Faculty of Engineering

THE MAXIMUM POWER POINT TRACKING (MPPT) ANALYSIS FOR THE BUILDING ATTACHED PHOTOVOLTAIC (BAPV) AT PUSAT ISLAM TUN ABANG SALAHUDDIN (PITAS)

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Bachelor of Engineering (Hons)

Electrical and Electronics Engineering

2018

UNIVERSITI MALAYSIA SARAWAK

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Final Year Project Report ☑
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THE MAXIMUM POWER POINT TRACKING (MPPT) ANALYSIS FOR THE BUILDING ATTACHED PHOTOVOLTAIC (BAPV) AT PUSAT ISLAM TUN ABANG SALAHUDDIN (PITAS)

NORHASLINDA BINTI MUAIDI

This accreditation of final year project is submitted

in partial fulfillment of requirements for the degree of

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Devoted completely to my precious mother, father, family,

and friends

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ABSTRACT

This final year project report describes the analysis of the Maximum Power Point Tracking (MPPT) for Building Attached Photovoltaic (BAPV) at Pusat Islam Tun Abang Salahuddin (PITAS). MPPT is the main significant in this project as the efficiency for the conversion of the solar energy to the electrical energy is very low, thus it makes the MPPT becomes very important key as to increase the system efficiency. Renewable energy in the future is becoming more important as the non-renewable energy is estimated to finish in a few decades and take a lot of time to reproduce again. Availability of renewable resources depending on the latitude and longitude of the location, such as at the equator receive more sunlight compared to Southern and Northern atmosphere. Towards to the end of this final year project, BAPV has been selected as it is the new versatile way of modern technology that can benefit for long-term financial from harvesting available solar energy and at the same time being attached the existing building. In other word, BAPV will be applied at the PITAS roof instead using common solar panels after consideration on the BAPV characteristics. PITAS location is selected for this project because it is one of the buildings in Universiti Malaysia Sarawak (UNIMAS) that was built according to Kiblah which facing sunrise and sunset. Therefore, two methods approach of MPPT is simulated in MATLAB software from their mathematical equation in the form of dynamic system consist of block diagram. The success of the simulation of each method will be compared to the fastest tracking the voltage and current from irradiance and temperature on-site data. Later on, the best method to determine MPPT for PITAS can be selected. The final step will be determining the area and angle for solar panels depending on the selected PITAS structure for BAPV installation. Thus, UNIMAS have the potential to be an electrical producer through PITAS with combination of MPPT and BAPV as for better renewable energy harvesting.

ABSTRAK

Projek tahun akhir menerangkan terhadap kajian analisis menjejak titik kuasa maksima (MPPT) untuk bangunan dipasang panel solar (BAPV) di Pusat Islam Tun Abang Salahuddin (PITAS). MPPT merupakan kepentingan utama dalam projek ini kerana ketidakcekapan penukaran tenaga solar kepada tenaga elektrik adalah sangat rendah, oleh itu membuatkan MPPT menjadi kunci penting untuk menambahkan kecekapan sistem. Tenaga yang boleh diperbaharui pada masa hadapan ialah sangat penting kerana tenaga yang tidak boleh diperbaharui dijangka akan habis dalam beberapa dekad dan mengambil masa yang lama untuk dihasilkan semula. Keberadaan tenaga boleh diperbaharui bergantung kepada latitud dan longitud lokasi seperti di Khatulistiwa menerima lebih banyak matahari berbanding di hemispera utara dan selatan. Dipenghujung projek tahun akhir ini, BAPV telah dipilih sebagai cara yang serba boleh daripada teknologi moden yang mampu memberikan manfaat terhadap kewangan dalam jangka masa yang panjang daripada tuaian tenaga solar sedia ada dan pada masa yang sama dipasang pada bangunan sedia ada. Dalam erti kata yang lain, BAPV akan diaplikasikan di bumbung PITAS sebagai ganti panel solar yang biasa selepas pertimbagan terhadap ciri-ciri BAPV. Lokasi PITAS dipilih untuk projek ini kerana ianya salah satu bangunan dalam Universiti Malaysia Sarawak (UNIMAS) yang telah dibina mengadap Kiblat yan mana bertentangan dengan matahari terbit dan terbenam. Oleh itu, dua kaedah pendekatan untuk mendapatkan MPPT disimulasikan menggunakan perisian MATLAB berdasarkan persamaan matematik mereka dalam bentuk sistem yang dinamik yang mempunyai gambarajah blok. Kejayaan setiap kaedah pendekatan akan dibandingkan dengan kecepatan menjejaki voltan dan arus elektrik berdasarkan sinaran matahari dan suhu pada tempat kajian. Kemudian, kaedah paling bagus dalam menentukan MPPT untuk PITAS akan dipilih.Langkah akhir ialah menentukan jumlah kawasan dan sudut bagi panel solar mengikut struktur PITAS dan lokasi strategik untuk BAPV. Oleh yang demikian, UNIMAS mempunyai kebolehan untuk menjadi bangunan pertama sebagai pengeluar elektrik melalui PITAS dengan. kombinasi MPPT dan BAPV dalam menuai tenagadiperbaharui dengan lebih baik.

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LIST OF SYMBOLS

G_{max}	-	Irradiance
I_L	-	Photo generated current
I_{MPP}	-	MPP current
I_{bn}	-	Incident solar radiation
I_o	-	Saturation current of photovoltaic array
I_{sc}	-	Short-circuit current
$I_{scr}(K_t)$	-	Short-circuit current temperature coefficient
P_{MPP}	-	MPP power
R_s	-	Series resistance
R_{sh}	-	Internal shunt resistance
T_c	-	Photovoltaic cell temperature
T_{max}	-	Temperature
T_p	-	Perturbation period
T_r	-	Reference temperature
V_{MPP}	-	MPP voltage
V_{oc}	-	Open-circuit voltage
θ_s	-	Elevation
$\emptyset$	-	Latitude
Δx	-	Amplitude of perturbation imposed to x
G_d	-	Global irradiance on fixed plane
I	-	Current
n	-	Number of days in a year
P	-	Power extracted from the photovoltaic

X	-	Variable that has been perturb
θ	-	Zenith angle of solar panel with horizontal is equal to zero
A	-	Ideality factor
EGO	-	Energy band gap for silicon
q	-	Charged of electron
β	-	Angle of solar panel with respect to the horizontal
γ	-	Azimuth
δ	-	Declination in degree
θ	-	Angle of solar panel between incident beam of flux with normal
λ	-	Insolation factor
ω	-	Hour angle (15^{o}per hour)

LIST OF ABBREVIATIONS

AC	-	Alternating Current
BAPV	-	Building Attached Photovoltaic
BIPV	-	Building Integrated Photovoltaic
DC	-	Direct Current
DIF	-	Diffuse Horizontal Irradiance
ES	-	Extremum Seeking
FOCV	-	Fractional Open-Circuit Voltage
GUI	-	Graphical User Interface
INC	-	Incremental
MPP	-	Maximum Power Point
MPPT	-	Maximum Power Point Tracking
P&O	-	Perturb and Observe
PITAS	-	Pusat Islam Tun Abang Salahuddin
PV	-	Photovoltaic
PVGIS	-	Photovoltaic Geographical Information System
SO	-	Self-Oscillation
UNIMAS	-	Universiti Malaysia Sarawak

CHAPTER 1

INTRODUCTION

1.1 Project Background

The definition of the properties of energy is energy that can be transferred from one object to another object and cannot simply be destroyed. Scientist today trying to figure out and to find new sources of energy as the non-renewable energy could be finished in a couple of decades. Statistically, by comparing between non-renewable energy and renewable energy it is found that non-renewable energy is mostly used to generate electricity more than renewable energy. Theoretically, non-renewable energy is fossil fuel such as coal, natural gas and oil that are carbon based materials were formed over millions of years from remain of ancient animals and plants. Basically extraction of fossil fuel is by releasing the stored chemical energy by burning process into a large amount of useful energy then it will heat up water to produce steam, the steam will move the generator turbine and the generator produces electricity. However, the burning of this energy causes global warming, air pollution and produce harmful gases. Therefore, it is important to utilize the renewable energy because it is available over the time and non-limited sources.

Potential renewable energy can be harvested in Malaysia is hydro and solar only excluded the wind energy it is because according to Malaysia Meteorological Department, the wind speed in Malaysia is weak [3] and unreliable to capture compares at European countries. Solar energy on the other hand is suitable in Malaysia because of the graphical location of Malaysia at the equator which enables Malaysia to experience equatorial climate. Thus, throughout the year Malaysia able to receive sunlight every day without fail for an average of 12 hours. The sunlight radiates to the earth and some of the heat is radiated back to the space and some of it is absorbed by the Earth as to keep the Earth temperature balanced. The initial cost to build new power plant for renewable energy is quite costly, however the operational cost not as much as the initial cost. Therefore, comprehensive of feasibility research must be done before harvesting the renewable energy as to fully fulfill the energy capacity of that location and ways to increase the efficiency of available energy.

Energy demand today keeps increasing as the urbanization rapidly growth day by day including in Malaysia. Current population in Malaysia is more than 31 million and expected to increase another 1.32% in 2018 [5]. Future electricity demand must be fulfill starting now as the Malaysia population is increasing every year from year 1960 until 2017 based on the graph on Figure 1.1 below. Thus, with good feasibility research Malaysia can be one of the countries using solar to generate electricity and it much simpler in design compared to other renewable energy because it is not producing much noise. Through this research also the solar energy as a subject to study and install the solar panel at one of important and commonly used building in Universiti Malaysia Sarawak (UNIMAS). Further discussion will be discussed in the next sub topic.

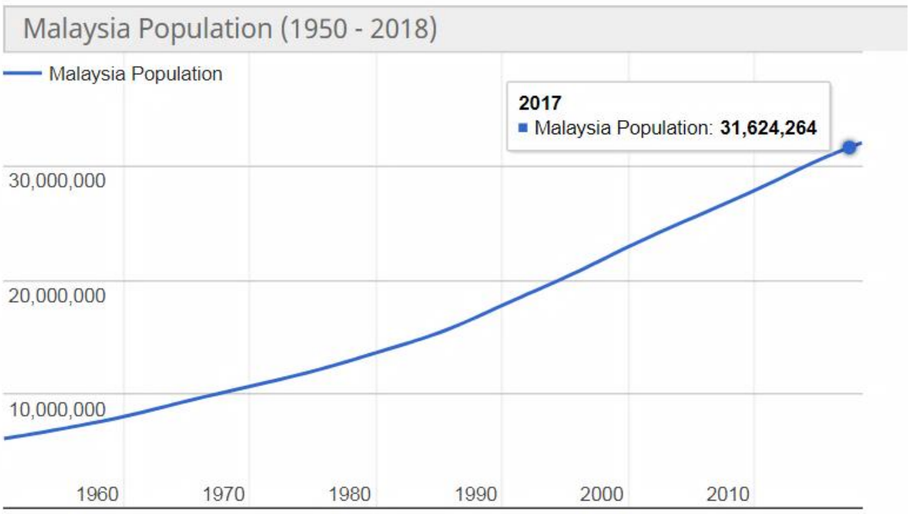

Figure 1.1: Current Malaysia Population [5]

This project started by collecting information related to suitable renewable energy that can apply for one of UNIMAS buildings through past five years of previous projects, books and websites. Renewable energy itself has its own disadvantage which is low efficiency and has possibilities to be uneven throughout the day. The solution for solar energy is the maximum power point tracking (MPPT) as it increases the efficiency of the solar panel with several methods approaches. Renewable energy is important in the future as a main energy producer because it can reduce climate change and it can be used for long term. Regarding this project, preliminary data of the total load of the building, the determination of angle for flat surface, on-site data of irradiance and temperature is obtained before proceed to the MPPT analysis using suitable software. Towards the end of this project, it is expected to know the position of maximum power point (MPP) at the building, determined the area of the solar panel, determine the angle for placing the solar panel and select the most suitable method to analyze MPPT by using software. Thus, this project background can be summarized in the flow chart in the Figure 1.2.

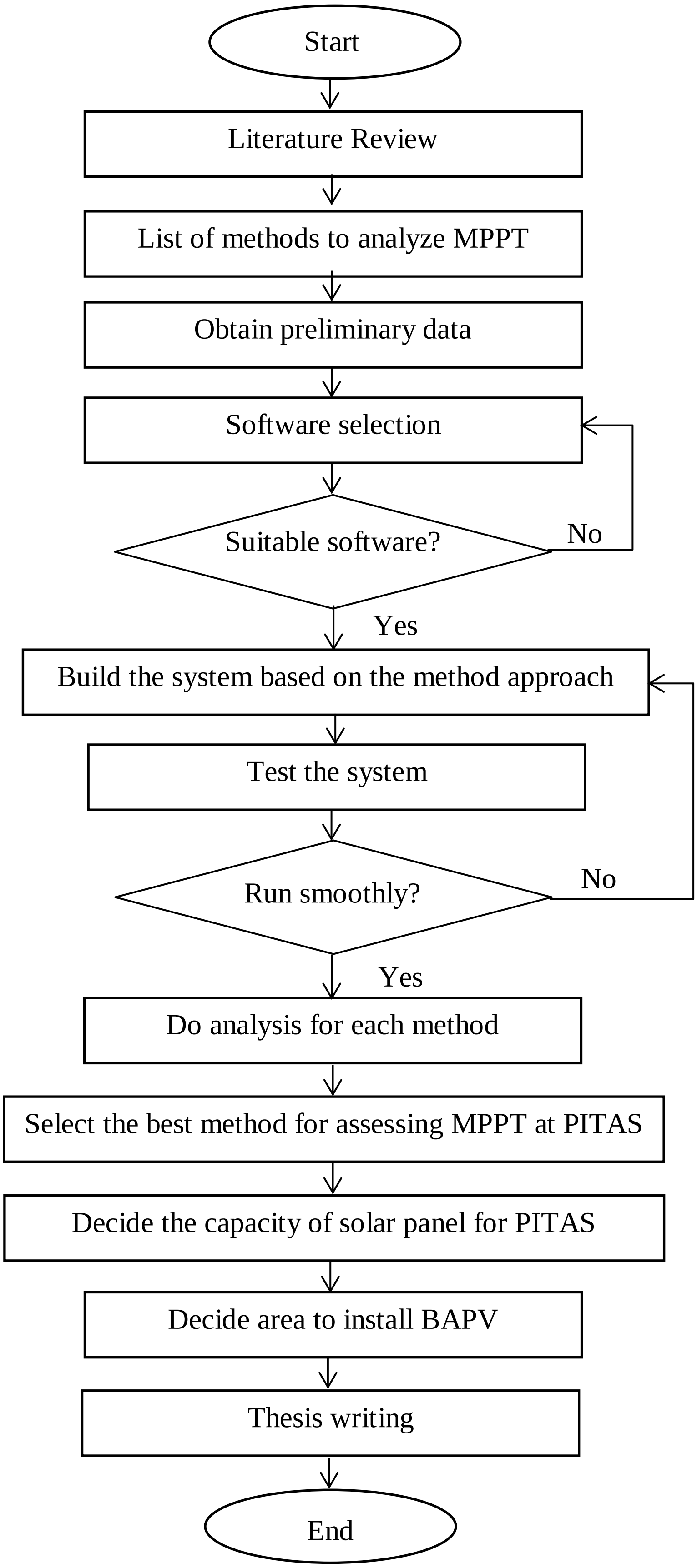

Figure 1.2: Project Background Flowchart

1.2 Introduction to the Study

Significant keys throughout this project are about Pusat Islam Tun Abang Salahuddin (PITAS), building attached photovoltaic (BAPV) and also MPPT which will be explained further in this part. The main purpose of choosing PITAS for this project is because of the location of this building. As previously mention that Malaysia experience equilateral climate, it enables this building to receive all sunlight throughout the day especially it was built according to Kiblah. In other word, sunrise from the East until sunset from West will be radiated at the from front till edge of PITAS building. Therefore, the strategic location and the way it was built is the major reason of choosing this building for this project. PITAS also one of the UNIMAS buildings that frequently used in the campus for praying and extra curriculum activities is one of the reasons for PITAS to have a sustainable and uninterrupted supply. Importantly, PITAS will be the first building in UNIMAS that from energy consumers to energy producer through this project. Energy consumer means that the building fully dependent on the utility supplies while the energy producer is where the energy is produced and feed the load directly. Thus, it is not possible for PITAS to be an energy producer because it has the potential as the purpose of the building and its location contributes huge significantly especially no shading from nearest buildings or tree. If the power generated is more than required energy capacity, PITAS can be the centre of energy producer and share the extra energy to nearest load such as Bunga Raya College and Tun Ahmad Zaidi College.

Another scope of this project research is about the solar energy. Even though PITAS have the potential to be an energy producer through this project, the main concern is PITAS have limited space to build solar farms next to the building. However, there is a solution for this problem is by applying the BAPV throughout the PITAS building. The difference between BAPV and building integrated photovoltaic (BIPV) is that the building itself. BIPV a group of solar cells integrated into the building envelope elements such as construction materials as roof tiles and glass facades while on the other hand BAPV are regular solar cell systems that are generally installed on top of roofs [13]. This technology is declining in cost which make the building integrated and building attached photovoltaic can efficiently and cost-competitively assist in delivering electricity in urban environments. The integration of photovoltaic (PV) modules on building façades and rooftops is an ideal application of solar electricity generators in the urban environment [17]. Thus, BAPV is the most suitable that can fully utilize whole PITAS building to install the solar cell and harvested the available solar energy in this research.

It is important to install the PV panel 90^{o} toward the incident ray of sunlight to the panel before installing the PV module at PITAS. Furthermore, with additional information on knowing the position of placing the panel and the capacity used can maximize the available energy solar energy. Therefore, analysis of MPPT at PITAS is the final significant for this project. MPPT is analyzed and stimulate using suitable software which is MATLAB software by several methods approaches. Each method approach has their own way to reach MPP, the conditions and the steps to get MPP also being considered. From the fast and effective method to obtain MPP later on will be applied to PITAS. Thus, this analysis can determine the MPP for PITAS as guidance for BAPV installation later on.

1.3 Problem Statements

PITAS do have the potential to be electrical producer as it was built according to Kiblah however full inspection needs to be done to consider as do not intrude the original design and structure of PITAS itself. The architecture design of PITAS such as the curve of the roof and original design purposes such as natural lightning and air ventilation also must be considered beforehand before selecting the BAPV installation area.

As mentioned earlier in this chapter, the main electrical producer today is from non-renewable energy such as burning fossil fuel. The main problem of non-renewable energy is it need cannot be replenished in a short period, causing the global warming, air pollution and the cost depend on the availability of the sources at the current time. If renewable energy becomes the main electrical producer in the future, a lot of aspects need to be considered such as the disadvantages of renewable energy is that it is difficult to generate the quantities of electricity that are as large as those produced by traditional fossil fuel generators [11]. Thus, proper analysis must be done as main sources of alternative renewable energy in Malaysia and its potential as well as the main reasons Malaysia is turning to alternative energy solutions; to fully utilize its renewable