# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# INVESTIGATION OF PASSIVE COOLING TECHNIQUE ON SOLAR PANEL'S EFFICIENCY

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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2019

# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: INVESTIGATION OF PASSIVE COOLING TECHNIQUE ON SOLAR PANEL'S EFFICIENCY

Sesi Pengajian: 2019

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Date:

## APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

Signature: …….

Supervisor : EN. ZAIHASRAF BIN ZAKARIA

# ABSTRAK

Pada masa kini, tenaga solar semakin popular sebagai tenaga boleh diperbaharui untuk menampung keperluan tenaga elektrik yang semakin meningkat disebabkan oleh pertambahan penduduk dunia. Ianya juga tiada pencemaran dan yang paling penting ialah sumber yang tidak akan habis. Walau bagaimapun, tenaga solar mempunyai batasan di mana ia mempunyai suhu optimum yang akan mempengaruhi kecekapannya. Menurut Piawaian Ujian Keadaan (STC) suhu yang disarankan ialah 25°C dan kecekapannya akan menurun apabila suhu meningkat dan menyebabkan lebih banyak tenaga haba yang dihasilkan. Haba yang tidak diperlukan harus dikeluarkan daripada panel untuk menjana kuasa keluaran yang tinggi. Tujuan kajian ini ialah untuk meningkatkan kecepakan panel solar pada tengah hari dengan menggunakan teknik pengejukan pasif. Dalam kajian ini, dua jenis reka bentuk sink haba yang berbeza digunakan iaitu sirip campuran dan sirip biasa untuk membandingkan kebolehannya untuk mengejukan solar panel. Hasil kajian menunjukkan bahawa sirip campuran lebih baik berbanding sirip biasa dengan kecekapan 7.11% dan 6.6% masing-masing. Untuk mendapat hasil yang lebih baik kipas mudah alih digunakan untuk mempercepatkan proses pengejukan melalui permukaan hadapan dan belakang panel melalui proses perolakan dan pengaliran. dimana terbukti untuk kelajuan 3 (3.3 m/s) kecekapan meningkat untuk kedua jenis sirip dengan kecekapan sirip campuran sebanyak 8.94 % manakala sirip biasa sebanyak 8.44 %.

## ABSTRACT

Nowadays, solar energy becomes popular as a renewable energy to support the demand of electricity due the increasing population of world. It also no pollution and the most important is infinite source. However, solar energy have limitation where it have their optimum temperature that will influence their efficiency. According Standard Test Condition (STC) the optimum temperature is 25°C and it performance will drop due rise temperature and cause more heat energy will produced. The unwanted heat must be release from the panel to produce higher output power. The aim for this research is to improve the efficiency of solar panel during noon by using passive cooling method. In this experiment, two different design of heat sink are used that is normal fin and mixed fin to compare their performance to cooling solar panel. The results of the experiment shows that mixed fin better than normal fin with efficiency 7.11% and 6.6% respectively. To obtain better results portable are used to speed up cooling process through front and bottom surface through convection and conduction process, it prove that by using speed 3 (3.3m/s) their efficiency will increase for both types of the where mixed fin is 8.94 % while normal fin 8.44 %.

## DEDICATION

My special dedication goes to my beloved parents, siblings and friends who always support and help me to complete final year project successfully. Meanwhile, to my supervisor, Mr. Zaihasraf Bin Zakaria, who guide me to achieve success for my final year project.

## ACKNOWLEDGEMENTS

Alhamdulillah, I would like to thanks to Allah S.W.T, the Most Merciful, and all praises to Allah for His blessing in completing this project. I would like to thank to my supervisor Mr. Zaihasraf Bin Zakaria for guidance and help in complete my final project. I would like also to thank to all people involve directly and indirectly in my final my project.

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| | | |
|---|---|---|
| **STC** | - | Standard Test Condition |
| **PV** | - | Photovoltaic |
| **CIGS** | - | Copper Indium Gallium Selenide |
| **CdTe** | - | Cadmium Telluride |
| **P** | - | Phosphorus |
| **B** | - | Boron |
| **Rsh** | - | Shunt Resistance |
| **Rs** | - | Series Resistance |
| **c-Si** | - | Crystalline Silicon |
| **eV** | - | Electron Volts |
| **Vmp** | - | Maximum power voltage |
| **Imp** | - | Maximum power current |
| **V** | - | Voltage |
| **I** | - | Current |
| **A** | - | Ampere |
| **W** | - | Watt |
| **Isc** | - | Short-Circuit Current |
| **Voc** | - | Open-Circuit Voltage |
| **FF** | - | Fill Factor |
| **W/m$^2$** | - | Watts Per Square Meter |
| **˚C** | - | Degree Celsius |

| | | |
|---|---|---|
| **m/s** | - | Meter per Second |
| $\beta$ | - | Tilt angle |
| **CNC** | - | Computer Numerical Control |
| **CFD** | - | Computer Fluid Dynamics |
| **W/mK** | - | Watts per Meter Kelvin |
| **η** | - | Efficiency |
| $Pin$ | - | Power Input |
| $Pout$ | - | Power Output |

# CHAPTER 1

# INTRODUCTION

## 1.0 Introduction

This chapter will discuss about the benefit and evolution of solar system to support demand of electricity every years and their limitation as stated in project background and problems statement. The solution of the problems and illustration of project implementation was stated in objective and scope.

## 1.1 Project Background

Every years the demand of electricity are rise due the increasing population of world. The main energy source such as coal and petroleum cannot support the demand of electricity as it will finally run out. The best solution is renewable energy. It is generated from the environment such as sun, water, geothermal and wind. Nowadays, it becomes popular as there are no pollution, cheaper for the long term and the most important is infinite source.

Solar energy is one of the most useful renewable energy. It absorbs energy or heat from sunlight and converts it into electricity. It also potentially used in many sectors in the future as new technologies continue to evolve to meet consumer demand. Many studies have been conducted to increase the efficiency of photovoltaic panels by using passive or active cool techniques. It is because the optimum temperature of solar panel is 25°C and the efficiency will drop about 0.45% per degree when over it (Popovici, Hudişteanu, Mateescu, & Cherecheş, 2016). As a result, only 15-20% will

produce electrical energy and the rest generate heat energy (Stropnik, 2016). Furthermore, by using cooling method the solar panel lifetime can be extend (Royo et al. 2016). Normally passive cooling method more easily and small initial investment unlike passive method (Grubisic-Cabo et al., 2016 and Elbreki, Alghoul, Sopian, & Hussein, 2016). However, the efficiency of passive cooling method are less compared active cooling method. Hence, various study was conducted to improve passive cooling method.

A photovoltaic (PV) cell also known as solar cell comprises at least two thin layers of semiconductor material. This cell will operate when it receive light and produces direct current. A single photovoltaic cell produces small output but it can generate more electricity in array connection.

The technology of solar cell can separate into three generations (Praveen & Vijaya Ramaraju, 2017). The first generation is commonly using a crystalline silicon wafer and the efficiency around 15-20%. The advantages is high performers and high stability. The second generation is photovoltaic cell made from amorphous silicon, CIGS (Copper Indium Gallium Selenide) and CdTe (Cadmium Telluride) with the efficiency is 10-15%. The advantages is costs manufacturing can be reduced, lessen mass and flexible to few of angle. The last generation is organic solar cell which based on organic substance for example polymers or small molecules. Due to high production cost, this type only used in some commercial applications. In this experiment only focus on crystalline silicon type. This experiment also uses a heat sink with attached at the rear to cooling solar panel and improve the efficiency of solar panel.

## 1.2 Objective

The objectives of this project are:

1. To study the effect of surrounding temperature to solar panel performance.
2. To design and fabricate heat sink for solar panel.
3. To investigate the efficiency of PV module.

## 1.3 Problems Statement

Each solar panel has an ability to transform photon energy from sunlight to produce electricity. The efficiency of solar panel will decrease when rising the temperature during peak at noon which causes more heat energy to be produced. The unwanted heat should be released from the panel to produce more output power. This system focuses on how the passive cooling method can reduce the temperature of the panel and improve the efficiency.

## 1.4 Scope

From the concept of heat transfer, the fabrication heat sink with fin are built. It considers the spacing between fin and design of fin. Besides that, to effectiveness cooling, the portable fan are used to speed up cooling process and reduce overheating at the solar module and increase the efficiency of the solar panel.