Easy Solar Photovoltaic Panel as Renewable Energy System Device

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***Abstract*-Solar power is energy from the sun that is converted into electrical energy. Solar energy is the abundant renewable energy source available, and the Malaysia has some of the richest solar resources in the world. Electric energy is becoming one of the source energy which is required daily. However, electric power outages always happened. Easy Solar Photovoltaic Panel as Renewable Energy System Device isimplemented as an electric power source by using solar as a help and support. It is used by providing charge through solar panel from sunlight. Then, the charge is flowing through the solar controller to charges battery that will flow to the load. Since energy that obtained from the battery are shaped in direct current (DC), then the inverter used to change direct current (DC) to alternating current (AC) for purpose of using device or application that using alternating current (AC) to operate.**

***Keywords*—**Solar Photovoltaic Panel; Electric energy;alternating current; direct current; inverter

I. INTRODUCTION

Easy Solar Photovoltaic Panel as Renewable Energy System Devicedelivers a cheaper alternative way of non-renewable energy. The technology has been invented but the incorporation to fit everything inside the Solar Panel's enclosure far from conventional. Mankind always need electricity. The project aims to deliver electricity to areas that have no electricity access. Other than that, the system can be usedforall the consumer level. People can use it as a source of electricity wherever they choose to go.

Easy Solar Photovoltaic Panel as Renewable Energy System Device is an important tool for survivor especially for people who involved in activities such as campaign, picnic and backpackers. Portable solar could provide power through power outlets (socket) for non-portabledevices that could be handy when used outdoors is great significance. Examples of non-portable devices that can be handy when used outdoors are an electric fan, hand phone charger, laptop charger, table lamp and just to list a few.

Solar power is considered as one the most environmental friendly and abundantly available alternative source of energy. The Easy Solar Photovoltaic Panel as Renewable Energy System Device is designed to optimize capturing solar energy, storing it into a battery, and providing both standard household alternating current (AC) and most common direct current (DC) power. It is easy to carry because of the minimized size. The four role trolley which attached on the portable solar ease the consumer to pull as it is moveable.

This device is designed to optimize capturing solar energy and storing it into a rechargeable battery.The energy generated from 24W solar panel transferred to rechargeable 12V battery, to the DC to AC Inverter and to the power outlet socket (240V).

II. METHODOLOGY

A. Software Design

The Arduino Uno is a microcontroller board that has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Four screw holes allow the board to be attached to a surface or case.

B. Hardware Design

The components including 2 units of 10kΩ and 10MΩ each resistors, 1 unit of variable resistor 10Ω, 2 units of 100nF capacitors, 1 unit of voltage regulator, paint, screws and cable tie. The hardware design completed with the elements as follows in Table 1.

Table I: The completion elements of Hardware Design

Elements of the Design	Quantity
LM 7806	1 unit
Varnish	1 litre
Colour spray (black)	1 unit
Nails	10 pieces
Screw	14 pieces
Flexible cable	1 meter
Cable tie	10 pieces
Door hinges	2 unit

The process of testing the circuit, such as littering processes, etching, insert the components and soldering should be done first while soldering make sure that has been done is not shorted to any of the circuits on the PCB.The PCB completion after the drilling process while for further processing of all components should be provided. Previously, the components installed on PCB, the schematic and the component. Components terminals to be mounted on the PCB should be done with the soldering process. The component terminal is bent at an angle of component 30 degrees when the foot went into PCB components to ensure that components are not detached from the PCB.

The circuit board with a good layer of conductive and insulating material copper for the circuit design board construction. Referring to the circuit diagram, circuit design was drawn on the PCB before the etching process that can design PCB circuit to avoid a short circuit while the circuit sketches should follow the actual size.

Component installation should do with drilling to be carried out. The electrical gadget used is hand drill machine. The first to be drilled must be marked with thumbtacks or sharp objects to ensure that the drill bit does not slip position during the drilling process underway. In addition, the hole to be drilled in accordance with the legs of a component in required shape. The PCB also cleaned after drilling to make it easier to insert the leg of the components.

C. Mechanical Design

TheEasy Solar Photovoltaic Panel as Renewable Energy System Device conceptis according to the electrical generator in the market nowadays. It is generating electrical energy to supply the energy to the electrical devices.

Theprojectuses the voltage regulator which to convert 12V DC of battery to 6V DC to supply energy source to our Arduino Uno (microcontroller). The circuit that used to measure the battery's status is the Arduino Voltmeter circuit. It is consist of 1MΩ and 10kΩ of resistance to measure the voltages. The Arduino was programmed to display the battery's status to the LCD monitor.

The 10Watt solar panel, solar charge controller, inverter that convert 12V DC to 230V AC, distribution box and 13Asocket are the main component of the mechanical design of the project.

The basic diagram of the Easy Solar Photovoltaic Panel as Renewable Energy System Deviceis containing the equipment inside the system device expect for the solar panel. The solar panel absorbers the energy from the sun as a power to produce the electrical energy.The inverter used to convert 12VDC to 240VAC. It has terminal input which is terminal live and neutral from 12VDC. Moreover, on the output there are live and neutral terminal to 240VAC.

The Arduino Uno is a microcontroller board that has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Solar charge controller is used to control the charging process to the battery. The red fast flashing indicator show that the battery is over low. Moreover, the slow flashing indicator show the battery is lower and when the indicator is often bright show the battery is normal. The green indicator states that the solar panel receive the sunlight.The distribution box is the part of protection on our project. When there is fault occurs it is automatically "trip" to protect the device that connected to the portable solar is safe.

In rural area, the technology is driven by portability, performance, and efficiency as shown in Figure 1. As technology becomes more portable, there is greater dependence on finding mobile power to sustain this technology. Carrying back up sources of mobile power such as extra batteries is very convenient to sustain devices running on portable power but, batteries cannot be replenished by themselves. It is more convenient to have a portable power source that is capable of providing power, recharging by itself, has a minimal or no negative impacts on the environment, and is convenient to carry around. Such a power source is purely a portable system, independent of power outlets.

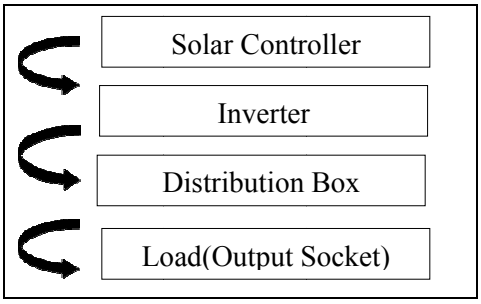


Figure 1: The flow of Basic diagram inside the Easy Solar Photovoltaic Panel as Renewable Energy System Device

The Easy Solar Photovoltaic Panel as Renewable Energy System Device is build up with distribution box, circuit box, LCD Display, 12V DC battery, inverter, solar charge controller and 24 Watt solar panel. The gadgets as mentioned above are the main component of this project as shown in Figure 2.

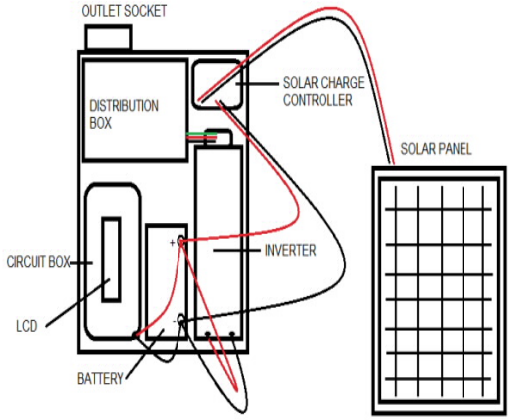
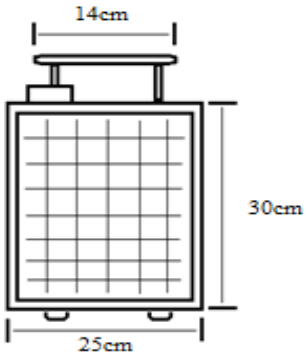
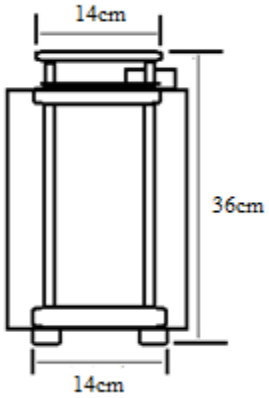
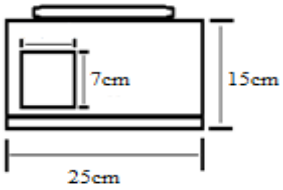
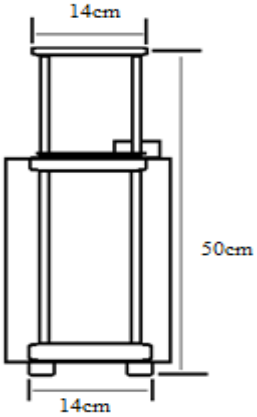


Figure 2:The diagram of main components inside the Easy Solar Photovoltaic Panel as Renewable Energy System Device

The plan view with accurate measurement of Easy Solar Photovoltaic Panel as Renewable Energy System Device is in detail in Table 2.There are front plan view, back plan view, top plan view and back plan view for the four role trolley.

Table II: Plan measurement of the mechanical design Easy Solar Photovoltaic Panel as Renewable Energy System Device

Plan View	The Plan measurement
Front Plan View	 Figure 3 :The front plan view of Easy Solar Photovoltaic Panel as Renewable Energy System Device
Back Plan View	 Figure 4 :The back plan view of Easy Solar Photovoltaic Panel as Renewable Energy System Device
Top Plan View	 Figure 5 : The top plan view of Easy Solar Photovoltaic Panel as Renewable Energy System Device
Back Plan View for the four role trolley	 Figure 6 :The back plan view of Easy Solar Photovoltaic Panel as Renewable Energy System Device

III. RESULTS AND ANALYSIS

A. Software Results and Analysis

The project programmed by using the Arduino software program code. Table 3 shows the program code and the explanation for each main instruction by using Arduino UNO. The Arduino program code is used to command the controller to control our circuit operation. The C language programming includesmeasuring the voltage value. Declaration syntax mimics usage context. C has no "define" keyword; instead, a statement beginning with the name of a type is taken as a declaration. There is no "function" keyword; instead, a function is indicated by the parentheses of argumentlist. Complex functionality such as I/O, string manipulation, and mathematical functions are consistently delegated to library routines.

Table 3: Program code by using Arduino UNO

Program Code	Explanation for the instruction

int sum = 0;
 	
sample_count = 0;
 	
float voltage = 0.0;
	// sum of samples takenunsigned char
	
	//current sample number
	
	// calculated voltage

void setup()
{
lcd.begin(16, 2);
}
void loop()
{
	// take a number of analog samples and add them up

while (sample_count< NUM_SAMPLES)
{
sum+= analogRead(A2);
sample_count++;
delay(10);
}
 	
voltage
lcd.setCursor(0, 0);
lcd.print("PORTABLE SOLAR");
lcd.print(voltage*DIV);
lcd.println (" V");
sample_count = 0;
sum = 0;
}
	//calculate the voltage
	
	// use 5.0 for a 5.0V ADC reference voltage
	
	//5.015V is the calibrated reference
	voltage = ((float)sum / (float)NUM_SAMPLES * V_REF) / 1024.0;
	
	//send voltage for display on LCD
	
	// voltage multiplied by 11 when using voltage divider that
	
	// divides by 11. 11.132 is the calibrated voltage divide
	
	// value

The program code for the project was tested by using Arduino UNO software. The program code was successfully done as shown in figure 7.

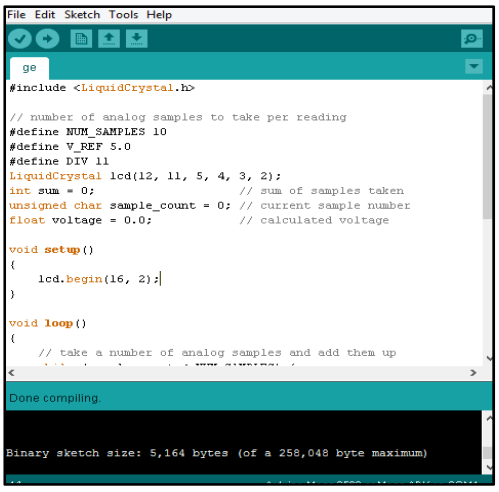


Figure 7: Arduino Uno source code window succeed with “Done compiling”.

B. Hardware Results and Analysis

The system of the project used some sort of programming by using the Arduino software. The project needs the programming because the circuit as shown in Figure 8 is being usedthe Arduino Uno Rev 3 to make the Arduino voltmeter circuit operated to measure the voltage values. This Arduino is used to command the controller to control our circuit operation. In this system, C language programming being used to measure the voltage values.

There are two kind of voltage display. First display is the measurement from storage battery.Secondly.the voltage display on the LCD Display is from the measurement of Solar Panel.

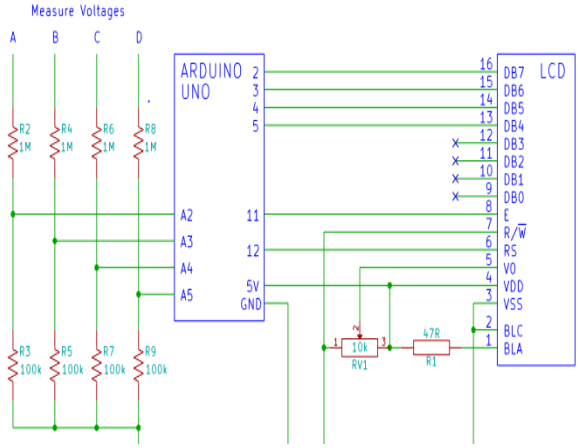


Figure 8:LCD Screen connection with Arduino UNO

C. Analysis towards Battery Storage Capacity

X (Battery size in AH) x Y (Battery Voltage) = Z (Power available in watt hours) (1)

For a 20AH, 12V battery the Watt Hours figure is 20(X) x 12(Y) = 240 WH (Z) (1)

The battery could supply 240W for 1 hour, 120W for 2 hours or even 2w for 120 hours i.e. the more energy you take, the faster the battery discharges by using the equation shown in Equation (1).

IV. DISCUSSION

The development of affordable storage solutions for solar power or other renewable energy sources such as wind will change the nature of electricity generation and distribution.However, a growing number of companies are now offering increasingly intelligent solar power management and storage solutions for the moveable (mobile), residential and commercial solar power markets.

Solar panels are generally the most cost effective way to generate solar energy, but cannot provide on demand power unless the sun is shining, which may not necessarily be when it is needed most. The solution is therefore to capture it in batteries which can then be drawn upon later to provide power.

The capacity of storage devices can vary by both the brand and the model of the product in question. It may even be the case that the ‘management’ portion of the technology is sold separately to the storage portion. The fully charged storage units, but generally that will be able to supply the electrical appliances with electricity for 2 to 3 days. So in most cases enough storage capacity for 10-15 hours’ worth of power, depending on how it is used. Of course larger storage systems may also be used as power back-ups for systems rural locations where no electricity supplies reliability which is shaky, remain fully operational. Last but not least, yet another opportunity to save money on electricity bills.

Deciding on the type of power inverter the requirement depends on the type of power output is needed. Pure sine wave inverters provide an output which harmonically follows a sine wave. This is similar to the utility-supplied grid power. These inverters switch polarity ("+" and "-") between power cables smoothly, gradually reducing or increasing the voltage as required in case if wondering why inverters have to switch polarity: this is the essence of alternating current, polarity changes happen approximately 50-60 times per second.

In contrast, modified sine wave is a simulation of the pure sine wave output when the inverter sharply drops or increases voltage to switch polarity. As a result, the output form closely matches pure sine wave but still has much greater distortions.

The modified and pure sine wave produce the same levels of output, the pure sine wave inverter produces a much smoother and less erratic output.Modified Sine Wave output is not suitable for certain appliances, particularly those with capacitive and electromagnetic devices such as: a fridge, microwave oven and most kinds of motors. Typically modified sine wave inverters work at lower efficiency than pure sine wave inverters which suits the project. Modified sine wave inverters are normally significantly cheaper than pure sine wave inverters. To sum up, even though modified sine wave inverters can work well with many appliances including light bulbs, mobile phone chargers and office equipment, if your budget allows it, we would always recommend buying a pure sine wave inverter.

Need to power small appliances like a mobile phone charger or energy efficient light bulbs, usage oflarger power inverter because it will consume significantly more power even in standby mode and work very inefficiently with small appliances. Therefore the power rating of the inverter should be chosen based on the power consumption of your load.

The input current for the inverter will be 2 times smaller for the 24V than the 12V making the inverter and the entire system safer and more reliable. Cables between your battery and the inverter do not have to be as thick as those used for a 12V battery bank and inverter.This is particularly important for large standalone solar systems inverters and for such power levels our recommendation is to opt for a 24V battery bank and an inverter with 24V input voltage.

V. CONCLUSION

Inconclusion, the project is intended to help users such as travellers, campaigners, Army Forces and those who involve in picnic activities to bring and use it as compressed electric power source to electrical appliances for example hand phone charges, fan, lamp, and laptop.

A. Limitation

The Easy Photovoltaic Panel as Renewable Energy System Device physical size is compacted. The roller and trolley ensure the project is easily to be pulled by the consumer.

B. Suggestion

The Easy Photovoltaic Panel as Renewable Energy System Device need to be improved in future and recommended to be enhancedas listed on below sequences.

a) Upgrade the design and improve in matter of the output voltage or more watts where every appliance that needs more power and creativity that available can be used.
b) Upgrade the energy storage in terms of battery which stores the electrical energy.
c) Use larger capacity of solar panel to charge the battery.
d) Upgrade to make it possible to recharge using the solar panel or 13A socket.

Acknowledgment

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