UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INVESTIGATION OF WATER SPRAY COOLING TECHNIQUE ON PHOTOVOLTAIC PANEL

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with honours.

BY

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DECLARATION

I declare that this report entitle 'Investigation of Water Spray Cooling Technique on Photovoltaic Panel' is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature:

Name: Kholilul Syahmiaizad Bin Baharuddin

Date: 10.12.2018

APPROVAL

I hereby declare that I have read through this report entitle 'Investigation of Water Spray Cooling Technique on Photovoltaic Panel' and found that it has comply the partial fulfillment for awarding the Bachelor of Electrical Engineering Technology (Industrial Power) with Honors.

Signature:

Supervisor's Name: Mr. Zaihasraf Bin Zakaria

Date : 10.12.2018

ABSTRAK

Kajian ini adalah untuk mengkaji bagaimana untuk membangunkan sistem penyejukan yang aktif menggunakan air semburan yang boleh meningkatkan kecekapan fotovoltaik dengan merujuk kepada intensiti dan suhu cahaya berdasarkan eksperimen dengan pelbagai keadaan sinaran dan suhu. Ciri IV akan menunjukkan kesan pada suhu yang semakin meningkat menyebabkan penurunan voltan pada kuasa dan voltan panel solar. Oleh itu, sistem solar dengan sistem penyejukan yang dilaksanakan adalah untuk meningkatkan kecekapan panel solar, voltan keluaran dan output kuasa, sistem penyejukan mesti ditambah. Sistem penyejukan ini menggunakan kaedah semburan air untuk menyejukkan panel fotovoltaik hadapan. Menggunakan air adalah salah satu unsur yang baik untuk penyejukan dan penyejukan cepat. Pada kajian ini, sel fotovoltaik dengan dan tanpa sistem pendinginan dilaksanakan untuk memahami dan mengenal pasti voltan litar pintas semasa dan terbuka untuk perbandingan kerana analisis dibuat untuk membuktikan sistem penyejukan air dapat membantu meningkatkan kecekapan dan voltan keluaran sel fotovoltaik.

ABSTRACT

This research's objective is to study on how to develop an active cooling system using spray water that can increase the efficiency of photovoltaic by referring to the light intensity and temperature based on the experiment with varies condition of irradiance and temperature. The IV characteristic will show the effect on the rising temperature causing a voltage drop on the power and voltage of the solar panel. Therefore, the solar system with the cooling system implement which is to improve the solar panel efficiency, output voltage and power output, the cooling system must be added. This cooling system is using spray water method for cooling the front photovoltaic panel. Water is being used as a good element for cooling and fast cooling. On this research, photovoltaic cell with and without cooling system are implemented to understand and identify the short circuit current and open circuit voltage for comparison as analysis is made to prove the water cooling system that can help to increase the efficiency and output voltage of photovoltaic cell.

DEDICATION

A special dedication to my beloved parents, Mr. Baharuddin Bin Salamun and Mrs. Siti Fatimah Binti Ibrahim for their support and pray. And also appreciate towards my supervisor, Mr. Zaihasraf Bin Zakaria for advising and helping me through this project.

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The success and final outcome of this project require big supported, assistance and also a lot of guidance form many people.

To implement this project in order to get the desired results, I need a clear indication of the success of this project. Thank God for the guidance I received from people around me, I have done this project successfully.

First of all I would like to thank the supervisor for giving me a great deal of guidance in this project. Knowledge and experiences when working with Mr. Zaihasraf are very valuable to me as the knowledge I gained can be use in the future.

I also would like to express my gratitude towards my parents as they gave a lot of moral support and motivated me to make sure the success of this project. “A success will be more memorable when we find it difficult to achieve the success”. To be honest, they are the ones who have provided financial support for the success of this project.

I would also like to thank my friends who have help to generate ideas and handing their hands during the completion of this project. Without them, I may not complete this project successfully.

Finally, I am really thankful and fortunate enough to get constant encouragement, support and guidance from all teaching staffs of Faculty Engineering Technology who helped me in completing our project work successfully. Also, I would like to extend my sincere esteems to all staffs in laboratory for their timely support.

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Chapter 1

Introduction

1.1 Background Of The Project

Malaysia's weather conditions nowadays keep showing the increasing of temperature in such recent years. The increased that has been observed is from 29°C to 37°C. Hence, this phenomenon enhanced the production of solar power industry in Malaysia. The development of solar power technology is not only use for generator plants but currently being supports for residential equipped for own use also. The increased temperature now leads for solar technology development in Malaysia. Widespread usage, easy to find equipment at electrical stores and also simple design for solar system make this sector at another level. The solar plant is one of the jurisdictions of Kementerian Tenaga, Teknologi Hijau Dan Air (KeTTHA). This means every installation for solar systems must have permission from KeTTHA to avoid any action taken from the authorities. The use of solar system can help to save cost. Consumers just need to spend their money for the installation and the maintenance which is done for every 6 months awhile. The problem of less efficacy on PV panels can be overcome by developing the project. In some countries, this system is already used since a long time ago. However, in Malaysia, this technology has not been expanding but it suits to be use because Malaysia's climate seems to be such a great condition to apply this system.

First and foremost, this system used the renewable energy which is solar power as the resource. The solar produces electricity by absorbing the sun through the PV panel and changed it to DC voltage. Then the voltage accumulated and been transferred to the water pump system. The water pump been triggered after the sensor detect the exceed

temperature from maximum allowable temperature (MAT). Next, the spray water system will cool down the PV panel for about 5 minutes. This process will be repeated until the maximum period usage of the PV panel which means once the PV panel got damage then the whole system will stop by itself.

1.2 Problem Statement

The public awareness on solar technology makes this sector a fast growing field. The main problem statement is by increasing the temperature of climate caused the PV panel efficiency reduction. This happen when the environment temperature is too high and exceeding the maximum temperature that can be absorbed by the PV panel. For example, each PV panel has their own maximum temperature level for it to operate effectively. Besides, dirt problems on PV panel could be happen too. This problem can cause the disturbance at the PV panel in accepting the sunlight source.

1.3 Objective

The main objectives to build this system are:

i. To develop a PV cooling system using water spray.

ii. To investigate the performance of the PV system.

1.4 Scope

This project will focus on:

i. The front water sprays techniques for the prototype.

ii. The usage of solar energy as main source to trigger all the equipment.

iii. To make sure the effectiveness of the PV panel is in the optimum condition.

1.5 Process Flow of Solar power using spray cooling system

The voltage obtained is for home usage such as lamps and fans. For a motor pump it needs a low amount of voltage so that the energy will not be wasted during the operation system. Energy generated must be fully supplied to the battery for home use. First and foremost, voltage gained from the PV panel which absorbs the sunlight, being store in the battery. The cooling system will start its process once the sensor detects a higher temperature on PV panel that exceeds the maximum allowable temperature (MAT). It will also trigger the water pump to turn on and water being spray on the front surface of the PV panel. This operation will be repeated once the temperature exceeds the MAT on the PV panel.

1.6 Contribution

As a conclusion, photovoltaic with cooling system has been designed and build. Therefore human don't have to rely heavily on non-renewable source such as fuel and gas. This project may conserve the energy source for future. Moreover, it has been improved to get maximum energy from the sun by increasing its effectiveness on PV panels. This model will contributes idea to others in developing green technology product and awareness about the importance for our nature. Ultimately, enhancing the latest technology that use the renewable energy source of solar energy as the primary source.

Besides, this project can save energy from losses in PV panel. Thus, clean energy can be supply for any application at home. The success of this project may attract people to use this technology either for their houses, buildings or factories

Chapter 2

Literature Review

2.0 Introduction

The main purpose of this project is made up the solar system by utilizing cooling system method which can give more the efficiency of the solar panel board to acquire more yield output voltage. Increasing temperature in weather can reduced the efficiency of PV panel which this condition is detrimental because the PV panel is not operating at its maximum state of efficiency. High temperature reception at PV will result in reducing the efficiency.

This writing is obtained of data accumulated from different sources to shape the reason for develop of solar system utilizing cooling system. The data was gathered from website, books, research article and journal to talk about the normal operation, theory and the main criteria to develop the project which utilizes the solar system and arduino

2.1 Photovoltaic System

The popularity of solar system module system of renewable sources expanded significantly during the last decades. Where solar system will converts solar power into

electrical energy. Photovoltaic energy is a renewable energy source produced by radiation from the sun and do not include versatile parts to produce this kind of energy. PV system can be intended to deliver from process watt range to megawatt extend. Not like the utilization of petroleum and gas, the utilization of the solar energy do not create contamination. The solar energy is a perfect and interminable wellspring of the energy for the solar system to produce voltage and current. (Fatimah Zohra Zerhouni, *et al*, 2010).

2.1.1 Operation

To change sunlight into electrical energy, solar cell is used in the solar system process. Solar panel impact will be delivered when the daylight falls on a two-layer semiconductor bringing about some measure of voltage being produced between the two layers. The yield current delivered can be utilized through external electrical circuit. Figure 2.1.1.1 signifies the electron, flow current and operation of photovoltaic. Photovoltaic structure have a three layer, which is N type on top and P type at back intersection. Between both layer have one layer is called P-N junction. That are three layer for made photovoltaic panel. The P-N junction have own structure electric field give voltage to electrons through to hole freed by light ingestion enabling it to stream in their own particular ways. The N-type state will receive the electron, and into the hole at P-type state. The cell's electric field yielded voltage meanwhile the electron flow produces current. Through the combination of the current and voltage will produce electric power.

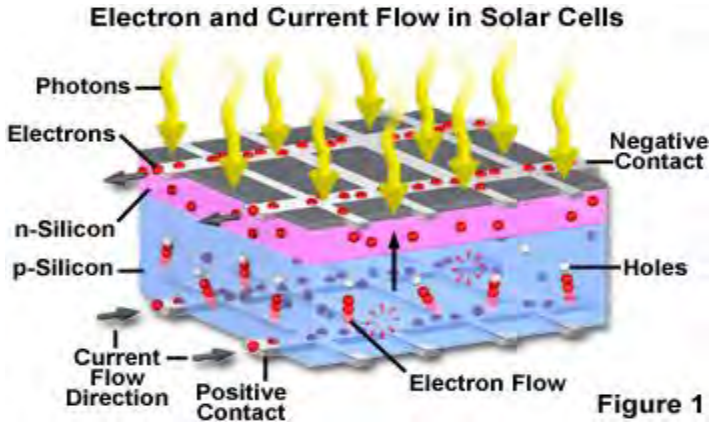

Figure 2.1.1. 1: Electron and Current Move in Photovoltaic

Solar system is convert into direct current (DC) by photovoltaic semiconductor in the sun based module by fascinating sunlight through the solar panel technique. As appeared in Figure 2.1.1.2, the photovoltaic are consolidated and fixed to build to give more efficiency. Module has consist of combination and sealed cell. A few module are combined in series or parallel connection to accomplish the want yield. The assembled modules is called array.

Figure 2.1.1. 2: Cell, Module and Array

To achieve the higher efficiency output, the solar panel module surface is introduced at a reasonable edge opposite confronting the sun way as portrayed in Figure 2.1.1.3.The solar panel module must be tilted 34° from the starting face of the sun in order to obtain maximum sunlight. The green zone in Figure 2.1.1.3 demonstrates the example of movement the sun. The tilted point likewise enables water to be depleted out. Water reservoir can make harm to the solar panel.

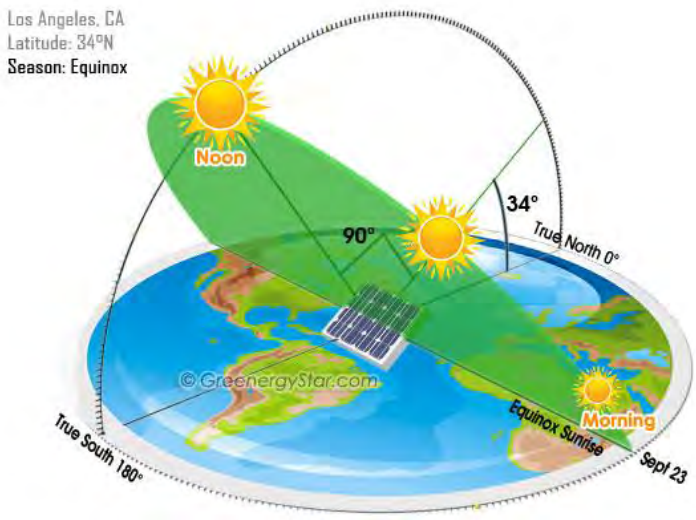

Figure 2.1.1. 3: The Angle and Sun Path of solar panel

Reception of sunshine from January to December in Figure 2.1.1.4. 4kWh is the normal radiation per day and the information is utilized to compute the needed amount of the solar array.

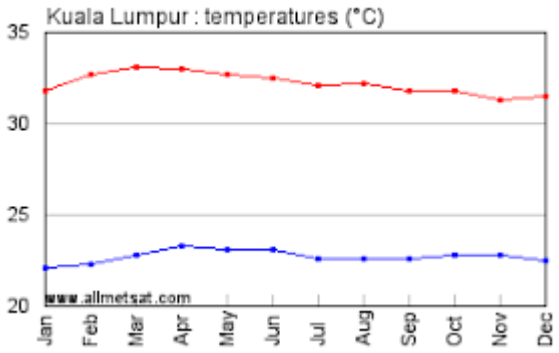

Figure 2.1.1. 4: The Graph of Average temperature in Malaysia

2.1.2 Type of Photovoltaic

Photovoltaic made from silicon and the photovoltaic have many type with different structure are used such as mono-crystalline silicon, thin-film silicon and polycrystalline silicon. Mono-crystalline and polycrystalline assume essential part in solar panel system. (L.A. Dobrzanski, *et al,* 2012). As seen in the table 2.1.2.1, the mono-crystalline silicon have the highest efficiency compare to others (L.A. Dobrzanski, *et al*, 2012).

Table 2.1.2.1 shows the efficiency and types of photovoltaic that absorbs sun ray. Poly-crystalline is 20.4%, Mono-crystalline efficiency is 25%. The result show the mono-crystalline has the highest efficiency and it will be used in the project (L.A. Dobrzanski, *et al*, 2012).

Table 2.1.2. 1: The Efficiency of the Module

NO	CLASSIFICATION	EFFICIENCY
1	Mono-crystalline	25.0±0.5
2	Polycrystalline	20.4±0.5
3	Nano-crystalline	10.1±0.2
4	Amorphous	10.1±0.3

2.1.3 Stand-Alone Solar System

In solar system, there have two type of solar system which is on-grid and off-grid. The popular one is off-grid. Different of both is on-grid where combine with grid and power from solar system can sold to service organization. Off-grid is the system not combine with grid. The output of solar system use for own usage and it's also called stand-alone system. (John Balfour, *et al*, 2013).

This prototype use stand-alone system because the solar system not connected to grid and output voltage just to use for own system. stand-alone system divided to two which is direct couple and small stand-alone system. Direct couple system is direct connect from output solar system to load and small stand-alone system need battery to use such storage the voltage before utilization as in figure 2.1.3.1.

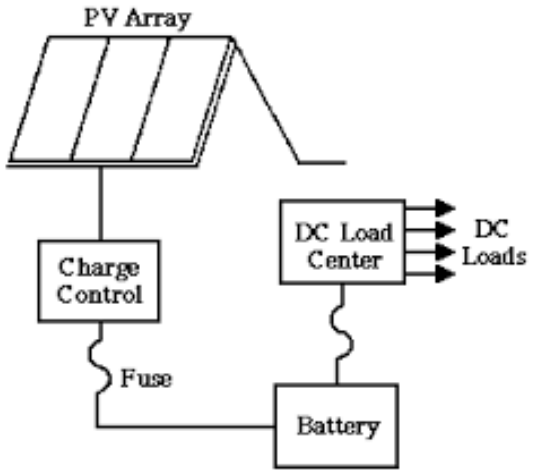

Figure 2.1.3. 1:Stand-alone Solar System

2.1.4 Wiring Connection of Solar Panel

There have two connection of wiring solar panel which is parallel and series. This project will use the parallel connection. In order to use series connection, connection from battery isn't associated by means of one common life wiring, rather wiring from battery is straight-forwardly connect to primary panel, trailed by a moment installed the principal wiring to the second solar panel and a third wiring from the second solar panel to the next solar panel. In series connection, voltage will fluctuates and the main solar panel can effects each of the panel it's happen when the current low. It disturbs the solar panel to work at optimum operation.

In parallel association, wiring from battery is associated with every one of the three solar panel by means of one common life wiring as portrayed in Figure 2.1.4.1. The point of interest in this installation can get a maximum output current and voltage more stable. If one of the on/off solar panel being harm, it will not effects the other two solar panel to create the voltage and current output.

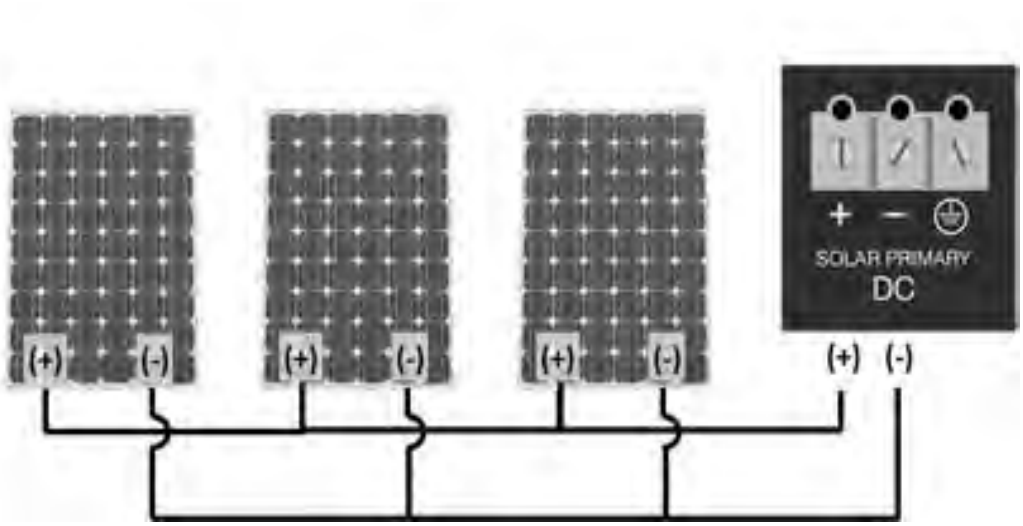

Figure 2.1.4. 1: Parallel Connection of Solar Panel

2.2 Battery

In stand-alone system, battery usage is most import because its will be storage the power from output solar system. It's also supplies higher current to start the motor compare to direct couple system. By using the battery, voltage will be controlled to keep away any harmful to the load. (Arjyadhara Pradhan, *et al*, 2012).

A rechargeable battery portrayed in Figure 2.2.1 is the most appropriate for the solar panel. It is intended to deliver bring lower current to keep it from harm. The rechargeable battery is free maintenance, cheap, and have longer life span (Arjyadhara Pradhan, *et al*, 2012).

Figure 2.2. 1: Rechargeable Battery