ volts}$$

Installing a general DC circuit breaker between the solar panels and the charging regulator or the inverter, and it is irreplaceable and performs the tasks of protecting the solar energy system. The used C.B for the design has the following features:

1. Protecting of solar panels in case of damage to the inverter and the occurrence of a short circuit
2. Protecting of the inverter in the event of a contact with the panels as a result of water leakage
3. The possibility of manually separating the panels from the rest of the components if the number of strings in parallel is only two. Double MC4 connector Branch can be used to assemble the two lines and then install the circuit breaker before entering the inverter or the charging regulator, but if the number of parallel rows is more than two breakers must be installed in the Combiner Box, hence

- The branch circuit current can be calculated using equation (13) as below.

$$(1.25) \times (\mathrm{I_{sc}})\mathrm{x} \times \left(\text{number of parallel rows per line (1 or 2 only)}\right) \qquad (13)$$

$$= (25) \times (9.45)(1) = 12\text{Amps}$$

- Calculation of the main circuit breaker current of the collector is

$$(1.56\ ) \times (9.45) \times (9) = 133 \text{ amperes}$$

According to selected controller, the rated current of the voltage Controller is calculated as in equation (14) shown below:

$$\mathrm{I} = (\mathrm{I_{SC}})\left(\mathrm{N_{para}}\right)(\mathrm{F_{safe}}) \qquad (14)$$

$$= (9.45)(9)(1.25) = 106.3\text{ Amps}$$

7.4. Sizing of Inverter Calculations

The power of devices that may run at the same time is

$$(P_{\text{total}}) = 4238\text{ Watts}$$

The inverter needed must be able to handle about (5000 Watts) at$(220\text{V} - \text{AC}, 48\text{V} - \text{DC})$.

The inverter must be selected with a minimum power that is (25%-30%) greater than the capacity to operate the load. The required power is$(3390\text{ Watt}) \times (1.25) = 4238\text{ Watts}$, therefore the chosen inverter can handle roughly **5 kW** in case for safety.

7.5. Calculations of Circuit Breaker Between Batteries and Inverter

One of the most essential criteria in safeguarding the inverter and the system from fires produced by current in the cable connecting the batteries and the inverter is the circuit breaker. It exceeds the legal limit in the case of an unsuitable thin cable, which takes into account the usage of a DC circuit breaker. the current of the employed breaker is calculated using the following formula.

Breaker current = Maximum inverter power/battery bank voltage

$$\text{Breaker ampere} = (5000/48) = 105\text{ ampere}$$

From the calculations of the solar energy system for the health center illustrated above, the required results for designing a stand-alone PV system illustrated in table (2) below.

Table 2. Calculation Results of Proposed System Sizing.

Equipment Type	Characteristics
The required load capacity	3390 W.h– AC
System voltage	48V
The capacity of the battery bank	2808 Ah-DC
Voltage and current charging regulator	48V - 100A
Inverter	48V DC - 5000W
Number of solar panels	18-Panal - 280W – 220V – AC

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8. SIMULATION RESULTS AND DISCUSSION

Figure (4) illustrated below is an arrangement of the steps, which used in the simulation of the solar energy system for the health Facility of the required area. MATLAB programming has used to simulate this process to reach the best results. The used steps are:

- Insert the model for the representation of the solar surfaces and determine the type of solar cells used and the number of cells in succession to generate the necessary effort, and finally determine the number of cells needed in parallel to ensure the capacity required to encroach the health center.
- Inclusion of the model for the single-phase DC-AC power transformer and the inclusion of the models for its control.
- Inserting the batteries and determining their voltage and capacity according to the Ah needed to feed the health center at night.
- Connect the models together and run the program.
- Show simulation results and check if there are any errors.

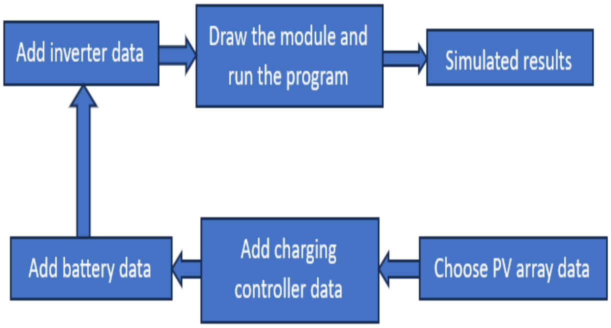

Fig.4 Schematic analysis of solar PV design process steps using MATLAB Simulink

Figure (5) below illustrates the module simulation of the health facility feeding system with solar energy. The system consists of a solar cell model, a DC-DC power converter, a DC-AC power converter, in addition to used loads.

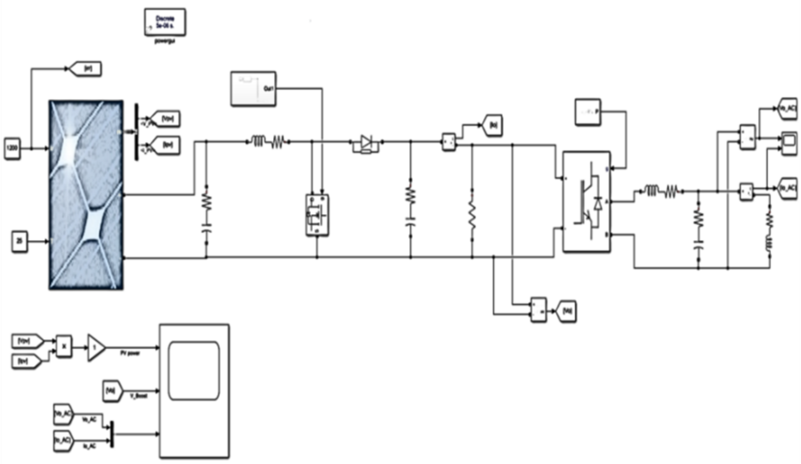

Fig.5 Module simulation using MATLAB/Simulink

Figures (6 & 7) below illustrate the voltage and power curve of the system. It can be seen that the number of planes in a row is (2 strings)and that in parallel are(9 strings). The power that obtained from the system to supply loads in the case of solar radiation of 1KW/m^2 is approximately 5KW, while the value of the capacity when solar radiation is 500W/m^2 is approximately 2500W. The array type is according to American Solar Wholesale ASW-280M including two series modules and nine parallel strings.

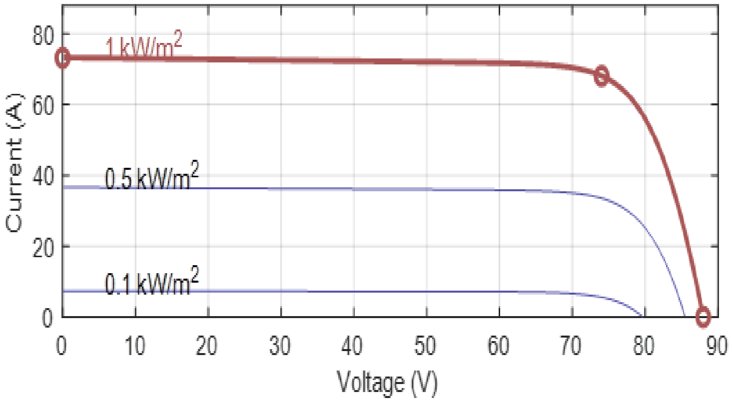

Fig.6 Voltage and current curve of the solar panel array characteristic

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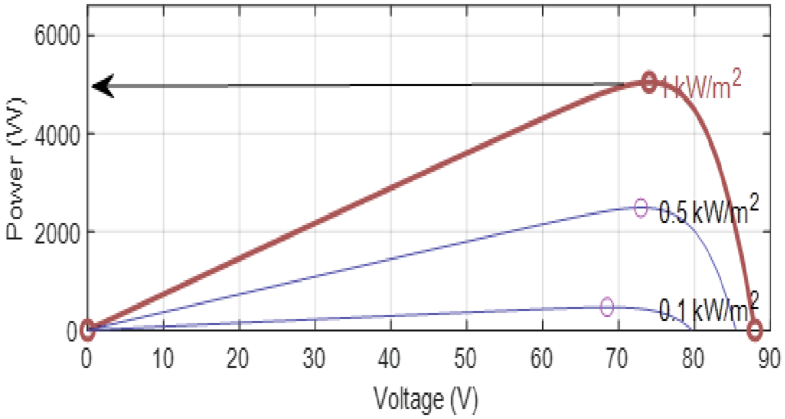

Fig.7 Voltage and power curve of the solar panel array characteristic

Figures (8 to 10) drawn as below consisting of graphs of the power value obtained from the system, in addition to the operating voltage of the DC-AC power converter, furthermore a drawing of the output voltage and current of the DC-AC converter.

It can be seen that the constant current generated from the solar energy system has been converted into an alternating current that can supply the required loads at a frequency of 50 Hz as illustrated below.

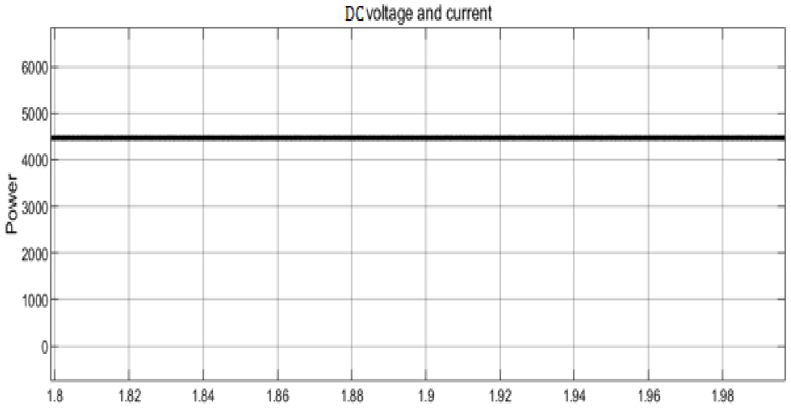

Fig.8 Output power of the system and DC voltage and current.

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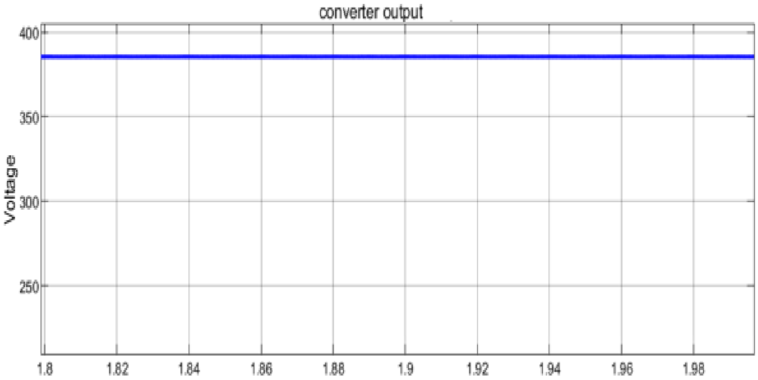

Fig.9Input voltage of the DC-AC converter output.

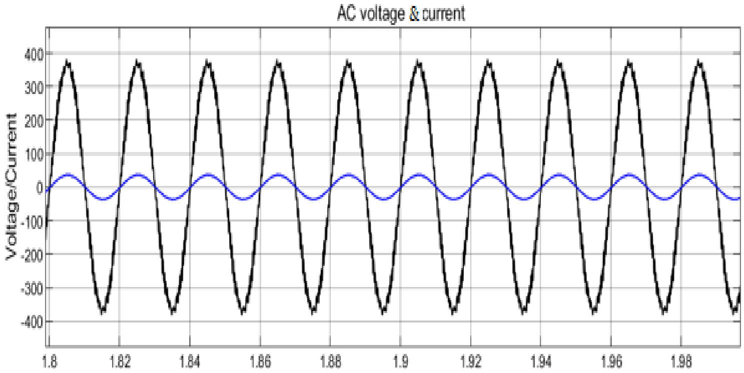

Fig.10Output voltage and current of the DC-AC converter.

9. CONCLUSSION

AZ-Zawia city, Libya Country is a relatively sun-rich region, with an annual solar irradiation of 5.32 up to more than 7.2 KWh/m^2/day due to its geographic location. Because of the proven benefits of this type of energy, there is a strong trend toward the usage of stand-alone solar system located in remote regions. The author introduces the techniques for designing and selecting equipment for a stand-alone solar system based on Watt-Hour demand in this study. A residence in Zawia city, Libya with a medium energy usage chosen as a case study. Furthermore, the elements that influence the design and sizing of each piece of system equipment have also discussed and calculated. To ensure adequate, reliable, and cost-effective

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system design, over- and under-sizing has avoided. The same processes used for other applications other geographical regions and that consume more energy. However, the proper design parameters for these locations have used. As a result, solar energy systems in this portion of the world would be incredibly efficient. The components required for the design of a stand-alone photovoltaic system will power all electric appliances effectively. Furthermore, the analysis concludes that photovoltaic power systems can help to alleviate the region's power deficit problem and improve the reliability of quality power supply, which is necessary for critical loads.

In this paper also, for clinic Centre located in AZ-Zawia City, modelling, sizing and optimization of a stand-alone photovoltaic system have been illustrated. The model simulated using MATLAB consists of 5KW inverter type of MPPT, 36 batteries 12V and 1403.5A.H with 95% efficiency, in addition to a 32KW.H/d PV. This study provides a step-by-step guide for designing a PV system for off-grid sites where grid supply is not practical or cost-effective. Following Using this approach, one may size a system, simulate the load, and estimate Identify the system's intended performance. Consequently, this paper may be useful for creating a separate PV system.

In other words, the module simulation using MATLAB/Simulink has effectively simulated. Furthermore, the voltage and current curve of the solar panel array characteristic have clearly investigated. Moreover, the voltage and power curve of the solar panel array characteristic has identified. In addition, the output power of the system characteristic & the input voltage of the DC-AC converter characteristic have simulated. Finally, the output voltage and current of the DC-AC converter characteristic have simulated.

Actually, it is up to each of us to utilize energy wisely in order to ensure that we have enough energy in the future. In addition, it is up to people who will develop the next generation of energy technology. Customers should all save energy and makes efficient use of it.

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