



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**A STUDY OF POLY-CRYSTALLINE AND THIN-FILM
SOLAR PANEL FOR RENEWABLE ENERGY
APPLICATION**

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

by

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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:

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ABSTRAK

Sejak kebelakangan ini, penggunaan tenaga solar diperkembangkan secara meluas terutamanya di dalam sektor industri. Sektor industri memerlukan lebih banyak tenaga untuk dijanakan secara meluas. Tenaga solar yang besar memerlukan lebih banyak panel solar supaya lebih banyak tenaga yang dapat dijanakan. Analisis ini dijalankan untuk membezakan prestasi antara poli kristal dan filem nipis dari segi voltan, kuasa dan kecekapan. Ini bertujuan untuk menentukan jenis material yang bagus supaya boleh diaplikasikan di dalam sesuatu industri. Projek yang dianalisis menggunakan penyongsang kuasa yang menukarkan arus terus kepada arus ulang-alik. Projek ini menggunakan sistem Internet Perkara (IOT) yang membolehkan keputusan dikeluarkan secara terus melalui sistem komputer. Hasil pengeluaran yang bagus menentukan jenis material yang sangat sesuai untuk diaplikasikan di dalam industri.

ABSTRACT

In recent times, the use of solar energy has increased significantly in the industrial sector. The industrial sector needs more energy to be generated more broadly. Large solar power needs more solar panels to produce more electricity. This study was conducted to differentiate between crystal poly and thin film in terms of voltage, power and output. This is to determine the right kind of material to be used in the industry. Projects are analyzed using a power inverter that transforms the direct current into an alternative current. The project uses an Internet of Things (IoT) system that enables results to be taken directly through a computer system. Good production results determine the right type of material to be used in the industry.

DEDICATION

First of all, I dedicated this thesis to my parents Nor Azli Bin Moh and Hasnita Binti Adam who has unwavering support and encouragement to finish my project. I also want to dedicated this thesis to my supervisor, Mr. Mustafa Bin Manap and to both of my members Shahirah Fariha Binti Suhaimi and Hillary Robert for sharing some ideas and guiding me to make a fully decision while conducting this thesis.

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LIST OF SYMBOLS

mm	-	millimetre
K	-	Kelvin
μm	-	micrometer
W/m^2	-	Watt per meter square
s	-	second
min	-	minute
kWh	-	kiloWatt hour
mm^2	-	millimeter square
kW	-	kiloWatt
kV	-	kiloVolt
a.m	-	ante meridiem
p.m	-	post meridiem
V	-	Volt
W	-	Watt

LIST OF ABBREVIATIONS

CdTe	Cadmium Telluride
a-Si	Amorphous Silicon
CIGS	Copper Indium Gallium Selenide
GaAs	Gallium Arsenide
IOT	Internet of Things
MPPT	Maximum Power Point of Tracking
PV	Photovoltaic
IC	Integrated Circuit
DC	Direct Current
AC	Alternating Current
BC	Before Century
SPD	Surge Protection Device
MCB	Main Circuit Breaker
TNB	Tenaga Nasional Berhad
BOS	Balance of System

CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter will give an overview about the background of project, problem statement followed by the objective and scope that have been identified. The process of the work will be discusses in this chapter.

1.2 Background of Project

We have two kinds of renewable and non-renewable energy sources. The renewable energy definition is the energy from natural but flow-limited sources. In duration, they are virtually inexhaustible but finite in the amount of energy per unit of time available. Solar energy is expected to become increasingly attractive in the 21st century as it is a clean, inexpensive and renewable energy source that can be harnessed almost anywhere in the world. Solar energy is a radiation from the sun that can generate heat, chemical reactions or electricity. The full amount of solar energy is excesses of the current and anticipated energy requirement in the world. If properly exploited, this highly diffused source has the potential to fulfill all future energy needs. (S. Ashok, 2019). Solar panel was invented to bring benefits to our future. There are many types of materials for solar panels, but this project has been prioritized into two materials that are poly-crystalline and thin film.

A large number of grains consisted of polycrystalline materials. In addition, the lattice arrangement of atoms within each grain is almost alike, but the orientation of the atoms is dissimilar for each adjacent grain. There is a grain

boundary on the surface that separates neighboring grains. Grain boundaries impede dislocation movement and thus have a reinforcing effect. The strength of polycrystalline materials is increased by decreasing their grain size. It has the additional beneficial effects of increasing ductility, fracture toughness and fatigue life when reducing grain size. The strength increases due to the distance that dislocations travel through a grain core to reach a grain boundary decreases with the grain size. (Adrian P. Mouritz,2012).

Thin-film solar cell is a device innovated to convert light energy into electrical energy through the photovoltaic effect and consists of micron-thick photon-absorbing material layers deposited over a flexible substratum. In 1970, it was originally introduced by the analyst at the Institute of Energy Conversion at the University of Delaware in the United States. In maintaining strong durability, thin film solar cells is the best choice because it are the lightest PV cells due to their limited design and the efficient semi-conductor built into their cells. There are several types of thin-film solar cells that are widely used due to their lower price and efficiency in producing electricity, including Cadmium Telluride (CdTe), Amorphous Silicon (a-Si), Copper Indium Gallium Selenide (CIGS) and Gallium Arsenide (GaAs). (Daniel Burgess,2018)

1.3 Problem Statement

The main problem faced by a solar panel is the insolation or the intensity of sunlight is measured in full hours of sun equivalent. One hour of maximum or 100% sunshine received by a solar panel is equal to one equivalent full sun hour. Although the sun may be above the horizon for 14 hours a day, this can only result in six hours of full sun. (Value for insolation=6). This is due to the position of the sun above the

earth. The position of the sun reflects how much of the earth's atmosphere when the light rays must pass. (D, Onyekachi and Nwabueze, 2011)

To compare the performance of one solar cell to another, the parameter efficiency is used. Moreover, the efficiency relies on the spectrum and intensity of the incident sunlight and the solar cell's temperature to reflect the solar cell's performance. The rest of the sunlight that hits the panel is wasted as heat. While solar emission and temperature also cover the output voltage.

1.4 Objective

These are the objectives of this project:

- i. To compare the efficiency of power stored between the solar panel.
- ii. To investigate the performance of power output for the material of solar cell.
- iii. To measure and compare the output voltage for both poly-crystalline and thin film solar panel.

1.5 Scope

The scope of this project are include this following statement:

- i. Focused on two type of materials which are poly-crystalline and thin-film solar panel.
- ii. Using a power inverter.

- iii. Poly-crystalline solar panel dimension around (156mm x 156mm) while thin-film solar panel dimension around (1001 x 1402x 7.4 mm).
- iv. Using a monitoring system which is IOT to view the measurement of voltage, power and energy.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Nowadays, renewable energy has evidently become a trend in solar power. This chapter will present an overview of the background of solar energy that is widely used in this world. Next, the invention of many types of solar cells was listed from the most efficient to the less efficient. In addition, this chapter provides information on my scope of study, which is different material of solar cells used, poly-crystalline and thin-film, and the efficiency of solar cells. Thus, Maximum Power Point Tracking (MPPT) is an algorithm technique that includes controls used to extract maximum available power from the PV module under certain conditions. The voltage at which maximum power can be generated by the PV module is called the maximum power point.

Even solar energy is widely used this lately, there are several factors influencing solar cell performance that can reduce solar panel efficiency. The environment gives the most effect for performance of solar cells. Last but not least, it is important to know the duration of peak sun hour in order to achieve the high efficiency and performance of a solar panel.

2.2 Solar Energy

Solar energy powered almost each thing in the earth and atmosphere system. Solar energy warms the surfaces of the air and the earth, driving winds, currents, evaporation, clouds and rain. Imperatively, when the energy of the sun enters the atmosphere in the form of electromagnetic radiation, the process will begins. This energy's seasonal distribution depends on the Earth's orbital characteristics that revolve around the Sun. In the range of radiation, the solar spectrum extends from shorter wavelengths to longer wavelengths. At the top of the earth's atmosphere, the spectrum belonging to a 6000 K black body is closer to the incident radiation from the Sun. When the radiation of the Sun passes through the earth's atmosphere, dust particles, gas molecules, ozone and water vapor reflect, scatter, and absorb it. At a given location and time, the magnitude of the attenuation of the solar radiation is determined by the atmospheric structure and length of the atmospheric pathway traveling through the solar radiation. This radiant energy is finally transformed into a diversity of other forms of energy that is entering the earth and atmosphere system. (Aswathanarayana, 2010)

Solar energy is a favorable and freely available energy source for managing long-term energy crisis issues, among other renewable energy sources. The solar industry is constantly evolving throughout the world due to soar energy demand, while major energy sources and fossil fuel are restricted and other sources are costly. Currently, it has become an implement for developing countries' economic status and sustaining the lives of many needy people as it is now cost-effective following to accelerate their development after long aggressive research. In a future energy demand, the solar industry will be the best choice in terms of accessible, profitable,