



**STUDY ON THE IMPLEMENTATION OF PARABOLIC DISH BASED ON  
CONCENTRATED SOLAR POWER UNDER MALAYSIA ENVIRONMENT –  
(DIRECT NORMAL IRRADIANCE)**

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**A report submitted in partial fulfillment of the requirements for the degree of Bachelor  
of Electrical Engineering (Control, Instrumentation and Automation)**

**Faculty of Electrical Engineering**

**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**2017**

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**2017**

### STUDENT'S DECLARATION

I declare that this report entitles “Study On The Implementation of Parabolic Dish Based On Concentrated Solar Power Under Malaysia Environment – (Direct Normal Irradiance)” 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.

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Date :

“Dedicated to my beloved family, especially my father & mother  
“Ramli Hanapiah and Julia Hussain”

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## ABSTRACT

Parabolic Dish (PD) is one of Concentrating Solar Power (CSP) technologies that change over sunlight to electricity. PD has demonstrated the most outstanding efficiency by changing over almost 31.25% of solar radiation into electricity and PD has developed as one of dependable and productive Renewable Energy (RE) technology. In any case, the assessment for the PD system performance by utilizing test approach are expensive and takes time. This project is to study on the effect of the Direct Normal Irradiance (DNI) based on the site selection generated from weather station in Malaysia and factor affecting DNI performance in PD system. This review is utilizing a recreation approach and MATLAB was utilized as the reference model of PD and analysis. The solar irradiation information data were downloaded from the Meteonorm7 Software and five locations will be selected in Penang, Kota Bharu, Kota Kinabalu, Kuching, and KL Airport, in Malaysia region has been chosen as the area for analysis. From the analysis of five selected locations, Penang is the best location for planting a CSP technologies using PD system and not preferable locations is at Kuching. This is because of Penang highest DNI intensity, low precipitation area with low relative humidity environment condition compare the others and for Kuching have lowest DNI intensity, high precipitation area with high relative humidity environment condition. As a conclusion, the installation of PD in Malaysia need to consider on DNI of area and the performance of PD. Based on the analysis, it could be possible for being implemented in Malaysia because of its DNI are near reaching minimum requirement of CSP technologies and also there is no technical reason that cannot build CSP technologies with low DNI value. Modification of PD system are needed for enhancing the performance for possibilities of installation.

## ABSTRAK

Dish parabola (PD) adalah salah satu teknologi kuasa solar tertumpu (CSP) yang berubah dari cahaya matahari kepada tenaga elektrik. PD telah menunjukkan kecekapan yang tertinggi dengan menukar lebih hampir 31.25% daripada sinaran suria kepada elektrik dan PD telah dibangunkan sebagai salah satu teknologi tenaga yang produktif dan boleh diperbaharui (RE). Dalam kes ini, penilaian bagi pelaksanaan sistem PD dengan menggunakan sistem ujian sebenar adalah mahal dan mengambil masa. Projek ini adalah untuk mengkaji tentang kesan Sinaran Solar Langsung (DNI) berdasarkan pemilihan tapak yang diambil dari stesen kaji cuaca di Malaysia dan faktor prestasi DNI terhadap sistem PD. Kajian ini adalah menggunakan pendekatan membuat semula dan software MATLAB telah digunakan sebagai analisa. Maklumat data penyinaran solar diambil dari Software Meteorom7 dan lima lokasi dipilih di Malaysia antaranya di Penang, Kota Bharu, Kota Kinabalu, Kuching, dan KL Airport, sebagai kawasan untuk dianalisis. Daripada analisis daripada lima lokasi terpilih, Pulau Pinang adalah lokasi terbaik untuk membangunkan teknologi CSP menggunakan sistem PD dan Kuching adalah bukan lokasi yang baik. Hal ini kerana Pulau Pinang mempunyai intensiti DNI yang tertinggi, kawasan hujan rendah dengan keadaan persekitaran kelembapan relatif rendah dengan dibandingkan dengan yang lain dan untuk di Kuching pula mempunyai intensiti paling rendah DNI, kawasan hujan tinggi dengan keadaan persekitaran kelembapan relatif yang tinggi. Kesimpulannya, pemasangan PD di Malaysia perlu mengambil kira di kawasan DNI dan prestasi PD. Berdasarkan analisis ringkas, boleh dikatakan ia mungkin boleh dilaksanakan di Malaysia kerana DNI di Malaysia menghampiri keperluan minimum DNI untuk pelaksanaan teknologi CSP dan jugak tiada alasan menyatakan tidak boleh membina teknologi ini dengan nilai DNI yang rendah. Pengubahsuaian PD sistem diperlukan untuk menambah lagi kecekapan haruslah dilakukan.



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## LIST OF SYMBOLS

CSP	: Concentrated Solar Power
PD	: Parabolic Dish
DNI	: Direct Normal Irradiance
RE	: Renewable Energy
PV	: Photovoltaic
FYP	: Final Year Project
NREL	: National Renewable Energy Laboratory
NASA	: National Aeronautics and Space Administration

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## CHAPTER 1

### INTRODUCTION

#### 1.0 Project Background

Nowadays, our world need to overcome the negative impacts on the environment and the problems associated with fossil fuels. They need to forced many countries to inquire and change to environmental friendly as alternatives using renewable energy to sustain the increasing energy demand. So, solar energy is one of the best renewable energy source with least negative impacts on the environment and different countries already have formulated solar energy. Solar energy is the cleanest and most abundant renewable energy source available. Modern technology can harness this energy for a variety of uses, including generating electricity, providing light or a comfortable interior environment, and heating water for domestic, commercial, or industrial use. Various of technologies are used nowadays to harness the energy from the sun as solar thermal energy, ocean thermal energy conversion, solar ponds, solar tower and photovoltaic system. Now we realize that the solar power also knows as concentrated solar power (CSP) and photovoltaic (PV) are the most commonly used in further technologies and in process of development. CSP is using renewable source of energy of sun by absorbing the concentrated of heat on sunlight and transfer to electrical energy while PV devices generate electricity by absorbing the light via solar panel containing solar cell.

PV devices produce electricity directly from sunlight via electronic process that happens actually in specific types of material, called semiconductors. Electrons in these materials are free by solar energy and can be actuated to go through an electrical circuit, powering electrical devices or sending electricity to the grid. PV advances works like when the Photons begin strike and ionize semiconductor material on the solar board, creating



external electrons to break free of their nuclear bonds. Because of the semiconductor structure, the electrons are constrained in one direction making a flow of electrical current. While the solar cells are not 100% productive to a limited extent since a portion of the light range is reflected, some is too weak to create electricity (infrared) and a few (ultraviolet) makes heat energy rather than electricity.

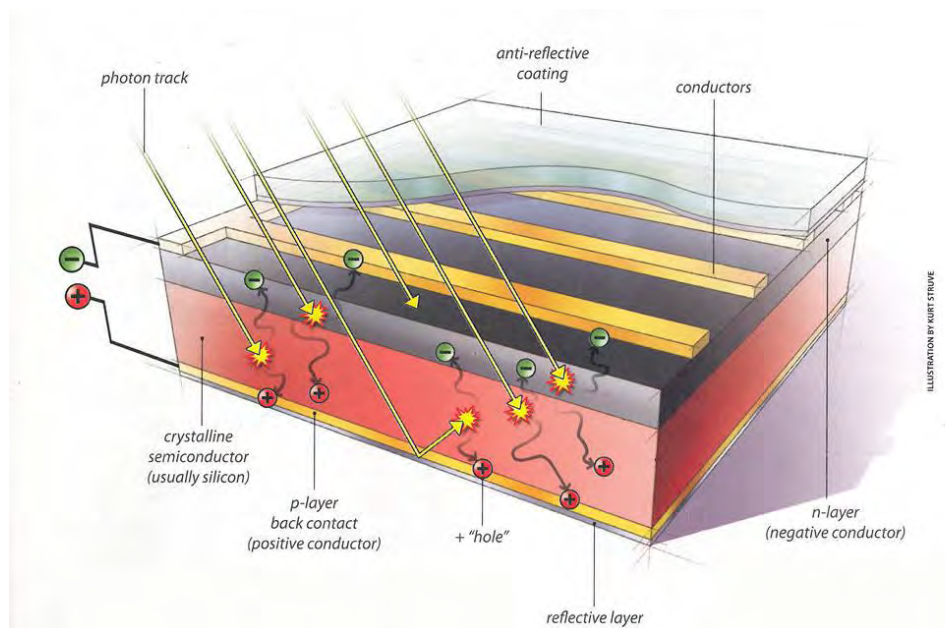


Figure 1.1 : Diagram of Typical Crystalline Silicon Solar Cell

For the Concentrated Solar Power (CSP) is the most likely candidate for providing the majority of this renewable energy, because it is amongst the most cost-effective renewable electricity technologies and because its supply is not restricted if the energy generated is transported from the world's solar belt to the population centres. Three main technologies have been identifying during the past decades for generating electricity in the 10 kW to several 1000 MW range:

- i. Dish/engine technology, which can directly generate electricity in isolated locations.
- ii. Parabolic and Fresnel trough technology, which produces high pressure superheated steam.
- iii. Solar tower technology, which produces air above 1000°C or synthesis gas for gas turbine operation.

While these technologies have reached a certain maturity, as has been demonstrated in pilot projects in Israel, Spain and the USA, significant improvements in the thermo-hydraulic performance are still required if such installations are to achieve the reliability and effectiveness of conventional power plants.

CSP are very depending on the intensity of the sun radiation called DNI (Direct Normal Irradiance). Direct Normal Irradiance (DNI) is the amount of solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position in the sky. During clear sky condition, solar energy reaching more than 80% of DNI of the earth surface and some of it was absorb and scattered by ozone layer, water vapour and oxygen. The primary factor that changed solar radiation like weather condition such cloud and storm also will affect the DNI in which cloudy beam radiation become almost zero DNI.

## **1.1 Motivation of Research**

Nowadays solar technology has been widely used in some country as backup power to the consumer but not in our country yet in Malaysia. Photovoltaic and Concentrated Solar Power both are type of solar technology and mature technologies. In this research, CSP can produce higher power output compare to PV but this CSP technologies not yet implemented in Malaysia and need to study the implementation of PD using CSP. CSP technologies seem using a PD looks quite possible to being implemented because of most of CSP technologies need large space of land but not PD seem not took more space than others CSP technologies.

Installation of PD in Malaysia has several things need to being consider such as DNI data. DNI main factor of installation PD using CSP technologies and without achieved the minimum required DNI, it possibly effect the performance of PD. DNI data need to be calculated and analysis based on the site location that need to be implemented and every location has difference intensity value of DNI.

## 1.2 Problem Statement

Many countries are working forward on innovation of renewable energy (RE), even though the support incentives from government and non-government to reduce the capital cost consumption for every single day we had through. Hence, there is a need to investigate the reliability of the RE to promote implementation solar renewable energy. This project focused on investigating of installation of PD using CSP based on DNI analysis data in Malaysia. PD is among the best CSP solar technologies based on high efficiency compare to others and need to be implemented. Meanwhile, the sun intensity DNI need to be consider as a major factor of installation of PD in Malaysia environmental. For CSP system technologies and PD performances it will be covered in Chapter 2 where the literature review in this report.

But for this project, the required method to solve the problem are collecting the DNI data of Malaysia using software. It slightly challenges because need to be familiar with the software before we could use it.

## 1.3 Objective

The objective for this project is:

- i. To investigate the feasibility installation of Parabolic Dish (PD) technology system based on Concentrated Solar Power (CSP).
- ii. To provide and collect data of Direct Normal Irradiance (DNI) in Malaysia environment using Meteonorm7 software.
- iii. To analyse Direct Normal Irradiance (DNI) and the effecting factor of Precipitation/Rainfall and Relative Humidity on DNI intensity of Parabolic Dish (PD) using MATLAB Software.

## 1.4 Scope of Research

The scope for this project is to study the feasibility installation of parabolic dish (PD) based on concentrated solar power (CSP) and their DNI potential in Malaysia environmental. From the study, we could analyst and clarify the implementation of the parabolic dish in Malaysia based on the performance of parabolic dish (PD). This project also will focus on 4 major scope that are:

- i. This research is only undergoing in Malaysia environment.
- ii. This research will be on 25kW of parabolic dish using CSP technologies.
- iii. This research is about analysing the potential of CSP technologies using PD based on DNI data used for analysis based on five type weather station selected in Malaysia. (Penang, Kuching, Kuala Lumpur Airport, Kota Kinabalu, and Kota Bharu)

## 1.5 Project Outline

In this report we will go through into five chapters:

Chapter 1:

In this chapter, we will discuss about the project background which is explain about the project. The problem statement of this project and the scope of the research also

Chapter 2:

In this chapter, reviews of the previous researcher about the project that are related with this project will be discussed. The information will be become additional source for the project in to be able 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 to the literature review.

### Chapter 3:

For the chapter 3, the explanations about the flow chart of the project from the beginning to the end of the project. It will explain the principles of the method and techniques that are using by the previous researchers. The selected technique must be chosen to approach the objective of this project. The data will record from the experiment setup. The Gantt chart also will be discussed in this chapter.

### Chapter 4:

For this part, the result of the project will be discussed. This will include the data collection, analysis of data plotting and explanation regarding the data gathered.

### Chapter 5:

For the last chapter, it will discuss about the conclusion of the project for the implementation of parabolic dish (PD) using concentrated solar power (CSP) technologies based on analysis of direct normal irradiance (DNI) data to determine worth it or not for being implemented in Malaysia. Recommendation for this research are also being discusses in this chapter.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.0 Overview**

This chapter is to provide the review from previous research based on the journal they wrote and had been done by several researchers for the parabolic dish (PD) using Concentrated Solar Power (CSP). As we know, CSP technologies is the alternative for solar energy besides photovoltaic (PV) common people know that used semiconductor plate based on the sun light to generate energy, but for CSP is used heat source from the direct sunlight to generate the energy.

The concept is to find viability for installation of PD in Malaysia environment based on Direct Normal Irradiance (DNI) analysis. Gathering of DNI data from the journals, books, and software will help for the analysis to determine the possibility of installation of PD in Malaysia environment.

#### **2.1 Solar Technologies**

There are a few sorts of solar systems that are at present accessible. Nonetheless, each of them depends on very extraordinary ideas and science and each has its novel points of interest. Examination and correlation between various advancements will help us to embrace the most proficient and valuable innovation given a particular arrangement of conditions. Generally, photovoltaic solar boards (PV) and concentrated solar power (CSP)

are the two most develop innovations. They have been marketed and anticipated that would encounter quick development later on, subsequently our accentuation will be on these two innovations.

PV innovation is moderately developed and right now has accomplished a specific level. Be that as it may, their yield is not exceptionally stable in the consistently changing climate and relies on upon the sun spectrum. Like photovoltaic board system, CSP system have been broadly popularized and under quick improvement, with 1.17GW (40GW limit was accomplished by photovoltaic segments in 2010). Analysts anticipate that it will achieve same level as photovoltaic frameworks in 2050. Both surpass 4000TWh/year and every will possess more than 10 percent of worldwide power era[1]. Solar radiances have offers favourable circumstances in lower set up and energy stockpiling system cost. Late advancement of thermoelectric innovation may likewise push the solar thermal power innovation into another stage.

Table 2.1: Characteristic of PV and CSP

Characteristic	PV	CSP
Use	Direct & Diffused Sunlight	Direct Sunlight
Size	From Watt to MW	10Mw to few hundred MW
Installation	Everywhere (roof etc.)	Flat Unused Land
Capacity	700 – 2000 Full Load Hours	2000 – 7000 Full Load Hours
Reserve Capacity	External	Internal (Fossil Operation)
Proofed Life Time	More than 20 Years	More Than 20 Years
Annual Production (2004)	More Than 25000 GWh	More Than 2500 GWh
Levelized Energy Cost (LEC)	0.20 – 0.35 €/kWh	0.15 – 0.25 €/kWh

(Source: Robert Pitz-Paal, Concentrated Solar Power Answer to key question, DLR)

## 2.2 Concentrated Solar Power (CSP)

Concentrated Solar Power (CSP) involves a progression of advances conceived for the change of the immediate part of solar radiation into high temperature thermal energy by method for concentrators in view of mirrors or focal points. CSP plants is that the energy can be effortlessly put away a lot of thermal energy with negligible calamities, accordingly

they can give energy on request during day and night. CSP plants add to settle the power frame by repaying variances of renewable energy sources on the off chance that they are a piece of a similar system [2].

CSP technologies utilize mirrors or focal points to focus the solar radiation for warming fluid inside receiver and delivering steam; the steam then drives a turbine generator to produce electricity similarly as the ordinary power plants. Curiously, CSP can be outfitted with thermal storing system to produce electricity though during cloudy or after sunset. CSP has unique structure; in this way it will create diverse outcomes on the temperatures, concentrating proportion and the efficiencies. There are four sorts of CSP technologies as appeared in current technologies that is Parabolic Troughs system, Linear Fresnel system, Parabolic Dish System and Power Tower system.

#### Main CSP technologies

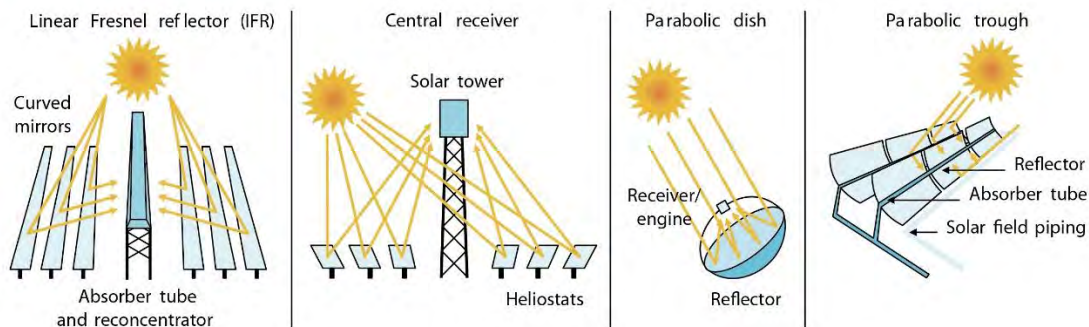


Figure 2.1: Four Types of CSP Technologies

CSP systems can be separated into line focusing and point focusing systems. Two remarkable sorts of line focusing systems are Parabolic Trough and Linear Fresnel, while the Parabolic Dish and Power Tower are point focusing systems. Line focusing system is furnished with single axis following system. It can focus sun beams around 100 circumstances and achieve working temperature up to  $150^{\circ}\text{C}$ [3]. For point focusing systems, for example, Parabolic Dish system and Power Tower system, they can concentrate sunlight to the extent 1,000 times and achieve working temperature more than  $1000^{\circ}\text{C}$  [3]. Point focusing systems are prepared with double axis tracking system to guarantee that daylight is