



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF A SOLAR PHOTOVOLTAIC MOUNTING
SYSTEM FOR A FLAT ROOF IN A HOT CLIMATE
(MALAYSIA)**

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

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ABSTRAK

Sistem pelekap adalah merupakan salah satu ciri penting dalam setiap pemasangan. Sementara itu, sistem pelekap solar photovoltaic pula adalah satu sistem di mana ia digunakan untuk menetapkan panel solar di atas permukaan seperti bumbung atau plot kosong. Ia adalah asas sistem solar di mana asas yang baik memastikan kecekapan seluruh sistem dan pulangan ke atas pelaburan. Terdapat beberapa jenis sistem pemasangan solar photovoltaic seperti pelekap tanah, pelekap tiang, pelekap bumbung dan sebagainya. Seiring dengan dunia yang semakin canggih dari segi teknologi, kos pemasangan bagi sistem pelekap solar photovoltaic turut meningkat tinggi. Ia juga menjadi semakin rumit dan sangat sukar untuk dipasang. Oleh itu, tujuan projek ini dilakukan adalah untuk membangunkan satu sistem pelekap solar photovoltaic bagi bumbung rata yang sesuai dalam iklim panas. Projek ini akan memberi tumpuan kepada struktur reka bentuk dan pembangunan sistem baru yang sangat ringkas, mudah dipasang dan menyediakan satu sistem pemasangan kos pemasangan yang rendah. Dalam projek ini, kekuatan struktur sistem photovoltaic pemasangan solar akan juga dianalisis. Struktur reka bentuk akan disediakan dengan menggunakan perisian *SolidWorks* dan *SpaceClaim Engineer*. Manakala bagi proses menganalisis reka bentuk yang dicadangkan, simulasi Finite Element Analysis (FEA) telah dijalankan dengan menggunakan perisian *Solid Thinking Inspire*. Perisian ini adalah alat penjanaan konsep yang mampu untuk melaksanakan analisis statik linear yang dalam projek ini adalah anjakan, tekanan von mises dan faktor keselamatan.

ABSTRACT

A mounting system is one of an integral feature of any installation. Meanwhile, a solar photovoltaic mounting system is a system where we used to fix solar panel on surfaces like roofs or empty plots. It is the base of the solar system where a good base ensures the efficiency of the overall system and a return on investment. There are several types of solar photovoltaic mounting system such as ground mounting, pole mounting, roofs mounting and so on. As the world become technologically advanced, the solar photovoltaic mounting system installation cost nowadays become incredibly high. Also, the system occurs to be very complicated and difficult to be installed. The aim of this project is to develop a solar photovoltaic mounting system for a flat roof in a hot climate. This project will focus on the designation structure and development of a new system which are very simple, easily installed and providing a low installation cost mounting system. In this project, the structural strength of the solar photovoltaic mounting system will be also analyzed. The design structure will be drawn by using SOLIDWORKS and SPACECLAIM ENGINEER software. While for the process of analyzing the design proposed, a Finite Element Analysis (FEA) simulation was conducted by using Solid Thinking INSPIRE software. This software is a concept generation tool which capable to perform linear static analysis which in this project is the displacement, von mises stress and the factor of safety.

DEDICATION

Specially dedicated to my family, lecturers, beloved friends and all people that willingly involve and helping me through all tears and hardships in completing the project.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

BDP	=	Bachelor Degree Project
PV	=	Photovoltaic
PSH	=	Peak Sun Hour
Mono-si	=	Mono crystalline silicon
Poly-si	=	Polycrystalline silicon
C-si	=	Crystalline Silicon
FEA	=	Finite Element Analysis
RE	=	Renewable Energy
IEA	=	International Energy Agency
kWp	=	Kilowatt Peak
kPa	=	Kilopascal
VMT	=	Von Misses Stress

CHAPTER 1

INTRODUCTION

Chapter 1 will provide a detail explanation on the background research of this project. This chapter will also include the problem statement, the objectives, scope, project significance as well as the summary for this project.

1.1 Background

It has been found that among all the renewable energy sources, solar energy is the most prospective one in Malaysia (M.R. Islam et al. 2013). Solar photovoltaic system has become more popular and high in demand as the world become technologically advanced. Development of a solar photovoltaic mounting system for a flat roof in a hot climate is the title of this project where as the main idea is to develop a new mounting system, designed to simplify and reduce costs for the installation. This project research will focus on investigating the most necessary type of solar photovoltaic mounting system to be applied in a hot climate especially in Malaysia

There are several types of solar mounting system that ever exist in this world. For example, ground mounting, pole mounting, roofs mounting and so on. However, in this project research the solar mounting system to be designed is that to be mounted in a flat roof. Nowadays, the cost for the installation of a solar photovoltaic mounting system was incredibly high. Therefore, in order to reduce the installation cost it is needed to identify the criteria which causing it to be as costly as it is today. Basically, this project will first compare between solar tracking mounting system

with the solar non-tracking mounting system by considering several significant criteria such as Malaysian weather, design structure, energy consumption and etc.

After making a comparison, it is proven that a mounting system without solar tracker is the most applicable system in Malaysia which is a hot climate country. The cost of the installations also appears to be lower compared to a solar tracking system. Next, the design work will be carried out. Also, a Finite Element Analysis (FEA) simulation will be carried out to investigate the displacement, von mises stress and factor of safety under given value of wind speed pressure. It is to endure that the system developed is in a high strength and will withstand a higher wind load. The entire objectives, scopes and others will be discussed in the next chapter.

1.2 Problem Statement

There are several problems that can be stated in the project. The most obvious one is the cost for a solar photovoltaic mounting system nowadays was very expensive. Everyone knows that installing the solar photovoltaic system in a house itself will cost a huge amount of money. Therefore when the mounting system installation cost also expensive, people especially Malaysian will not really into it. This is because price is the first thing to be considered to impress the consumers.

The existing system nowadays was also having a very complicated design structure. The complicated design was referred to the solar photovoltaic mounting system with solar tracker. When it comes to solar mounting system with solar tracker, there is another aspect that needs to be taken care which is the solar tracker. The solar tracker will be installed in the mounting system itself therefore the location for the installation and the mounting of the tracker itself will make it even more complicated.

As the design structure for today solar mounting system occur to be more complicated, it will become very difficult to install it. It may take several days and a

few employees to complete the installation. Automatically, the labor cost also increased.

1.3 Objective of Project

Objective of research is the important part in every research. It is because at the end of this project, the core of the final year project is in finding out whether the objectives achieved or not.

The objectives that are strived to be achieved at the end of this project are as follows:

- (i) To designed and develop a very simple and easily installed solar photovoltaic mounting system.
- (ii) To analyzed the structural strength of a mounting system for solar photovoltaic.
- (iii) To provide a low installation cost for solar photovoltaic mounting system.

1.4 Scope of Project

In completing this project, several scopes had been outlined. This project will cover on the solar photovoltaic mounting system for a flat roof in a hot climate which to be more specific in Malaysia. The system designed should be simple and easily installed compared to the existing system. Since it was proven that a solar mounting system without solar tracker is the most applicable system in hot climate, the project will only focus on the solar non tracking system. The early design stage of this project will involve software such as SOLIDWORKS and SPACECLAIM ENGINEEER to design the structure of solar photovoltaic mounting system. Material used is from a high quality and low cost such as aluminum or stainless steel to ensure that the system can provide a low installation cost. Further studies on the characteristics of a proper and highly recommended type of solar photovoltaic mounting system will also covered in the FEA simulation using Solid Thinking INSPIRE software.

1.5 Project Significance

The purpose of this project is to encourage the consumers to support renewable energy that had been given to us by providing a lower installation cost of a solar PV mounting system and a simple and easily installed system. People nowadays almost not recognize the benefit of the renewable energy at the surrounding and tend to complain about the cost of using it which was incredibly high from day to day. Therefore, this project will help by reducing the installation cost for the mounting system. In addition to the purpose given, this project helps the earth in such ways in terms of prevent pollution and support the Go Green Technology. Besides, this project will also help in promoting the world solar technology and gives courage to the researchers and people to know more about solar technology as it is the most easily obtained source.

CHAPTER 2

LITERATURE REVIEW

Literature review is a review of a research that has been made regarding the particular problem that has been identified and needs to be solved. This review should describe summarize, evaluate and clarify the project. It also goes beyond the search for information and includes the identification and articulation of relationships between the literature and the field of research.

In this chapter 2, reviews of the previous researches project that are related with this project research will be discussed. The information will be become additional source for the project to make some improvement and more successful. To have a brief understanding of the researches related to the project, a few literature reviews had been done. This chapter will describe the related literature reviews.

2.1 Renewable Energy

The renewable energy is defined as an energy that comes from resources which are continually replenished on a human such as wind energy, solar energy, small waterpower, tide energy, hydrogen energy and so on (M.R. Islam et al. 2013). Malaysian energy sources primarily comprise oil, natural gas, hydro power and coal although renewable energy (RE) sources such as solar power and biomass are currently being exploited (Poh and Kong, 2002). Based on studies, an increased in marketing expansion of the solar and wind power system in the past 30 years has

showed that the costs has potentially dwindle and the performance criteria has shown an improved progress (Herzog, Lipman et al. 2001).

2.2 Solar Energy

Solar energy is one of the most promising renewable energy sources which have a huge potential of conversion into electrical energy. The conversion of solar radiation into electrical energy by Photo-Voltaic (PV) effect is a very promising technology, being clean, silent and reliable, with very small maintenance costs and small ecological impact (Tiberiu Tudorache et al. 2012). Solar energy can be found daily and also used in widely terrene scoped of application (Tarusana, Rahima et al. 2013).

2.3 Solar Photovoltaic (PV) System

PV system is known as the future energy source of the world (Hasan and Khan, 2012). Solar photovoltaic (PV) modules convert sunlight directly into electricity. Under such a climatic condition, photovoltaic (PV) system has become another favorite renewable energy source. In Malaysia, climatic conditions are the main factor for the development of solar energy due to the abundance sunshine throughout the year (Alia Farhana, 2009)

The process of conversion of solar energy happened when the light striking the silicon semiconductor causes flow of electron that produces electricity. The process energy conversion of solar energy to electrical energy is illustrated in the figure 2.3 below.

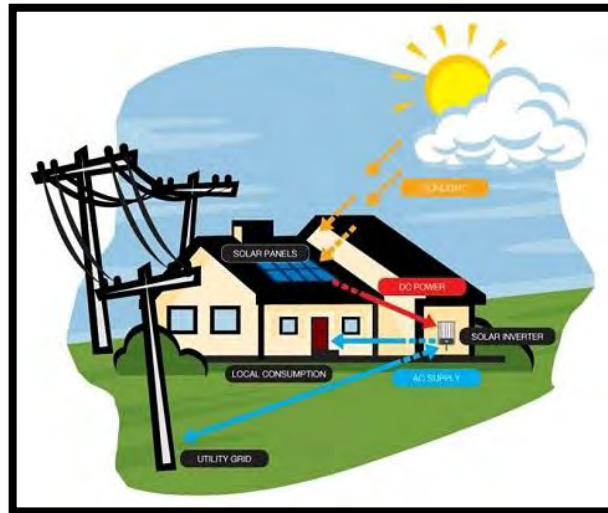


Figure 2.1: Conversion Process of Photovoltaic System

Solar photovoltaic (PV) system can be divided into two categories which is the grid-connected PV system and the stand-alone or off-grid PV system. Both systems are different in term of the existence of conventional utility grid. Further information regarding both systems will be explained in the next subtopic.

2.4 Off-Grid Solar Photovoltaic (PV) System

Off-grid or stand-alone system is refer to the system that is not connected to a grid or national electrical grid. The application of photovoltaic (PV) systems is well introduced for stand-alone application (Ranjit Singh Sarban Singh et al. 2013). Standing alone PV systems is free of utility grid and is able to supply its own electricity by producing enough energy through the application of certain components (Ke, Yanchen et al. 2012). The explanation on how an off-grid solar PV works is represented in the figure 2.2 below.



Figure 2.2: Stand-alone PV system working principle

2.5 On-Grid Solar Photovoltaic (PV) System

Different from the off-grid solar PV system, on-grid PV system is the system where the power generated is connected to the utility grid. The principle on how on-grid solar PV works is as illustrates in the figure 2.3 below.

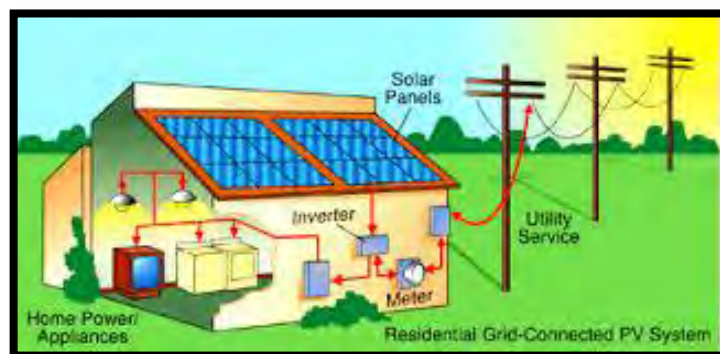


Figure 2.3: On-grid connected PV system working principle

2.6 Solar Photovoltaic Mounting System

A solar mounting system is an integral feature of any solar installation. The right solar mounting system, if installed correctly, will provide the structural support a solar system needs, in order to protect it from wind-induced failure and other potential weather hazards. A mounting system can also set the orientation and elevation of a solar system, in order to maximize its energy performance. There are

three common type of solar PV mounting system which are roofs mounting, ground mounting and pole mounting.

2.6.1 Roofs Mounting System

Roofs mounting system is the system that highlighted in this project. Roofs mounting system is where solar panels are fix in the mounting board that attached to a roof. For a roof mounting system, there are two types of system which is penetrated roof type and ballasted roof system which in this project ballast is used in the design. Figure 2.4 below shows the picture of a roofs mounting system.



Figure 2.4: Roof Mounting System

2.6.2 Ground Mounting System

Ground mounting system is a system where solar panel is fit in the mounting board that attached to the ground. The figure 2.5 below shows the picture of a roofs mounting system.