



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**THE STUDY OF ASSET MAINTENANCE PRACTICES FOR  
SOLAR PHOTOVOLTAIC (PV) SYSTEM IN MALAYSIA**

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

by

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## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

**TAJUK: The Study of Asset Maintenance Practices for Solar Photovoltaic (PV) System in Malaysia.**

**SESI PENGAJIAN: 2015/2016 Semester 1**

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**Date** : **9 December 2015**

## **APPROVAL**

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Engineering Technology in Electric (Power Industry). The member of the supervisor is as follow :

.....

(Emy Zairah Binti Ahmad)

Project Supervisor

## ABSTRACT

This thesis is about renewable energy which is grid-connected with battery back-up of Photovoltaic (PV) system. Since the PV system is one of the biggest renewable energy resources that can generate electrical power and become fastest growing power generation in the world, thus it is very crucial to ensure the PV system is working well. Although the maintenance requirements for PV systems are minimal such as occasional cleaning for optimal performance and the need of new inverter after 10-15 years but, it is very important. Therefore, this thesis is also focused on Operation and Maintenance (O&M) practices of PV system that have done to minimize the failures that occur at PV system. When covering about the PV system, the basic knowledge such as the basic component of PV system should know, while when covering about operation and maintenance, the common failures or problems that always occur in PV system must be identified. This is because to ensure it is must be really understand before the factors that cause this problem is carried out. Last but not least, the inspection that required to fix the failures or problems is also discussed in this thesis.

## ABSTRAK

Tesis ini adalah mengenai tenaga yang boleh diperbaharui iaitu grid tersambung dengan bateri back-up dari Sistem Photovoltaic (PV). Sejak sistem PV merupakan salah satu sumber tenaga boleh diperbaharui terbesar yang boleh menjana kuasa elektrik dan menjadi penjanaan kuasa yang paling pesat berkembang di dunia, oleh itu ianya sangat penting untuk memastikan sistem PV itu berfungsi dengan baik. Walaupun keperluan penyelenggaraan bagi sistem PV adalah minimum seperti pembersihan sekali-sekala untuk prestasi optimum dan memerlukan penyongsang baru selepas 10-15 tahun tetapi, ia adalah sangat penting. Oleh itu, projek ini juga memberi tumpuan kepada Operasi dan Penyelenggaraan (O & M) amalan sistem PV yang telah dilakukan untuk mengurangkan kegagalan yang berlaku pada sistem PV. Apabila merangkumi tentang sistem PV, pengetahuan asas seperti komponen asas dalam sistem PV mesti tahu, manakala apabila merangkumi tentang operasi dan penyelenggaraan, kegagalan biasa atau masalah yang sentiasa berlaku dalam sistem PV mesti dikenal pasti. Ini kerana untuk memastikan ianya perlu difahami sebelum faktor-faktor yang menyebabkan masalah ini dijalankan. Akhir sekali, pemeriksaan yang diperlukan untuk membaik pulih kegagalan atau masalah juga dibincangkan dalam tesis ini.

# DEDICATIONS

To my beloved parents

Hasan Bin Daud & Che Yah Binti Ayub

Siblings

Thanks for your support, encouragement and best wishes.



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# CHAPTER 1

## INTRODUCTION

### 1.1 Overview

The purpose of this thesis is to study the asset maintenance practices for solar photovoltaic (PV) system in Malaysia. Basically, common practices are focus on operations and maintenance (O&M) that is very important on achieving the maximum level of the performance and high reliability from the solar asset. This will provide the information needed to make a sensible and informed decision whether a PV system is work as it should or not. Therefore, the requirements knowledge of each components in PV system should be taken into account for establishing detailed procedure or give more information about the maintenance needed.

### 1.2 Background

Photovoltaic or often referred as PV is a direct process that producing the electricity from sunlight and always work all the time as long as sun is shining, but the electricity produced is depend on the intense and strikes of sunlight that directly to PV modules (means that the rays of sunlight is perpendicular to PV modules). It will generate the electricity without any noise or air pollution but offer the consumers the quiet, fast and reliable way to get the electricity source. This accessible of energy resources are increasing and famous around the world due to decline of fossil fuel energy and complication of environment problems. The awareness about the important of environment makes this eco-friendly resources has been increased gradually to avoid the problems become more serious. The global warming and climate change is an example of



environment factors or problems that cause the uses of renewable energy becoming popular nowadays.

Since this affordable energy resource is continue to be a fastest-growing sector in the market, it plays an important resource that consumers trust it will gives the maximum efficiency during process of delivery the electricity energy. Thus, one of the most important things to make sure the PV system have maximum performance of efficiency is by focus on their operation and maintenance (O & M) without just look at its appropriate design and construction.

Thus, the standardized procedures for operations and maintenance (O&M) checking are required to unsure that PV system has high reliability and operation that may improve lifetime performance and energy production. Like any other equipment or system installation, it is very essential to perform a well maintenance because it can help maximize uptime and minimize the risks of downtime. In solar system, a well maintained can actually give up to 30% better than that is not in energy production because of no noise or disruption during delivery of solar power.

Solar maintenance practices can help maximize uptime and extend the life of the plant. The delivery of solar power without any disruption maintains the stream of economic value generated by each kilowatt hour of production, and proper service is a critical component to ensuring optimal performance while minimizing the risks of downtime. A well-maintained solar installation can actually perform 10 to 30% better than one that is not. But installing solar arrays are just the beginning because without proper or regular operation and maintenance, system components could be void of all warranties.

Therefore, this report will be a guideline about the operation and maintenance (O&M) need for all the components in PV system. The modules, battery and inverter or power conditioning unit is an example of the several main components of PV system that work together to produce the electricity direct from sunlight and known as a renewable energy. This guideline is good practices and should be an important reference that can be used before or after testing, design and construction to optimizing performance, reliability and safety.

### **1.3 Problem Statement**

In facing of increasing installation of photovoltaic (PV) system, the standardized procedures for operations and maintenance (O&M) practices or checking are required to ensure that PV system has high reliability and operation that may improve lifetime performance and energy production. Therefore the following questions or challenges are required to overcome, which are :

- i. Does an asset maintenance practices for PV system have been done in Malaysia?
- ii. What are common problems or failure area of solar PV that required for maintenance?
- iii. What is the maintenance needed to make the PV system work more effectively?

## 1.4 Objectives

The objectives of this research are to know and solve the problem or common failure area of PV system to make sure it will achieve the highest level of performance by minimize the risks or possibility of downtime and to make sure it work more effectively as a trusted renewable energy. It is included :

- i. The study or know of asset maintenance practices for solar PV system in Malaysia.
- ii. Study about the common problems or failure area of solar PV maintenance that have been done in Malaysia.
- iii. Study and explore the problem or failure area of solar PV that required the routine maintenance.

## 1.5 Scopes

The scopes of this research are as follows:

- i) The study covers about the solar PV system in Malaysia, only for solar farm and grid connected
- ii) The data will be obtained through interviews of a few persons, distribute the questionnaires and perform a site visit
- iii) The data obtained will be analyzed and compared among the companies that selected

- iv) The most effective maintenance practices will be justified and the data will be presented statistically or in form of graph

## **1.6 Thesis Organization**

This thesis is made up of five chapters. Chapter 1 discusses the basic issues of this research. Chapter 2 reviews of the operation and maintenance (O&M) of the Photovoltaic system. Chapter 3 analyzes the research methodology of this study. Chapter 4 reveals the findings of the study and discuss of the obtained result. Finally, chapter 5 includes the conclusion of the study and recommendation for future research.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 PV System Component

Grid-connected of PV system that may and not may use any battery is divided into two categories which are, grid-connected for small power application that have power ratings in the range 1KW above such as households, and grid-connected for large power application that normally have power ratings in the range of 1MW above such as solar power plants. The main components of grid-connected PV systems are PV modules, inverter or power conditioning unit and loads. The use of battery can be avoided as much as possible when the PV system is connected to grid as energy storage medium. Although the batteries is expensive for large system, but sometimes it is also added to ensure that loads always get the energy, even if grid power is not available.[1]

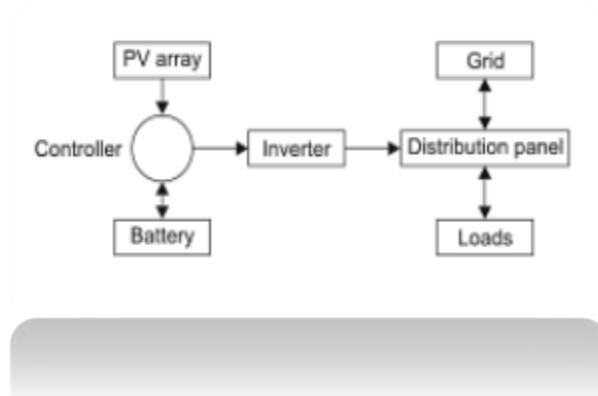


Figure 2.1: Grid-connected with battery back-up

As mentioned above, the grid-connected of PV system is composed of a variety of equipment or components (figure 2.2) that make it capable to supply energy and the basic function of these components are :

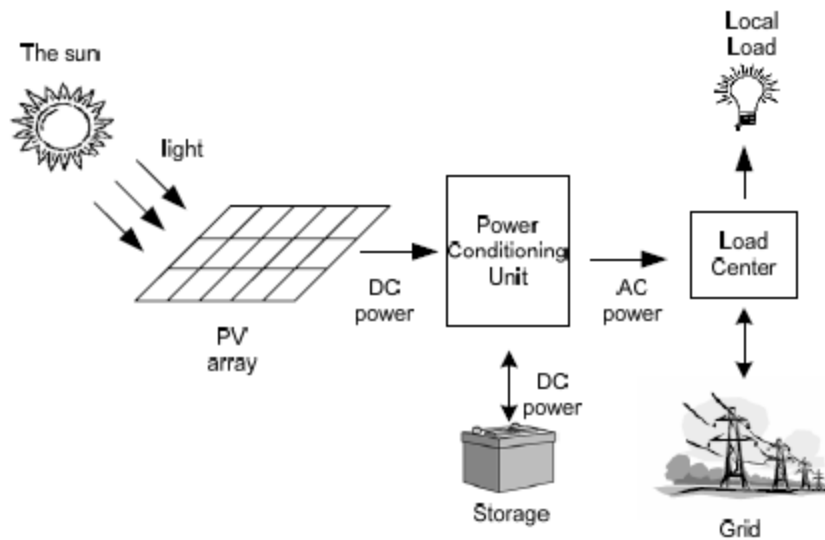


Figure 2.1: Main components of PV system [2]

- a) Photovoltaic cells that made from semiconductor is used to convert the electricity from sunlight. It is connected together with modules to produce a large power output of photovoltaic cells and this module is called as panels and arrays when connected in series and parallel to form larger units to produce energy that covers almost any electric need.
- b) The battery storage is used to provide the energy or make the energy when the radiation produce from sun is not enough whereby it is important at night or when the sun is not shining. It is divided by two categories which are primary and secondary batteries.[3] Primary batteries like carbon-zinc and lithium batteries can store and

deliver electrical energy, but can't be recharged. Thus, this type of batteries is not used in PV systems. While for a secondary battery, it is also can store and deliver electrical energy, but can be recharged by passing a current through it in an opposite direction to the discharge current. This type of batteries such as lead-acid batteries is used in PV system.

- c) An inverter is an electrical device that used to convert the direct-current (DC) electricity to alternating-current (AC) electricity. There are several types of inverter in grid connected system which is string, micro and multi-string inverter. String inverters with no diode loss are connected in series with an AC module. Each string has separate MPP tracking and lower cost with mass productions and also can be implement with high voltage MOSFET/IGBT. Although it is quite popular during introduced, but the MPP tracking is still not sufficient to achieve a certain efficiency requirement. Micro-inverter is a good mass production that potentially leads to low manufacturing and have no PV mismatch due to it only have one PV control that can maximize efficiency. While for multi-string inverter, it has features that can optimal MPP tracking for a single string of PV system. [4]
- d) DC loads are appliances, motors and other equipment that powered by direct current.
- e) AC loads are appliances, motors and other equipment that powered by alternating current.

There are several common failures or problems in PV system that significantly affecting the system efficiency. This includes the modules, inverter, support structure, AC/DC subsystem, communication and others. If the PV system is included a battery back-up, the battery storage also one of the failure that should perform a maintenance. The Figure below shows the major of failure at PV system.

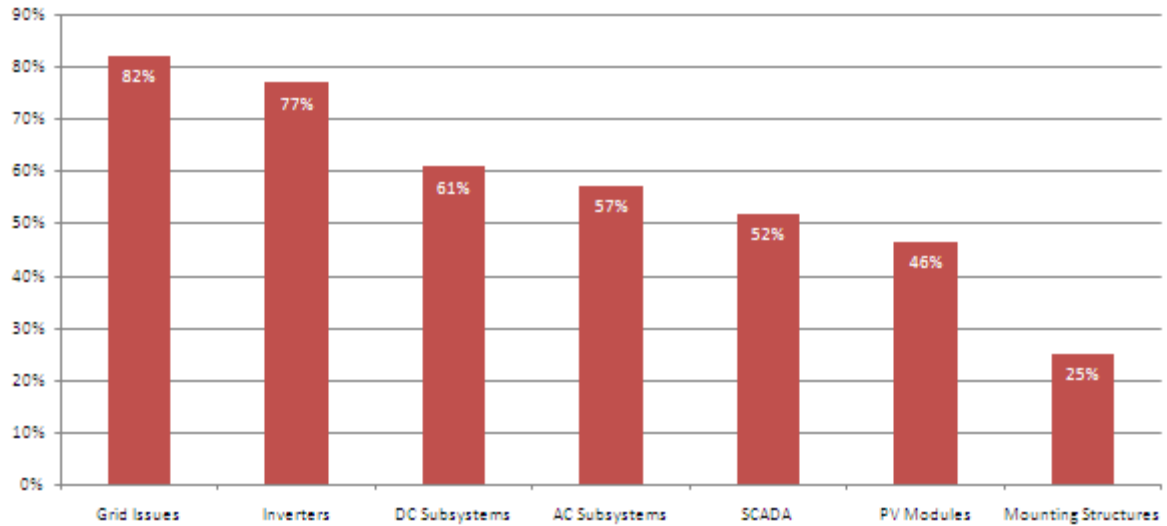


Figure2.3 : The major of failure area at PV system [5]

## 2.2 Photovoltaic Module



Figure 2.4: The PV Module at Gading Kencana

The maintenance or inspection required for solar panel or module is every 3month to ensure the panel work properly.