UNIVERSITI TEKNIKAL MALAYSIA MELAKA

HYBRID SOLAR-WIND GENERATOR FOR SMALL SCALE ELECTRONIC DEVICES

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

by

MOHAMMAD FIRDAUS BIN NORAZMAN
B071110213
890222-05-5179

FACULTY OF ENGINEERING TECHNOLOGY
2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **HYBRID SOLAR-WIND GENERATOR FOR SMALL SCALE ELECTRONIC DEVICES**

SESI PENGAJIAN: **2014/15 Semester 1**

Saya **MOHAMMAD FIRDAUS BIN NORAZMAN**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	TIDAK TERHAD	

Disahkan oleh:

_____ _____

Alamat Tetap:

NO. 42 KAMPUNG BARU AIR HITAM

72120 BANDAR SERI JEMPOL

NEGERI SEMBILAN

Cop Rasmi:

Tarikh: 10 DISEMBER 2015

Tarikh: _____

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Hybrid Solar-Wind Generator for Small Scale Electronic Devices” is the results of my own research except as cited in references.

Signature	:	…….
Author’s Name	:	Mohammad Firdaus Bin Norazman
Date	:	15 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 Electronic Engineering Technology (Industrial Electronic) (Hons.). The member of the supervisory is as follow:

……

(Mohd Fauzi Bin Ab Rahman)

ABSTRAK

Pada masa kini, banyak tenaga elektrik yang dibekalkan kepada jalan raya seperti lampu persimpangan , penunjuk lampu jalan , lampu jalan dan lain-lain . Kos elektrik boleh dijimatkan dengan menggunakan tenaga boleh diperbaharui untuk mengeluarkan tenaga elektrik. Tenaga angin dan telah menjadi sumber yang popular kerana ianya banyak dan mudah untuk ditukar kepada tenaga elektrik. Oleh itu, projek generator hibrid berasaskan angin dan solar akan dibangunkan untuk membekalkan elektrik yang dijadikan model di lebuh raya dan jalan raya. Projek ini merealisasikan hibrid generator solar dan angin untuk peranti elektronik kecil dimana papan tanda amaran dengan papan tanda LED seperti belok kiri / panah kanan biasanya dipasang di lebuh raya dan jalan untuk menasihati pengguna ketika memandu. Papan tanda tanda LED ini biasanya dihidupkan oleh bateri bukan boleh dicas semula. Walau bagaimanapun, bagi jangka masa yang panjang, ia tidak ekonomi. Sistem hibrid dalam projek ini adalah salah satu menggabungkan turbin angin dan modul PV dengan bateri boleh dicas semula untuk tujuan simpanan. Projek ini menyiasat potensi tenaga solar dan angin dan keperluan untuk pemasangan di lebuh raya atau jalan raya, reka bentuk dan model hibrid generator solar angin untuk peranti elektronik kecil dan menguji dan menilai tahap sebenar dan prestasi sistem hibrid yang lengkap.

ABSTRACT

Nowadays, a lot of electrical energy supplied to the road such as intersection lamp, street lamp indicator, street lamp and others. The cost of electricity can be saved by using renewable energy to produce electricity. Wind and solar energy have being popular ones owing to abundant, ease of availability and convertibility to the electric energy. Thus, a project hybrid generator based on wind and solar for small scale electronic devices will be developed as means to supply electricity to model of highway and roads. The hybrid system in this project is one combining wind turbine and PV module with rechargeable battery for energy backup purpose. This project covers realization of a hybrid solar-wind generator for small scale electronic devices, which a caution signage with LEDs signage such as turn left or right arrow usually are installed at highways and roads to advise users when driving. These LEDs signage usually are powered by non-rechargeable batteries. However, for a long run, it is not economical. This project investigate the solar and wind energy potential and requirement for installation at highways or roads, design and model a hybrid solar-wind generator for small scale electronic devices and test and evaluate the real working states and performance of the completed hybrid system.

DEDICATION

Dedicated to my parents Norazman and Salmiah, brothers & sisters and all who use live with electricity.

ACKNOWLEDGEMENT

First and foremost, many thanks to Allah S.W.T for his blessing completing this final year project. My greatest appreciation and thanks to my supervisor, Mohd Fauzi Bin Ab Rahman for guiding, supervising and also advising me to complete this final year project successfully.

My deepest gratitude goes to my beloved family especially my parents who always support me in many ways such as giving me moral support, money, guidance and many more. For the generous assistance implementing various experiments, I would like to acknowledge my course mates. Thank for all the times spent and never ending patience in order to change opinions and ideas with me.

Last but not least, I sincerely thank my lecturers, technicians and all my friends for their support and help directly or indirectly.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

3D	-	3 Dimension
A	-	Ampere
AC	-	Alternating Current
AH	-	AmpereHour
CAD	-	Computer-Aided Design
DAS	-	Data Acquisition System
DC	-	Direct Current
HAWT	-	Horizontal Axis Wind Turbine
I	-	Current
LED	-	Light-Emitting Diode
MPPT	-	Maximum Power Point Tracking
PSM	-	Projek Sarjana Muda
PV	-	Photovoltaic
PVC	-	Polyvinyl chloride (PVC)
RERC		Renewable Energy Research Center
Si	-	Silicon
UMT	-	University Malaysia Terengganu
V	-	Voltage
VAWT	-	Vertical Axis Wind Turbine
W	-	Watt

CHAPTER 1
INTRODUCTION

This chapter basically explains the introduction that includes the purpose of hybrid solar-wind generator for small scale electronic devices. It also describes the objectives, problem statement and scopes of this project.

1.1 Introduction

Nowadays, with the advance of renewable energy, electrical energy supplied to the road can be saved. Increasing usage of electrical energy that uses non-renewable energy will lead to pollution. Thus, to replace the conventional non-renewable sources is by develop a clean and renewable energy such as solar and wind energy. One of the most promising applications related to renewable energy is the hybrid energy technology stated by Daniele et al, 2013. Hybrid systems are the ones that use more than one energy resources. According to Fesli et al, 2009 it is possible to have any combination of energy resources to supply the energy demand in the hybrid systems, such as solar and wind. Integration of systems (wind and solar) has more influence in terms of electric power production.

The project of hybrid solar-wind hybrid generator small scale electronic devices is developed as means to supply electricity to model of highway and roads. It covers realization of a hybrid solar-wind generator for small scale electronic devices, which a caution signage with LEDs signage such as turn left/right arrow .It is installed at highways and roads to advice users when driving. The hybrid system in this project

is one combining wind turbine and PV module with rechargeable battery for energy backup purpose.

1.2 Problem Statement

On sunny day, the photovoltaic (PV) module system is most applicable as compared to at night while wind turbine system can generate energy regardless of whether it sunny or not, so long there is a wind. Many product available in the market uses only one source as the generator, either PV or wind. Combining and integrating these two generator would give better power output and more energy as it can generate energy regardless in the present of wind and solar. There are some problems according to the product or project in the market such as some of products in the market need other external power supply to provide electric to power up the system and many projects simply based on one source either wind or solar which is not hybrid. Other than that, products in the market are commonly used on a large scale and limited due to high cost.

1.3 Objectives

The objectives of this project are shown as below:

1. Investigate the solar and wind energy potential and requirement for installation at highways or roads such as weather data analysis, system performance and others.
2. Design and model a hybrid solar-wind generator for small scale electronic devices.
3. Test and evaluate the performance of the completed hybrid system.

1.4 Project Scope

The focus of this project is to develop a model with an acceptable precision to estimate the actual performance of the hybrid solar-wind generator for small scale electronic devices under varying weather conditions. This project will limit to the electrical and mechanical part for the construction of the prototype. Some obstacle related to noise and turbulent winds will be ignored. Furthermore, the study of battery charging lifetime will be ignored as the main purpose is to test and evaluate the performance of hybrid system. However, the battery power stored is estimated to endure long enough to power up LEDs in the case of generator unable to harvest energy due to unexpected weather condition.

1.5 Report Outline

This report contains 5 chapters and they are outlined as below:

Chapter 1 explains the introduction that includes concept hybrid solar-wind generator for small scale electronic devices. It also outlines the objectives, problem statement and scopes of this project.

Chapter 2 describes the literature review which is the reference circuit used in order to implement this project, gives a brief review about the past project and important component used to distinguish this project with existing projects.

Chapter 3 provides description about the methodology in order to implement this project from the start until the end. The methodology is illustrated using the flow chart and each of the content of the flow chart is described in this part.

Chapter 4 explains the development of the system operation. In this chapter, testing results that conducted to each module are presented and discussed.

Chapter 5 summarizes the overall conclusion for this report and a few future recommendations

1.6 Conclusion

In the end on this chapter, it explains about the whole background of this project that consists of objectives, problem statements and project scopes. Investigation of hybrid solar-wind generator includes finding the information related to existing solar and wind system that can be used as the references in order to get the idea to implement this project. Then, the problem statements identified earlier are used to improve the system, so that it will have certain novelty compared to existing hybrid solar and other single source generator that available in the market. Besides, the project scopes help to show the important part that must be focused in implementing the project.

CHAPTER 2
LITERATURE REVIEW

This chapter basically describes the literature review which is the reference circuit used in order to implement this project, gives a brief review about the past project and important component used to distinguish this project with existing projects.

2.1 Introduction

In recent years, solar energy and wind energy applications have grown rapidly to meet environmental protection requirements and electricity demands. This chapter presents a literature review on the theory and basic principle for the components that involved in this project. This includes their general characteristic, basic function, operation, advantages and many more. The hybrid system by several aspects such as solar and wind energy application potential analysis, PV array, wind turbine, battery performance predictions and optimal sizing method for hybrid solar-wind system.

2.2 Hybrid Solar-Wind Energy System

According to Fesli et al, 2009 hybrid systems are the ones that use more than one energy resources. Integration of systems (wind and solar) as in Figure 2.1 has more influence in terms of electric power production and the systems are called as "hybrid systems". Hybrid solar-wind applications are implemented in the field, where all-year energy is to be consumed without any chance for an interrupt. Thus, a hybrid solar-wind power system that takes advantage of wind and solar energy's complementary characteristics would seem to be a viable idea as stated by Mousa et al, 2011. It is possible to have any combination of energy resources to supply the energy demand in the hybrid systems, such as oil, solar and wind.

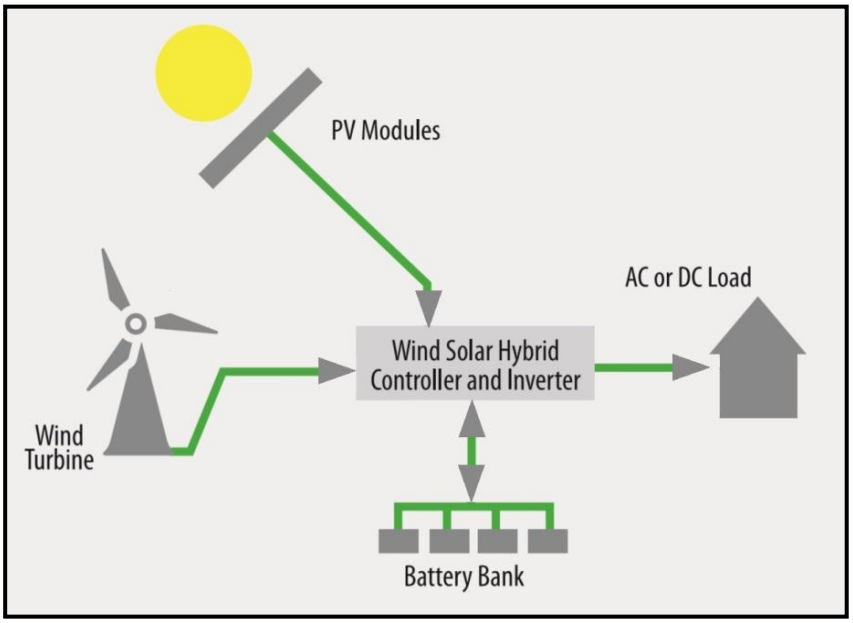

Figure 2.1: Hybrid System of Solar and Wind

(Source: http://www.callaglory.com/Wind-solar-hybrid-power-system.html

This system is similar with solar power panel and wind turbine power. Differently, it is only an add-on in the system. Photovoltaic solar panels and small wind turbines depend on climate and weather conditions. Therefore, neither solar nor wind power is sufficient alone. A number of renewable energy expert claims to have a satisfactory hybrid energy resource if both wind and solar power are integrated within a unique body. On sunny day, the photovoltaic (PV) module system is most

applicable while wind turbine system is more applicable at night because of windy condition. However, it is also applicable on daytime. In other words, it is needed to support these two systems with each other to sustain the continuity of the energy production in the system.

To realize this, a portion of the required energy for an ordinary home has been obtained. Experimental setup for the domestic hybrid system consists of a low power wind turbine and two PV panel. Depending on the environmental conditions, required energy for the system can be supplied either separately from the wind or solar systems or using these two resources at the same time as shown in Figure 2.2

.

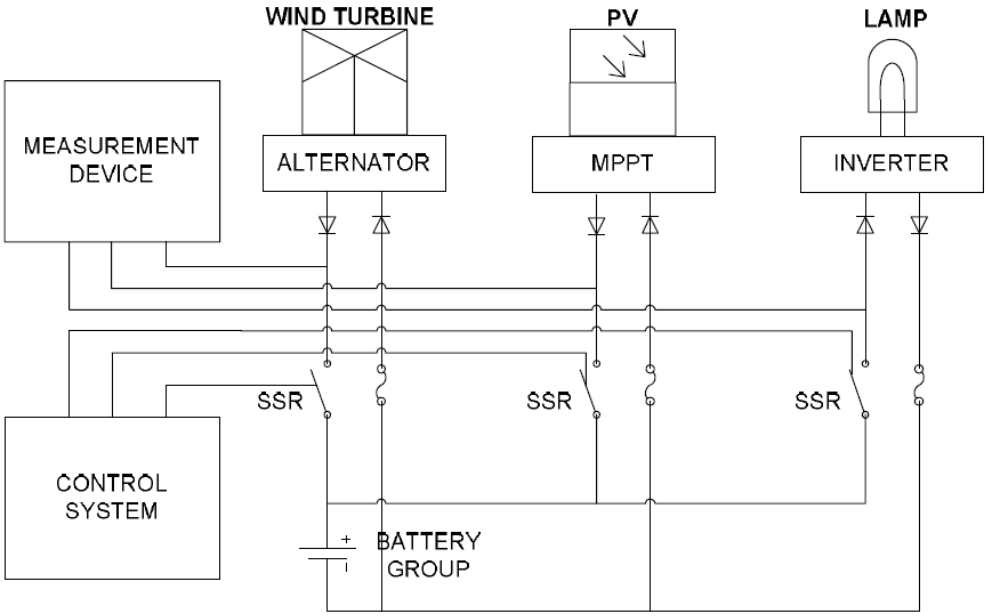

Figure 2.2: System block diagram of Hybrid System (Fesli et al, 2009)

The hybrid system in Figure 2.2 is one combining wind turbine and PV module with rechargeable battery for backup purpose. The wind turbine used to captures the wind's kinetic energy of mass which to convert mechanical energy to electrical energy. While, PV module used to convert solar radiation into DC electric power. Battery is the energy storage in the system, which is stores excess power and distributes it when there is demand. The hybrid systems that combine solar and wind energy generation units with battery backup can attenuate their individual fluctuations and reduce energy storage requirements significantly. With the

complementary characteristics between solar and wind energy resources for certain locations, hybrid solar-wind power generation systems offer us a highly reliable source of power as stated by Lu et al, 2002. Inverter is used to convert DC input to AC output. The incoming source from PV module is in DC sources which must be converted to the AC power before supply to the AC loads. MPPT regulates the energy coming from these panels and ensures a continuous high power generation. The current from the MPPT is used to charge the battery.

2.3 Solar Energy System

2.3.1 Definition

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect as stated by Gelma, 2011. PV power generation uses solar panels comprising a number of cells containing a semi-conducting material. According to Zhou Wei, 2007 as long as light is shining on the solar cell, it generates electrical power. When the light stops, the electricity stops.

2.3.2 Basic Operation

Dobrzanski, 2008 stated that a PV cell is basically a semiconductor diode whose p-n junction is exposed to light. Basically PV cell is made from several types of semiconductor such as monocrystalline and polycrystalline silicon cells. Silicon PV cells are composed of a thin layer of bulk Si or a thin Si film connected to electric terminals. One of the sides of the Si layer is doped to form the p-n junction. A thin metallic grid is placed on the sun-facing surface of the semiconductor. The collision of the light or sun radiation through the solar cell generates carriers that produce electric current if the solar cell is short circuited. Charges are generated when the

energy of the incident photon sufficient to detach the covalent electrons of the semiconductor. This phenomenon depends on the semiconductor material and on the wavelength of the incident light. Basically, the PV phenomenon may be described as the absorption of solar radiation, the generation and transport of free carriers at the p-n junction and the collection of these electric charges at the terminals of the PV device. Figure 2.3 shows the physical structure of a PV cell.

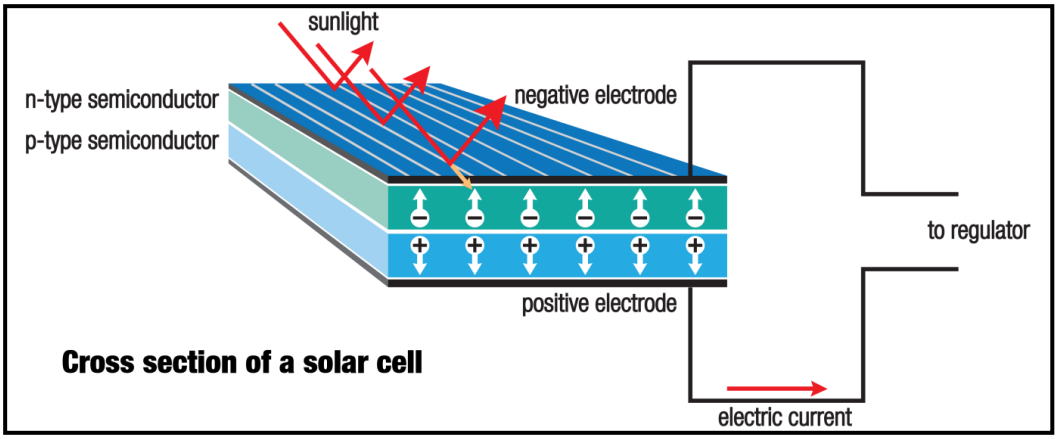

Figure 2.3: Basic PV cell structure

(Source: http://solarpanelhisar.com/tag/solar-cell-charger/)

The rate of generation of electric carriers depends on the flux on incident light and the capacity of absorption of the semiconductor. The capacity of absorption depends mainly on the semiconductor band gap, on the reflectance of the cell surface (that depends on the shape and treatment of the surface), on the intrinsic concentration of carriers for the semiconductors, on the electronic mobility, on the combination rate, on the temperature and several other factors. The solar radiation is composed of photons from different energies. Photons with energies lower than the band gap of PV cell is useless and do not generate voltage or electric current. Photons with energy superior to the band gap can generate electricity, but only the energy corresponding to the band gap is used. The rest of the energy dissipated as heat in the PV cell body. Semiconductors with lower band gaps may take advantage of a larger radiation spectrum, but the generated voltages are lower.