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DEVELOPMENT OF POWER SUPPLY USING SOLAR ENERGY FOR SMART AGRICULTURE SYSTEM

ALHAFIZUL BIN IBNOHASIM

Thesis submitted in fulfillment of the requirements
for the award of the degree of
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ABSTRAK

Sektor pertanian perlu menjalani pemantauan harian yang perlu diselaraskan dalam masa yang tepat bagi memastikan kualiti pengeluaran yang baik. Untuk menjalankan sistem IoT untuk sistem pertanian pintar mesti membatalkan bekalan kuasa kepada penggunaan komponen. Kajian ini bertujuan untuk membangunkan bekalan kuasa untuk sistem pertanian pintar dan menggunakannya dalam persekitaran sebenar menggunakan tenaga suria. Untuk membuat fungsi sistem ini, anda memerlukan panel solar, pengawal pengecas suria, bateri, penukar DC ke DC, beban dan wayar. Beban bacaan boleh dimuat naik ke dalam sistem dan dipaparkan melalui aplikasi atau laman web setelah semua komponen telah disatukan. Arus akan mengalir dari sumber kuasa ke WiFi UNO dan terus ke penderia, membolehkan ukuran penderia dipaparkan dan injap soleniod dibuka selama 7 minit untuk setiap unit. Jika bacaan sensor berbeza daripada nilai yang diperlukan, kami boleh menggunakan sistem untuk mengarahkan injap solenoid terbuka. Apabila data boleh dipindahkan dan memantau pada aplikasi dan tapak web, dan injap solenoid boleh berfungsi dengan baik, solar boleh dijamin berfungsi untuk membekalkan arus kepada semua komponen.

ABSTRACT

The agriculture sector must undergo daily monitor that need to tun in precise time to ensure the good quality of the production. To running IoT system for smart agriculture system must unsing the power supply to component can using. This study aim to develop power supply for smart agriculture system and use it in real environment using solar energy. To make this system function, you'll need a solar panel, solar charger controller, battery, DC to DC converter, load, and wire. The reading load can be uploaded into the system and displayed through the application or website once all of the components have been brought together. Current will flow from the power source to the WiFi UNO and straight to the sensor, allowing the sensor's measurements to be displayed and the soleniod valve to open for 7 minutes for each unit. If the sensor reading differs from the necessary value, we may use the system to direct the solenoid valve to open. When data can be transferred and monitor on the application and web site, and the solenoid valve can function properly, solar can be guaranteed to work to supply current to all component.

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LIST OF ABBREVIATIONS

GlobHor	Global horizontal irradiation
GlobEff	Effective Global, coor. For IAM and shading
E_Avail	Available Solar Energy
Eunused	Unused energy (battery full)
E_miss	Missing energy
E_User	Energy supplied to the user
E_Load	Energy need of the user (Load)
SolFac	Solar fraction (EUsed / ELoad)

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The Internet of Things (IoT) is gaining traction in almost every sector, including banking, industry, consumer, automotive, and may others. In today's world, everything is linked to everything else in some way. From our offices, we can monitor the lights and appliances in our homes. Activities in industries and other fields are monitored and observed from distance. Controlling street lights from distance, using a smart food order system, and so on are no longer ideas. Gone are the days when monitoring and control required the presence of an individual on the scene.

Technology has advanced to the point that you can do almost everything from the comfort of your own home or office cubicle. The Internet of Things (IoT) plays a significant role in this. The Internet of Things (IoT) links various objects such as sensors, actuators, electronics, and network connectivity to enable them to exchange data and stay connected (ShilpaDevalal&A.Karthikeyan, 2018).

In agriculture, an example of loT technology implementation is a greenhouse production environment controlling and monitoring device. In the agriculture manufacturing system, critical temperature, humidity, and soil signals are collected in real time and transmitted through wireless networks via an M2M (machine to machine) support platform. The art and science of cultivating soil, growing crops, and raising livestock is known as agriculture. It necessitates the processing and distribution of human-grade plant and animal products. Agriculture produces the bulk of the world's food and textiles. Agricultural products include cotton, wool, and leather. (JIchun Zhao & Jun-feng Zhang & Jian-Xin Guo, 2010).

Despite the fact that solar energy is so simple to apply in any setting. However, it is not so unusual in the field of agriculture because society prefers to spend human energy to control or supervise agriculture in excellent condition, or vice versa. A system has both advantages and downsides. It is indisputable that human energy assures agriculture's survival, but agriculture demands a tremendous amount of energy to sustain.

The transmission of solar energy from the sun into electrical energy. Solar technology can capture that energy and use it to generate electricity, provide light or a comfortable interior environment, and heat water for domestic, commercial, or industrial users.

With regard to the aforementioned environmental concerns, solar energy appears to be our saviour. If you've been paying attention, you'll notice that all sectors are attempting to abandon the use of many environmentally unfriendly fossil fuels in favour of renewable energy in solar power systems.

Agriculture is one of these industries. The agricultural sector stands to benefit greatly from the use of this clean energy source. Because of the world's growing population, there is a greater demand for agricultural products.

All technology still using supply to turn on for everything can function. For this project I using solar energy to supply current to all component can connected each other. From sunlight will radiate lighted to the panel solar. Sunlight energy is Direct Current (DC) will converted to Alternating Current (AC) through go to component. This has to type to supply current to appliance load. Solar panel can supply direct to appliance load assisted by converter type DC to AC or can supply from the solar panel will be send to the battery for storage and will be supply to the appliance load when it is needed.

When the load is DC, it may be taken straight from the solar panel without connecting the inverter in this solar system because there is a Chager Controller in the solar system to control the output voltage to be stored or supplied directly to the load. This inverter converts DC from the solar panel to AC for load users who are experiencing Alternating Current Voltage. If our load is Voltage Direct Current, it makes no difference if the Inverter is working well.

1.2 Problem Statement

Risk in the agricultural sector is caused by a variety of factors, including natural, biological, climatic, and input and production prices, all of which have negative consequences (Agwe, Fissha, Nair, & Larson, 2009; AIT/UNEP, 2011; Jain & M, 2006).

Climate change is one of the most significant threats to agricultural extension programs, affecting farms and farmers in a variety of ways. Climate change effects, according to Mulder (2017), should not be overlooked in the pursuit of sustainable growth. Extension service providers, on the other hand, are not yet professionally trained and prepared to assist farmers in managing agricultural risks through immediate and low-cost solutions (Ali, Man, Abd Latif, Muharam, & Zobidah Omar, 2018).

Beside, Located far from sources state that is difficult burning electricity used motor pumps. Whom have modal can use pumps to raise water to farmland using of fuel oil with enormous costs.Technology Solar Power is as an alternative energy to work the farm pumps, It are abundant in world. The appropriate government program in terms to saving energy and reducing the use of duel oil. The use of solar energy as a renewable energy source is something very important, so that the use of solar energy can be expected to be able to solve the above problem (Maidi Saputra, Ahmad Syuhada, & Ratna Sary, 2018).

The income to the agricultural labor class shows as labor expense to agricultural commodity producers. Labor costs are included in the broad category of operational costs, which also include fertilizer, pesticides, gasoline, fodder, seeds, and irrigation fees. All of these costs are likely to be impacted by better communication, which has an impact on prices, availability, and demand (Ghosh, 2002).

Rising temperatures, irregular weather patterns, increased intensity of droughts, floods, and cyclones have all been evidence of climatic change, resulting in massive losses in agricultural production and livestock populations (Jain & M, 2006). These events will have a low quality of crop production as a sequence.

1.3 Research Objective

This project has objective as follows :

1. To develop power supply to IoT system for agriculture using Solar Energy.

2. To validate the developed system installed are able to monitor and transmit data with proposed methods in real environment.

1.4 Research Scope

IoT system for agriculture will be test at the pre-nursery at FTKEE. The test site will have the width of 0.7 hectares. Besides that, this IoT system for agriculture will also be test on 99,000 seed that have been planted on the site. There are also water tank with 2.4m of length and 7.8m of width will be connect to the agriculture machine. Solar energy 100W supply to local controller and WiFi UNO. The distance of the office that will be use monitor all the sensors is about around 2KM so we will use gateway that can reach up to 2KM. For the local network to control the solenoid valve, we will install router. This router will connect to the microcontroller to able to control the solenoid valve. This router also needs to reach up to 300m range.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Discuss the power to supply current to all appliance component in agriculture, as well control local controller to running the solenoid valve to through the water to tray use in agriculture. Beside, the other power to supply going Arduino UNO and Arduino WiFi to turn on all wireless sensor network have recently been used in variety of applications.

In agriculture, the power supply in area agriculture in the world populations still have no access electricity. I have not yet been electrified have some common. A characteristics such as a located in areas have water and always moist soil area. Also using low power and not using all times (Desai, Mukhopadhyay & Ray, 2021).

The solar energy represents a feasible solution for ensuring an independent operation over long periods of time for electronic equipments that are placed in isolated locations. The very broad spectrum of applications of solar energy based autonomous power supply units include also the equipments that are used in precision agriculture (Lita, Visan, Mazare, & Ionescu, 2019).

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Agriculture and allied sectors like forestry and fisheries accounted for 16.6% of the GDP in 2009, about 50% of the total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broadbased economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India (Yalla, Kumar, & B.Ramesh, 2013).

2.2 Solar Panel

Solar panel or Photovoltic system is a same. The function to convert sunlight or light into the electrical energy. It can used for wide variety of applications including remote system for cabins, telecomminications equipment, remote sensing. Solar panel have three type of solar panel is monocrystalline, polycrystalline, and thin-film.

Photovoltaic (PV) system same with solar panel. Which convert sunlight directly into the electrical energy DC. The size solar panel is 1020 x 670 x 35 mm. This type panel is mono-crystalline. Solar panel are typically 15-20 % . For the proposed panel design, a 18.59V and 5.38A. (naeem Pasha, & Moynul Hasan Akash,2020).

Solar panel are highly sensitive to performance of solar panel at Standard Testing Conditions (STC). The conditions correspond to the performance at a temperature of sunlight, an irradiance and Power maximum (Pmax) generally refers to maximum power point at STC. While outdoor measurements are often performed at quite different conditions. (M. Gabor, Schneller, Signeur, Rowell, Colvin, Hopwood, & Davis, 2019).

Solar technology has been growing in popularity around the world; however, it only provides a small portion of North America's power supply. Despite the numerous advantages of solar technology, there are technical limitations in utilizing this abundant source of energy. The conversion efficiency of a PV panel is low and advanced manufacturing technologies are needed to improve the capabilities of PV materials (Jasim, &Taheri, 2018).

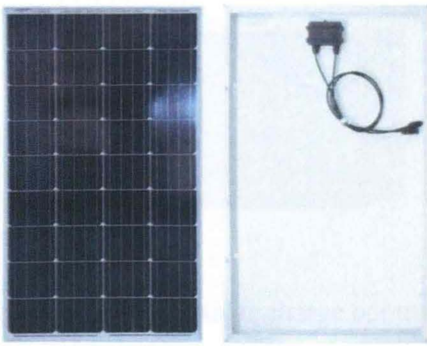

Figure 2.1:Solar Panel type Monocrystalline

2.3 Solar charger Controller

A solar charge rcontroller also know as a solar regulator. The function it a solar battery charger connected between the solar panel and battery also to loads. It's job is to regulate the battery charging process and ensure the battery is charges correctly or more importantly not over-charger. Solar charger controller have two types is PWM (PulseWidth Modulation) and MPPT (Maximum Power Point Tracking).

Both types are suitable for standalone PV systems and both perform efficient management of the battery and control of the PV system and its loads (fig. 1). PWM charge controllers do not perform MPPT therefore the PV array operating point depends on the power consumed by the load and the battery voltage. The MPPT charge controllers implement a DC converter at the PV array output which allows extraction of the maximum power from the PV array at given conditions (solar irradiation and temperature)(Antonov, Kanchev, & Hinov, 2019).

The PWM signal is power MOSFET's control are generated by the micro-controller for Photovoltaic (PV) or solar panel. It have three input for solar, battery and load. The CCP module of the PIC micro-controller generates the PWM signal from sensor the PV voltage and according to the algorithm written (Vaz, Gurudas, & Dayananda, 2019).

Maximum Power Point Tracker (MPPT), which increases the efficiency of the system effectively is used here. By using it, the system always operates at its Maximum Power Point (MPP), thereby producing its maximum power output. Thus, an MPPT maximizes efficiency of the array and reduces the overall cost of the system (Pathare, Shetty, Datta, Valunjkar, Sawant & Pai, 2017).

Figure 2.2: PWM solar charge controller

Figure 2.3: MPPT Solar Charger Controller

CHAPTER 3

METHODOLOGY

3.1 Introduction

The concept and approaches offered in this project are explained in this chapter. In addition, this chapter discusses the study that was conducted in order to accomplish the project. Explains how the networks network works in this project, as well as how solar energy can supply power to all component used in the project.

3.2 Block Diagram

A block diagram is a representation of a structure in which the major components or functions are represented by blocks that are connected by lines that display the relationships between the blocks. Hardware design, electronic design, software design, and process flow diagrams are all examples of where they are used in engineering.The block diagram of the system is shown in Figure 3.1 Each element has its own function.

According to Figure 3.1, When the sun shines on a solar panel, the energy absorbed by the Solar cell in the panel. This energy generates electrical charges that move in reaction to an internal electrical field in the cell, resulting in the flow of electricity. The electricity will pass via the charge controller and be stored on the battery, which will function when there is no sunlight. In fact, instead of the charge controller, electricity will be routed directly to the local controller and also to the Arduino WiFi for soil moisture detection.

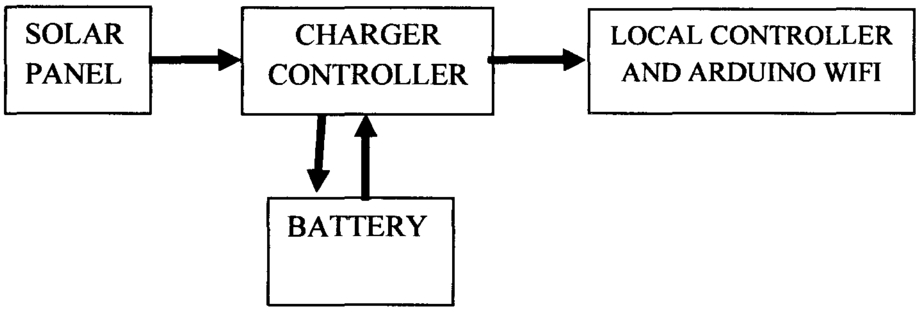

Figure 3.1 Block Diagram of Power Supply

3.3 Solar Panel

Solar panels convert solar energy into Direct Current (DC), which is a unidirectional power source. It solar panel generates a certain amount of power in less than a minute.

In this project, I used solar panel type monocrystalline solar cells. These cells are constructed from a cylindrical silicon ingot grown from a single crystal of high purity silicon in the same way that a semiconductor is. The cylindrical ingot is cut into wafers, which form cells. The circular wafers are wire cut to an octagonal shape wafer to maximise the utility of the cells. Because of their octagonal shape, these cells have a distinct appearance. These cells are also uniform in colour.

Monpcrystalline working when sunlight falls a monocrystalline solar panel, the cells absorb the energy and create an electric field through a complicated process. This electric field generates power by combining voltage and current, as defined by the equation P (power) = V (voltage) x I (current). This power can be used directly to power direct current devices (DC). An inverter can also be used to convert this power to alternating current (AC). The solar panel specifications for this project are listed in below.

Maximum Power (Pmax) = 100W 36 Cells

Voltage Maximum Power (Vmp) = 18.59V

Current Maximum Power (Imp) = 5.38A

Open-Circuit Voltage (Voc) =22.45V

Short-Circuit Current (Isc) = 5.76A

3.4 Solar Charge Controller

Solar charge controller is the device providing charging control from solar panel, battery and load. This device controls the flow of current from the solar panel direct supply directly to the load or going to the battery to be stored and to be used when needed. For this project I using PWM (Pulse Width Modulation) solar charge controller.

PWM is the most efficient method of achieving constant voltage battery charging by switching the power devices of the solar system controller. When the solar array is under PWM control, the current from the array tapers based on the battery's condition and recharging requirements.

Why I using PWM because it charging a battery with a solar system is a one-of-a-kind and difficult task. When a solar panel produced too much energy, simple on-off regulators were used to limit battery outgassing. However, as solar systems became more sophisticated, it became clear how much these simple devices hampered the charging process. The solar charge controller specifications for this project are listed in below.

Rated Volatge =12V/24V

Rated Current = 30A

Maximum PV Voltage = 0V

Maximum PV Input Power = 390W(12V)/780W(24V)

3.5 Battery

The battery using in this system to stored charger current from solar panel when solar panel completed connection to charge controller. There are four main types of battery technologies that pair with residebtial solar system is lead acid, lithium ion, nickel based and flow batteries.

All battery backup power technologies has its own set of unique characteristics. The battery chose closer looked types of solar battery has to offer to system. For this project using battery lead acid batteries. This battery have two types of lead acid batteries is flooded lead acid and sealed lead acid batteries. I chosee sealed lead acid batteries because this can rechargeable VRLA (Valve Regulated Lead Acid) and there are two primary types AGM and Gel.

The batteries will be used when the weather does not have sunlight to conduct energy to be given at each load. The specification battery using in this project is 12 V for voltage and current is 7.2Ah

3.6 Local Controller and Arduino WiFi

This local controller has 3 components, 2 components namely Arduino UNO and also relay where the arduino has been set to open and close the solenoid valve automatically. local contoller will active 8.00a.m until 8.10a.m and 5.00p.m until 5.10p.m.. This part can monitor and control from cayenne. Another component is Arduino wifi to monitor the reading soil moisture to transmit data to cayenne.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

After completing all the method from the previous chapter. In this chapter shows all the results obtained from this study. The tablets, formula and calculation are included. Detailed explanation of the part simulation are also provide. The simulation using PV syst for checked site situations.

4.2 Calculation Energy Consume

This calculation is for the location at which he works as a nursery nurse there at Rompin, Pahang. This calculation is divided into two parts: Power for Soleniod Valve and Power for Soil Moisture.

Table 4.1 provides a calculation to determine how much power is required to determine a suitable solar panels for agricultural use. This table contains a solenoid valve with 44 units, which will be set up on the pipe leading to the tray. There are also 2 water flow sensors to measure the amount of water coming out of the tank. This assumes the use of 4 Arduino UNO boards, which are used to automatically open and close the solenoid valve.

$$Output\ Watt = Votage\ x\ Current$$

$$Watthours\ per\ day = Output\ watt\ x\ Hours\ per\ day\ x\ Quantity$$

Table 4.1 Calculation energy consume of power for solenoid valve

APPLIANCE	VOLTAGE(V)	CURRENT(A)	WATT(W)	HOURS/DAY	QUANTITY	WATTHOURS/DAY(WHr/D
SOLENIOD VALVE	12	0.5	6	0.34	44	89.76
WATER FLOW SENSOR	5	0.02	0.1	0.34	2	0.068
ARDUINO UNO	5	0.075	0.375	11	4	16.5
					TOTAL	**106.328**

The calculation below determines how many batteries are required in this system. To begin, use the formula below to calculate the battery capacity that will be used for the equipment. After determining the capacity, we will determine the number of batteries required for this system. Instead, the battery capacity must be divided by the capacity of the battery being used.

Capacity Battery

$$= \frac{\text{Total energy consumption}}{efficiency\ x\ depth\ of\ discharge\ x\ nominal\ battery\ voltage} \text{ x day of autonomy}$$

$$= \frac{106.328}{0.85\ x\ 0.6\ x\ 12}\ x\ 4$$

$$= 69.50\ Ah$$

$$Number\ of\ Battery = \frac{\text{Total capacity battery}}{Power\ of\ battery}$$

$$= \frac{69.50}{7.2}$$

$$= 9.653 \approx 10 \text{ units}$$

The calculation below determines how many panels we need to generate battery charging and how much power can be accommodated by the component that requires power. To begin, we must determine the amount of panel energy required, followed by the total capacity power required by the solar panel, and finally, the number of panels used.

Sizing Panel

$$\text{Total panel energy needed} = \frac{\text{Total energy consume} / day}{Peak\ sunlight\ hour}$$

$$= \frac{106.328}{4.5}$$

$$= 23.63\ Wh$$

$$Total\ Wp\ of\ panel\ capacity = \frac{\text{Total energy needed}}{effiency}$$
$$= \frac{23.63}{0.17}$$
$$= 139\ Wp$$

$$Number\ of\ Panel = \frac{\text{Total Wp of panel capacity}}{Power\ of\ panel}$$
$$= \frac{139}{100}$$
$$= 1.39 \approx 2 \text{ modules}$$

The table below shows the second part of the nersury game, which is the power for soil moisture. The Arduino uno for 8 sensors and Arduno UNO for WiFi has 8 is shown in Table 4.2units as well.

$$Output\ Watt = Votage\ x\ Current$$

$$Watthours\ per\ day = Output\ watt\ x\ Hours\ per\ day\ x\ Quantity$$

Table 4.2 Calculation energy consume of power for soil Moisture

APPLIANCE	VOLTAGE(V)	CURRENT(A)	OUTPUTT WATT(W)	HOURS/DAY	QUANTITY	WATTHOURS/DAY(WHr/D
ARDUINO UNO (SENSOR)	5	0.075	0.375	24	8	72
WiFi UNO	5	0.075	0.375	24	8	72
ARDUINO UNO (WiFi)	5	0.075	0.375	24	8	72
					TOTAL	**216**

Capacity Battery

$$= \frac{\text{Total energy consumption}}{efficiency\ x\ depth\ of\ discharge\ x\ nominal\ battery\ voltage} \text{ x day of autonomy}$$
$$= \frac{216}{0.85\ x\ 0.6\ x\ 12}\ x\ 4$$
$$= 141.18\ Ah$$

$$Number\ of\ Battery = \frac{\text{Total capacity battery}}{Power\ of\ battery}$$
$$= \frac{141.18}{7.2}$$
$$= 19.608 \approx 20 \text{ units}$$

Sizing Panel

$$\text{Total panel energy needed} = \frac{\text{Total energy consume} / day}{Peak\ sunlight\ hour}$$
$$= \frac{216}{4.5}$$
$$= 48\ Wh$$

$$Total\ Wp\ of\ panel\ capacity = \frac{\text{Total energy needed}}{effiency}$$
$$= \frac{48}{0.17}$$
$$= 283.35\ Wp$$

$$Number\ of\ Panel = \frac{\text{Total Wp of panel capacity}}{Power\ of\ panel}$$
$$= \frac{283.35}{100}$$
$$= 2.82 \approx 3 \text{ modules}$$

4.3 Calculation of energy consume for pre-mursery at FTKEE

The energy calculation for the FTKEE UMP pre-nursery is shown in Table 4.3. This pre-nursery only uses a single unit for each component, such as a Soleniod Valve, an Arduino UNO for the Valve, soil moisture, and WiFi.

Table 4.3 Calculation energy comsume for pre-nursery FTKEE

APPLIANCE	VOLTAGE(V)	CURRENT(A)	OUTPUTT WATT(W)	HOURS/DAY	QUANTITY	WATTHOURS/DAY(WHr/D
SOLENIOD VALVE	12	0.5	6	0.34	1	2.04
ARDUINO UNO VALVE	5	0.075	0.375	11	1	4.125
ARDUINO UNO (SENSOR)	5	0.075	0.375	24	1	9
WiFi UNO	5	0.075	0.375	24	1	9
ARDUINO UNO (WiFi)	5	0.075	0.375	24	1	9
					TOTAL	33.165

Capacity Battery

$$= \frac{\text{Total energy consumption}}{efficiency\ x\ depth\ of\ discharge\ x\ nominal\ battery\ voltage} \text{ x day of autonomy}$$

$$= \frac{33.165}{0.85\ x\ 0.6\ x\ 12} x\ 4$$

$$= 21.68\ Ah$$

$$Number\ of\ Battery = \frac{\text{Total capacity battery}}{Power\ of\ battery}$$

$$= \frac{21.68}{7.2}$$

$$= 3.011 \approx 3 \text{ units}$$

Sizing Panel

$$\text{Total panel energy needed} = \frac{\text{Total energy consume} / day}{Peak\ sunlight\ hour}$$

$$= \frac{33.165}{4.5}$$

$$= 7.37\ Wh$$

$$Total\ Wp\ of\ panel\ capacity = \frac{\text{Total energy needed}}{effiency}$$

$$= \frac{7.37}{0.17}$$

$$= 43.353\ Wp$$

$$Number\ of\ Panel = \frac{\text{Total Wp of panel capacity}}{Power\ of\ panel}$$

$$= \frac{43.353}{100}$$

$$= 0.433 \approx 1 \text{ modules}$$

4.4 PVsyst Simulator

PV syst is simulator software that is used to obtain readings in the area where we want to install this system. This software also displays some required readings such as normalised production, performance ratio, balances and main results, loss diagram, and daily input/output diagram shown in the Appendix.

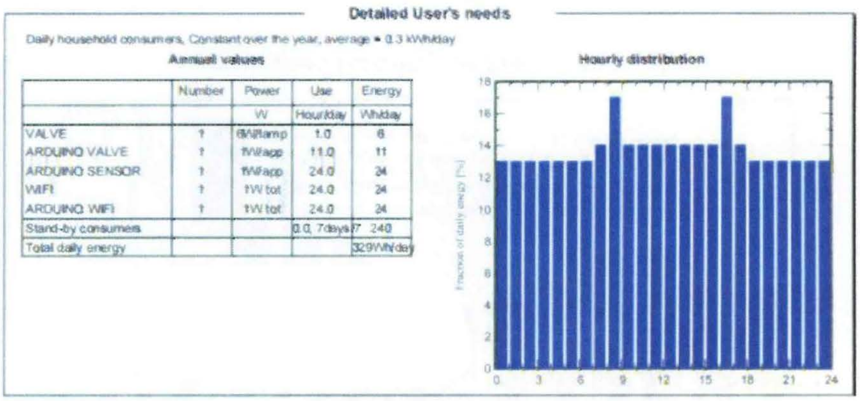

Figure 4.1 Detailed User's needs

The use details necessary in this system are depicted in Figure 4.1. There are two data gathered in this graphic. The first set of data is the yearly value for pre-nursery components, which are displayed in the table with a power reading for each component and use. Each has its own quantity of energy, which is also displayed.

A graph depicting the hourly distribution is located next to the yearly values. This graph depicts the energy usage of this system. Looking at the graph, there are two bars that reflect the maximum amount of daily energy utilised at 8 a.m. and 5 p.m. It was Soleniod Valve in the ON state between 8 a.m. and 5 p.m. Power losses are shown on the opposite bar when the Soleniod Valve is turned OFF.

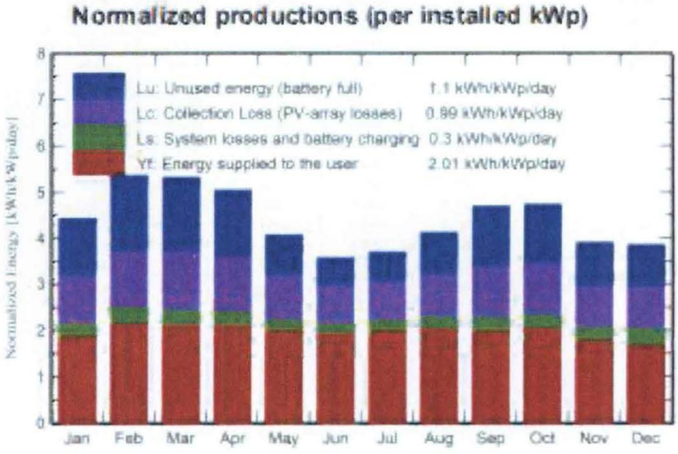

Figure 4.2 Normalized Production from PV syst

Figure 4.2 is a graph of Normalized production (per installed kWp). On this graph there are four data namely Unsed energy, Collection Loss, System losses and battery charging, and Energy supplied to the user.

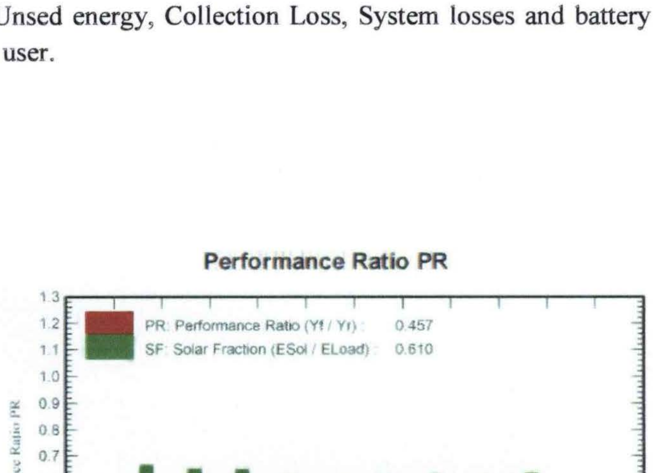

Figure 4.3 Performance Ratio from PVsyst

Figure 4.3 depicts the PR performance ratio, which includes two data points: the Performance ratio for energy supplied to the user. the second solar fraction, which compares solar energy to energy load

Balances and main results

	GlobHor kWh/m²	GlobEff kWh/m²	E_Avail kWh	EUnused kWh	E_Miss kWh	E_User kWh	E_Load kWh	SolFrac ratio
January	125.5	134.2	10.29	3.802	4.260	5.939	10.20	0.582
February	145.3	146.6	11.34	4.562	3.103	6.109	9.21	0.663
March	174.3	160.1	12.31	4.932	3.574	6.625	10.20	0.650
April	178.0	145.6	11.24	4.305	3.490	6.380	9.87	0.646
May	163.4	120.3	9.38	2.678	3.877	6.322	10.20	0.620
June	143.0	101.7	7.98	1.754	4.004	5.866	9.87	0.594
July	149.5	109.1	8.57	1.940	3.897	6.302	10.20	0.618
August	153.8	122.8	9.61	2.780	3.812	6.387	10.20	0.626
September	155.3	136.1	10.51	3.904	3.789	6.081	9.87	0.616
October	147.8	142.8	11.02	3.946	3.754	6.445	10.20	0.632
November	111.4	114.1	8.81	2.838	4.419	5.451	9.87	0.552
December	109.2	116.8	8.89	2.781	4.887	5.312	10.20	0.521
Year	1756.4	1550.4	119.95	40.222	46.867	73.218	120.08	0.610

Figure 4.4 Table of Balance and main results from PV syst

Figure 4.4 is the data balance and main results for this software. In this figure shows the table about GlobHor, GlobEff, E_Avail, Eunused, E_miss, E_User, E_Load and SolFac these data readings are in the average value of the month.

CHAPTER 5

CONCLUSION

5.1 Introduction

The significant findings of the research were concluded in this chapter. The outcome of the research gave overall description of this case study. The limitation or problems encountered during conducting this research also notified together with the recommendations for future research purpose.

5.2 Conclusion

In conclusion, the scope of this study is to provide power to IoT systems for agriculture using Solar Energy, which can power each component without the use of electricity. Furthermore, it is to ensure that the installed developed system is capable of monitoring and transmitting data using the proposed method in the real environment and, in any situation, remains capable of updating the most recent data.

5.3 Recommendation

I recommend some improvements to this concept, such as allowing solar panels to move in accordance with the sun's rays to guarantee that maximum energy is captured by solar panels in order to offer more solid energy. Furthermore, capturing irradiance readings with solar panels to ensure the most recent irradiance may be acquired without utilizing an average from other software.

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APPENDICES

Appendix A:

PV syst Simulator

Version 7 1 0

PVSYST

PVsyst - Simulation report

Stand alone system

Project SMART ARGICULTURE

Variant: FTKEE

Stand alone system with batteries

System power: 100 Wp

FTKEE UMP - Malaysia

| Author

PVsyst V7 1.0
Simulation date
10/01/22 15 43
with v7.1.0

Project summary

Geographical Site
FTKEE UMP
Malaysia

Situation

Latitude	3 54 °N
Longitude	103 43 °E
Altitude	13 m
Time zone	UTC+8

Project settings

Albedo	0 20

Meteo data
FTKEE UMP
Meteonorm 7 3 (1986-2005) Sat=100% - Synthetic

System summary

Stand alone system — **Stand alone system with batteries**

PV Field Orientation
Fixed plane
Tilt/Azimuth 30 / 0 °

User's needs
Daily household consumers
Constant over the year
Average 0.3 kWh/Day

System information

PV Array

Nb of modules	1 Unit
Pnom total	100 Wp

Battery pack

Technolo	ead-aci ealed el
of unit	1 Unit
Volta	12 V
Capac	14 Ah

Results s mm

Available Energy	120 k year	Specific pro ction	1200 kWh/kWp/year	Perf Ratio PR	45 67 %
Used Energy	73. kW			Solar Fraction SF	60 97 %

Table of contents

PVsyst V7.1.0
Simulation date
10/01/22 15:43
with v7.1.0

General parameters

Stand alone system | **Stand alone system with batteries**

PV Field Orientation				**User's needs**	
Orientation		**Models used**		Daily household consumers	
Fixed plane		Transposition	Perez	Constant over the year	
Tilt/Azimuth	30 / 0 °	Diffuse	Perez, Meteonorm	Average	0.3 kWh/Day
		Circumsolar	separate		

PV Array Characteristics

PV module		**Battery**	
Manufacturer	Generic	Manufacturer	Generic
Model	DS-A2-100	Model	Solar S12/17 G5
(Original PVsyst database)		Technology	Lead-acid, sealed, Gel
Unit Nom. Power	100 Wp	Nb. of units	1 Unit
Number of PV modules	1 Unit	Discharging min. SOC	20.0 %
Nominal (STC)	100 Wp	Stored energy	0.1 kWh
Modules	1 String x 1 In series	**Battery Pack Characteristics**	
At operating cond. (50°C)		Voltage	12 V
Pmpp	90 Wp	Nominal Capacit	14 Ah (C10)
U mpp	20 V	Temperat	Fixe 20 °C
I mpp	4.5 A		
Controller		**Batte Ma age ent ontrol**	
Universal controller		Thresh co nano as	SOC calculation
Technology	MPPT convert	Charg	SOC = 0.90 / 0.75
Temp coeff.	-5. m	ox	14.2 / 12.4 V
Converter		Discharging	SOC = 0.20 / 0.45
Maxi and EURO effici es	/ 95.0	approx.	11.5 / 12.1 V
Total PV pow			
Nominal (STC)	0 kWp		
Total	1 modules		
Module area	0.9 m²		

Array losses

Thermal Loss factor		**DC wiring losses**		**Serie Diode Loss**	
Module temperature according to irradiance		Global array res.	73 mΩ	Voltage drop	0.7 V
Uc (const)	20.0 W/m²K	Loss Fraction	1.5 % at STC	Loss Fraction	3.2 % at STC
Uv (wind)	0.0 W/m²K/m/s				
Module Quality Loss		**Module mismatch losses**		**Strings Mismatch loss**	
Loss Fraction	2.5 %	Loss Fraction	2.0 % at MPP	Loss Fraction	0.1 %

IAM loss factor
ASHRAE Param. IAM = 1 - bo(1/cos - 1)
bo Param. 0.05

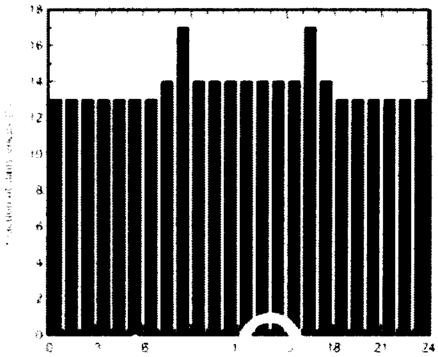
Detailed User's needs

Daily household consumers Constant over the year average = 0.3 kWh/day

Annual values

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
VALVE	[illegible]	6W/lamp	1.0	6
ARDUINO VALVE	[illegible]	1W/app	11.0	11
ARDUINO SENSOR	1	1W/app	24.0	24
WIFI	[illegible]	1W tot	24.0	24
ARDUINO WIFI	[illegible]	1W tot	24.0	24
Stand-by consumers			0.0 7days/7	240
Total daily energy				329Wh/day

Hourly distribution



Project: SMART ARGICULTURE

Variant: FTKEE

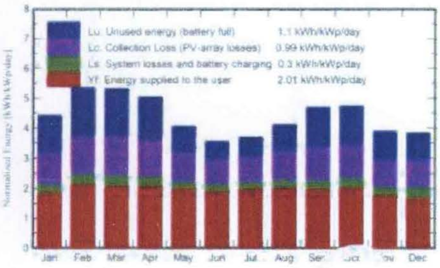
PVsyst V7.1.0
Simulation date:
10/01/22 15:43
with v7.1.0

Main results

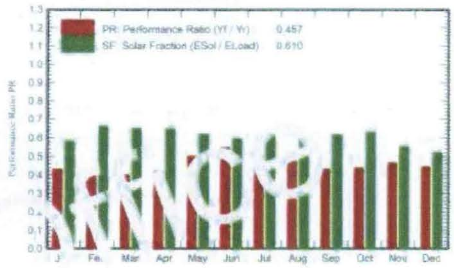
System Production

Available Energy	120.0 kWh/year	Specific production	1200 kWh/kWp/year
Used Energy	73.2 kWh/year	Performance Ratio PR	45.67 %
Excess (unused)	40.2 kWh/year	Solar Fraction SF	60.97 %
Loss of Load		**Battery aging (State of Wear)**	
Time Fraction	39.0 %	Cycles SOW	36.7 %
Missing Energy	46.9 kWh/year	Static SOW	90.0 %
		Battery lifetime	1.6 years

Normalized productions (per installed kWp)



Performance Ratio PR



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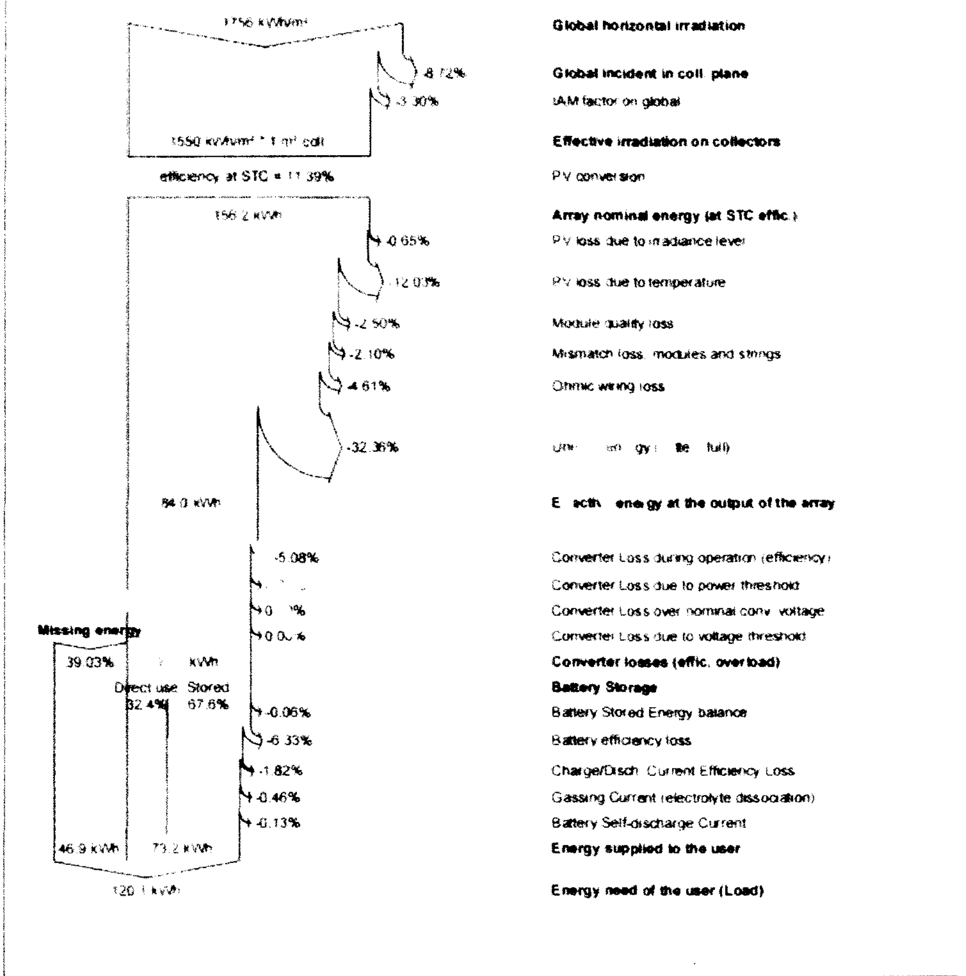
Year	1756.4	1550.4	119.95	40.222	46.867	73.218	120.08	0.610

Legends

GlobHor	Global horizontal irradiation	E_User	Energy supplied to the user
GlobEff	Effective Global, corr. for IAM and shadings	E_Load	Energy need of the user (Load)
E_Avail	Available Solar Energy	SolFrac	Solar fraction (EUsed / ELoad)
EUnused	Unused energy (battery full)		
E_Miss	Missing energy		

Loss diagram



Special graphs

Daily Input/Output diagram