



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**REGULATING THE COMBINATION OF PHOTOVOLTAIC
AND BATTERY SYSTEM FOR LIGHTNING DETECTION
SYSTEM**

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

By

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I hereby, declared this report entitled “REGULATING THE COMBINATION OF PHOTOVOLTAIC AND BATTERY SYSTEM FOR LIGHTNING DETECTION SYSTEM” is the results of my own research except as cited in references.

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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's Degree in Electrical Engineering Technology (Power Industry) (Hons.). The member of the supervisory is as follow:

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(Project Supervisor)

ABSTRACT

Renewable energy is the energy that has been widely used nowadays. A lots of technologies invented that used the renewable energy as their source of energy to supply power. Most of the country in Europe encourage their people to use renewable energy and not solely dependent on supply from the government. Recently, one of the famous renewable energy used is the solar system. This solar energy can produce electricity by converting sun energy to electrical energy through the solar photovoltaic system. The outcome of this project is to develop a system that independently operate or stand-alone system by applying the source of renewable energy which is the solar energy and combine with the automation tool for managing the operation of the batteries. This project utilized solar panel which can generate up to 12V to be use for supplying the lightning detection system. The aim of this project is to manage the distribution of power supply from the solar panel to the battery system for the use of lightning detection system. The first step to be taken is to identify the profile and the characteristic of irradiance during the daylight. Secondly, to investigate the important parameters to be considered in the stand alone solar system such as the irradiance, tilt angle, current, voltage and temperature and also the relativity between each parameters. From the result, the increase in the irradiance will increase the output power, the short circuit current and the open circuit voltages. The value of current is depends to the value of irradiance receive since both of them is directly proportional to each other. However, the value of voltages is inversely proportional to each other since the value of voltages will drop if the temperature is increased. The main strategy for this operation is to identify the optimum condition of environment to provide the optimum power for the lightning detection system.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

PV	-	Photovoltaic
DC	-	Direct Current
AC	-	Alternating Current
TNB	-	Tenaga Nasional Berhad
SE	-	Solar Energy
MW	-	Mega Watt
GW	-	Giga Watt
Wp	-	Watt Peak
Wh	-	Watt Hour
Si	-	Silicon
CdTe	-	Cadium Telluride
MHz	-	Mega Hertz
GHz	-	Giga Hertz

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter explains about the properties of photovoltaic solar system and briefly about the lightning detection system followed by the problem statement that come out during the research and the scope of the project. This solar system is design to supply power to this lightning detection system so that it can produce its own power supply without depending to the actual power supply such as from the generator or the socket outlet.

1.1 Project Background

The lightning activity in Malaysia was reported in an article informing that Malaysia was the country with the second highest number of lightning strikes in the world. The strike activities has always been a mystery where sometimes is trivial to predict when and where the lightning is going to strike. It also can be harmful and can cause injuries to humans and animals. One of the incident stated by (Bernama, 2014) happened in Alor Gajah where one student from MRSM Alor Gajah Melaka was struck by lightning in his school field. In other to solve those mysteries, a system to detect the lightning while upgrading the existed lightning detection system will be created by using a renewable source of energy to power up the system. The solar energy is the best to be used as the renewable energy source since it is environmental friendly, does not create any pollutant and will never run out of energy. The system will utilizes the solar energy as the main power source to power up all the system. It is an independent system that have its own power source and can operate anywhere as long as there is sunlight.

1.1.1 Lightning Strike in Malaysia

Malaysia is one of the location that have the most active lightning strike activities throughout the year. It is also reported by the United State National Lighting Safety Institution in the journal (Hassan et al. 2011) that Malaysia has the highest lightning activities in the world and the average-thunder day level in Kuala Lumpur is within 180-260 days per annum. The lightning strike have a very high current voltage and induced current released. It is one of the main factor for tripping process to happen at the residential area, the industrial area and the Tenaga Nasional Berhad (TNB) itself. It also can cause injury and fatalities to humans and animals, also it can cause lots of damages to electrical equipments. The lightning detection system is created to get the information about the lightning activity while giving an early precaution or early warning. The lightning have been a great concern to the humanity because of its effect to the safety, hazard and can produce damage to the application due to AC main power conducting electrical transient as reported in a journal (Ibrahim et al. 2012).

1.1.2 Natural Energy Sources

Natural energy sources is the main medium that we can use it to generate electricity for our own use. The natural energy can be divided by to categories which is the renewable energy sources and the non-renewable sources. The renewable energy sources is the energy that generated from natural resources such as the wind, sunlight, rain, and other examples. This renewable energy will never run out of sources as it is naturally replenished in a short time by the environment of the earth. Some of the examples that used this renewable energy is the solar system that use sunlight as it source of energy, the hydroelectric generator that use water as its main sources and the wind turbine that use the wind as its main power sources to generate electricity. All of this applications can continue to give electricity as all this natural resources will never depleted.

The non-renewable energy sources are also the natural energy that used to generate the electricity, but the sources will run out if we use it constantly without any plans. It also will be replace naturally, but it takes a very long time to produce even a small amount of it so that it is categorized as the non-renewable energy. It's also high in cost and some of it is not environmentally friendly. The examples of non-renewable sources are the natural gases, petroleum's, and coals. For our project, we are using sunlight as our main source of energy through the PV solar panel to charge batteries that will act as a storage.

1.1.3 Solar Power System in Malaysia

Solar power system is one of the system that use natural energy as it main sources and this system utilize the sunlight to produce electricity. The sunlight is one of the natural energy that can be classified as the renewable energy and will never run out or can be replaced in a short time. In Malaysia, the solar power system is considered as one of the promising sources of renewable energy as Malaysia receives high sunlight radiation along the year. (Johari et al 2011) stated that, since Malaysia is located at the equatorial zone, the average daily solar radiation is 4500 kWh/m² and the sunshine duration is about 12 hours. In a journal (Solangi et al. 2011) the highest solar radiation to be calculated in Malaysia is estimated to be 6.8kWh/m² in August and November. This statistic shows that Malaysia has a high potential in developing the solar power system. Moreover, this solar energy is less pollutant, environmental friendly and is the best solution to cover the environmental pollution issues and protect the climate change in Malaysia.

1.1.4 The Solar Power System Operation

The basic operation of solar power system will include the solar panel, the power charge controller modules, and the battery. This three items will act as the primary components or the main components for this system to operate. The solar panel will receive the sunlight and the atom in the silicon will be triggered to produce electricity. The electricity produced will be passes to the battery to maintain the charging process through the power charge controller modules. The power charge controller modules will monitors the current that charge the battery. When the battery level is full or rises to the certain value, the power charge controller modules will limit the charging process to avoid overcharging to the battery that can breakdown the battery. The output from the solar panel that charge the battery is the DC source. An AC source can be produced by adding an inverter from the battery.

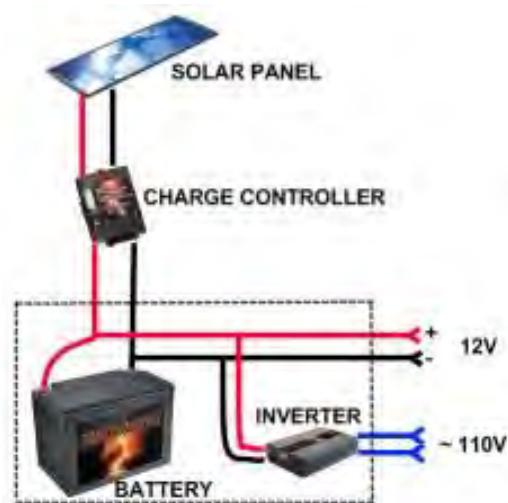


Figure 1.1: Simple Solar Power System Diagram

Source: Small Cabin/ 10A MPPT Solar Controller

1.1.5 Advantages and Disadvantages of the Solar Power System

The solar power system may have lots of advantages for us, but there are always pro and contrast in every aspect. In other to do avoid the upcoming problems in the future, we need to consider all the aspect we create any applications. Below are some of the advantages and the disadvantages for solar power system as stated in (Green Match, 2014):

1.1.5.1 Advantages of Solar Power System

Solar energy is one of the renewable energy that very popular in the world. It will never run out of energy and the solar radiation can be accessed everywhere as long as there is solar irradiance. The used of solar PV module can reduce the use of electricity since the electricity is generated by the solar panel from the solar energy which is free. The electricity produce is depends to the size of the solar system and the electricity used. By selling the excess electricity at high during the daytime and buying the electricity from the grid during the night time where the rate is lower can save a lot of money. The solar photovoltaic system do not require a lot of maintenance. By keeping them clean and no moving parts is good enough for the maintenance. The thing that need an additional care is the inverter due to the continuous working time. The solar system technology also constantly advancing and improving and the performance is always upgrade. The innovation in quantum physics and nanotechnology can increase the effectiveness.

1.1.5.2 Disadvantages of Solar Power System

Even though the solar system brings a lot of advantages, it also have the disadvantages to be consider. That is the reason the innovation about the solar system is never stop in other to upgrade the system. One of the disadvantages is, the cost to earn the system is fairly high. Even though the solar energy is free, the cost to set up the system is very expensive. The set up components includes the solar panels, solar charge controller on inverter, batteries, wiring and the installation. It also depends to the condition of the weather since the sunrays can be block by the atmospheric disturbance and the sun rays scattered by the cloud. The efficiency of the solar will drop when in cloudy and rainy days. The setting of the solar PV module will use a lot of space. A large scale solar system might need a large field to cover the installation process. The output power is depends to the size of the quantity of the solar module. The increase in the size of the solar will increase the output power, but the increase in the size will also increase the area needed to arrange the solar module.

1.2 Problem Statement

A lot of factors need to be taken in a process of built up a solar power system for the lightning detection system. The old version of lightning detection system are manage manually and it will have a lot of maintenance process. It also need a lot of cares to get the best result from the operation. A lot of important aspect need to be taken in other to make sure that the existed lightning detection system can work properly. In other to upgrade the old version of lightning detection system, a stand- alone lightning detection is design by utilizing the solar energy and taken into consideration all the important aspect in other to achieve the best condition to absorb solar energy and to produce enough power for the system to supply power will be design.

1.3 Objectives

The main objective is to build a renewable power system to power up the lightning detection system by utilizing the solar energy as the main source of energy. Below are the objectives of this project.

- ✚ To identify the profile of irradiance with the related parameters in order to determine the optimum condition for charging the battery.
- ✚ To provide a stand-alone solar system that will act as the main power supply for lightning detection system
- ✚ To identify the best criteria by taking into account all the important aspect

1.4 Scope

This project will cover in building a stand-alone system by utilizing solar energy sources to power up the lightning detection system. The scope will be based on the sizing process, power consumption from the main devices and the battery storage used. An analysis will be taken based on the location of solar radiation, the weather, percentage of power output from different aspect. In other to apply all of the objectives, a few scope have been stated below.

- ✓ Research on the existed lightning detection system
- ✓ Research for the solar power system
- ✓ Efficiency of the solar by manipulating a different criteria

1.5 Significant Of the Project

- ❖ To make a good use of the renewable energy
- ❖ Reduce the use the source from the actual power supply such as from the TNB
- ❖ Reduce the use of non-renewable energy so that we can have enough storage for the future
- ❖ Highlight the awareness of using renewable energy

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Chapter 2 will describe about the literature review on the same aspect as our project that has been researched from the journals, websites, and books. The literature review is actually a researched on the previous project that have the similarity on the title or the subtitle or in any aspect. This is important before we continue to get a better research and also to find out the best information through the project.

2.1 Lightning Strike in Malaysia

The lightning strike is an electrical discharge that happen between the atmosphere and an earth-bound object. This due to the collisions of the atom contained in the charged cloud up in the atmosphere. The occurrence of the lightning is the same as the static electricity spark concept but in a much bigger value. In the charged cloud, there is positive and the negative charged. The positive charged atom forms at the upper parts of the cloud and the negative charged atom forms at the bottom. When they are large enough and clash with each other, a giant spark which are the lightning will happens (Planet Science, 2012).

In Malaysia, the lightning activity is very active due to the climate in Malaysia. The climate itself always encourage the formation of the cloud and the lightning can happen wherever there are clouds. The study upon this lightning strike have been done by all kind of party to get information about this lightning strike. It can be harmful sometimes and if this happens, it can give a total fatality to human if they are being strike. Lightning discharge occurs when the electric current flows due to exert a pull on charged particles of positive and negative. There are three type of lightning discharge (Hassan et al. 2011):-

- ✓ Cloud to ground – when the charge at the cloud strike the ground
- ✓ Cloud to cloud (intercloud) – when the negative and the positive charge of different cloud attracted
- ✓ Intracloud – some charge at the base of the cloud attract the positive charge at the top of the cloud.

The lightning detection system will get the information through the induced electromagnetic signal resulted from the strike or the electromagnetic wave that produced in a wide frequency that can go up to several hundreds of MHz from a few Hz. According to the electromagnetic signal emitted from the lightning source, the location of lightning, its magnitude and type of discharge can be determined. The information of distance and the direction of lightning strike for the location of lightning has been performed by multi-station or single-station technique (Ibrahim et al. 2012).

2.2 Renewable Energy

Renewable energy is refer to the natural energy source than will never be run out or can be replenished in a short time. There are also the non-renewable energy that will take time to replace the energy sources. The renewable energy is water, solar, wind and other type of energy. Nowadays, a lot of country have done a researched about the renewable energy and there are going to use it as one of their power source in the future.

2.2.1 Renewable Energy in the World

Table 2.1: Primary reproduction of renewable energy in 2002.

	Primary production (1 000 toe)		Share of total, 2012 (%)				
	2002	2012	Solar energy	Biomass & waste	Geothermal energy	Hydropower	Wind energy
EU-28	97 755	177 269	5.1	65.5	3.2	16.2	10.0
Euro area (EA-18)	67 353	125 603	6.8	62.7	4.4	15.4	10.8
Belgium	576	2 816	7.1	83.3	0.2	1.1	8.4
Bulgaria	832	1 638	5.2	69.4	2.0	16.9	6.4
Czech Republic	1 594	3 247	6.1	87.2	0.0	5.6	1.1
Denmark	1 991	3 114	1.2	70.1	0.2	0.0	28.4
Germany	10 783	32 913	8.6	72.3	0.3	5.5	13.2
Estonia	568	1 056	0.0	96.1	0.0	0.3	3.5
Ireland	261	744	1.4	43.0	0.0	9.3	46.3
Greece	1 393	2 275	14.5	53.3	1.0	16.6	14.6
Spain	6 894	14 488	16.6	41.7	0.1	12.2	29.4
France	15 025	20 766	2.0	66.4	0.9	24.3	6.2
Croatia	757	1 181	0.6	62.6	0.6	33.8	2.4
Italy	9 249	17 894	9.9	36.7	27.7	19.2	6.4
Cyprus	45	106	62.5	21.2	1.4	0.0	15.0
Latvia	1 575	2 331	0.0	85.9	0.0	13.7	0.4
Lithuania	773	1 198	0.0	92.8	0.3	3.0	3.9
Luxembourg	38	94	5.3	78.9	0.0	8.9	6.8
Hungary	877	1 965	0.3	89.9	5.5	0.9	3.4
Malta	1	6	36.1	63.9	0.0	0.0	0.0
Netherlands	1 618	3 779	1.3	86.9	0.3	0.2	11.3
Austria	6 491	9 623	2.1	56.2	0.4	39.1	2.2
Poland	4 141	8 478	0.2	92.8	0.2	2.1	4.8
Portugal	3 552	4 358	2.3	63.3	3.1	11.1	20.2
Romania	3 749	5 242	0.0	75.4	0.4	19.8	4.3
Slovenia	715	990	2.4	60.5	3.3	33.8	0.0
Slovakia	744	1 434	2.9	72.0	0.4	24.6	0.0
Finland	7 826	9 931	0.0	85.0	0.0	14.6	0.4
Sweden	13 123	18 508	0.1	59.9	0.0	36.7	3.3
United Kingdom	2 566	7 095	3.6	66.2	0.0	6.4	23.7

Source: Eurostat (online data codes: ten00081 and nrg_107a)

Source: Eurostat (online data codes ten 00081 and nrg_107a)

Table 2.2: Share of renewables in gross inland energy consumption in 2012.

	Renewable energy total	Biomass & renewable wastes	Hydropower	Geothermal	Wind	Solar
EU-28	11.0	7.3	1.7	0.3	1.1	0.5
Euro area (EA-18)	11.1	7.1	1.6	0.5	1.2	0.7
Belgium	5.9	5.1	0.1	0.0	0.4	0.4
Bulgaria	8.9	6.2	1.5	0.2	0.6	0.5
Czech Republic	7.5	6.5	0.4	0.0	0.1	0.5
Denmark	23.3	18.2	0.0	0.0	4.9	0.2
Germany	10.4	7.5	0.6	0.0	1.4	0.9
Estonia	14.1	13.4	0.1	0.0	0.6	0.0
Ireland	5.9	2.9	0.5	0.0	2.5	0.1
Greece	9.6	5.6	1.4	0.1	1.2	1.2
Spain	12.6	5.9	1.4	0.0	3.3	1.9
France	8.2	5.5	2.0	0.1	0.5	0.2
Croatia	12.1	6.7	4.9	0.1	0.3	0.1
Italy	12.7	5.7	2.1	3.0	0.7	1.1
Cyprus	5.1	1.8	0.0	0.1	0.6	2.6
Latvia	36.4	29.2	7.0	0.0	0.2	0.0
Lithuania	16.4	15.2	0.5	0.1	0.7	0.0
Luxembourg	3.1	2.7	0.2	0.0	0.1	0.1
Hungary	7.5	6.7	0.1	0.5	0.3	0.0
Malta	1.1	0.8	0.0	0.0	0.0	0.2
Netherlands	4.3	3.7	0.0	0.0	0.5	0.1
Austria	30.1	17.5	11.2	0.1	0.6	0.6
Poland	8.8	8.2	0.2	0.0	0.4	0.0
Portugal	19.8	12.6	2.2	0.6	4.0	0.5
Romania	14.7	11.0	2.9	0.1	0.6	0.0
Slovenia	14.8	9.3	4.8	0.5	0.0	0.3
Slovakia	8.1	5.7	2.1	0.0	0.0	0.3
Finland	29.2	24.8	4.3	0.0	0.1	0.0
Sweden	37.2	22.3	13.6	0.0	1.2	0.0
United Kingdom	4.1	3.0	0.2	0.0	0.8	0.1

Source: Eurostat (online data codes: nrg_100a and nrg_107a)

Source: Eurostat (online data code: nrg_100a and nrg_107a)

The table 2.1 and table 2.2 shows the primary reproduction of the renewable energy in 2002 and it share of renewables in gross inland energy consumption in 2012 (EuroStat, 2015). This is one of the statistic in Europe about some of the renewable energy production and consumption in other country. It shows that the country around the world have taken a step in utilizing the renewable energy at their country.

2.2.2 Renewable Energy in Malaysia

In Malaysia, the awareness about the use renewable energy are not widely known but its shows a positive development from all kind of party including the government. The technology about the renewable energy in Malaysia also shows a very good development. The society in Malaysia have open their eyes to accept this new power source into their life. Before this we only see that only a big company or a big factory take the initiative in utilizing this kind of energy. But, nowadays, we can see that the residential house also have their own solar panel, and other type of energy. There are four potential renewable energy that suitable in Malaysia which is the solar, wind, hydro and the biomass (Azman et al. 2011).