
# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## DESIGN AND DEVELOPMENT OF HYBRID POWER GENERATION MODEL USING WIND AND SOLAR ENERGY FOR RESIDENTIAL BUILDING

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

by

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# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **Design and Development of Hybrid Power Generation Using Wind and Solar for Residential Building**

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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 of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

……

(Project Supervisor)

# ABSTRACT

The condition of the planet is getting worst day by day because of pollution which causes environmental friendly solutions are to becoming more prominent than ever. The use of fossil fuel and other non-renewable energy had led to environmental concern. On the other hand, regarding of stand-alone system, where by stand-alone system itself cannot provide continues power supply thus affect the reliability of the system. Therefore, one of the solutions for the above articulation is to have renewable hybrid energy. This project is to analyze metrological data collected in Malacca, design and develop a model of hybrid wind and solar off-grid system which will include the development of a model of the hybrid wind and solar energy system based on the design. To achieve the above statement, 1 year data for wind and solar will be obtain from Electrical Engineering Faculty (FKE). After that, an evaluation on wind turbines and solar panels will be made to determine type of wind turbine and solar panel to be used in design and development of hybrid wind and solar off-grid system. This project is expected to produce a 6V power supply which is 2.5% of the 240V power supply.

# ABSTRAK

Keadaan planet ini semakin hari semakin teruk disebabkan oleh pencemaran yang semakin menjadi. Dengan itu, perbincangan mengenai penyelesaian mesra alam sekitar menjadi lebih serious berbanding sebelum ini. Penggunaan bahan api fosil merupakan salah satu activiti yang membimbangkan dan merupakan salahsatu ancaman kepada alam semula jadi. Selain daripada issue pencemaran, penjanaan bekanan tenaga electrik yang berterusan merupakan salahsatu issue juga untuk sistem bekalan kuasa yang depanggil "*stand-alone*" sistem. Oleh yang demikian, penyelesaiaan untuk artikulasi di atas adalah untuk menghasilkan sistem yang baru iaitu sistem yang menggunnakan tenaga hibrid dan tenaga tersebut merupakkan tenaga yang boleh diperbaharui. Projek ini adalah untuk menganalisis data metrologi yang dikumpul di Badar Melaka, merekabentuk dan menghasilkan model sistem hibrid yang menggunakan angin anda cahaya matahari sebagai sumber tenaga. Menggunakan perisian PROTEUS untuk merekabentuk dan analisasi sistem tersebut. Akhir sekali, menghasilkan model sistem tersebut berdasarkan rekabentuk yang direka menggunakan perisian. Untuk mencapai matlamat di atas, data selama 1 tahun untuk angin dan cahaya matahar akan diperoleh dari Fakulti Kejuruteraan Elektrik (FKE). Selepas itu, penilaian pada turbin angin dan panel solar akan dibuat untuk menentukan jenis kincir angin dan panel solar yang akan digunakan dalam rekabentuk dan peghasilan sistem hibrid. Projek ini dijangka akan menghasilkan bekalan kuasa 12V, 5% daripada bekalan kuasa asal 240V.

# DEDICATION

This report is specially dedicated to all those who have supported, encouraged, challenged and inspired me and specially to my beloved family, honorable tutor and friends for all their guidance, love and attention which made it possible for me to make it up to this point.

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Last but not least, i would like to express my greatest gratitude to my parents, Ting Sing Ping and Wong Ee Lee and also to all my family members for their encouragement and supports throughout my education process. I will always be grateful for their sacrifice, generosity and love. Lastly I would like to thank all my fellow friends that also help me in completing my final year project.

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# LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

| | | |
|---|---|---|
| a-Si | – | Amorphous Silicon |
| A | – | Area |
| A | – | Ampere |
| AC | – | Alternating Current |
| CdTe | – | Cadmium Telluride |
| CIS/CIGS | – | Copper Indium Gallium Selenite |
| CO2 | – | Carbon Dioxide |
| DC | – | Direct Current |
| FKE | – | Faculty of Electrical Engineering |
| HAWT | – | Horizontal Axis Wind Turbine |
| irrad | – | Irradiance |
| I | – | Current |
| kWh | – | Kilowatt Hours |
| m/s | – | Meters per Second |
| mc | – | Multi-crystalline |
| OPC | – | Organic Photovoltaic Cells |
| p-Si | – | Poly-silicon |
| PMSG | – | Permanent-magnet Synchronous Generator |
| PV | – | Photovoltaic |
| PVC | – | PolyVinyl Chloride |
| TFSC | – | Thin-Film Solar Cells |
| UTeM | – | University Technology Malaysia Malacca |
| V | – | Voltage |
| VAWT | – | Vertical Axis Wind Turbine |
| $W/m^2$ | – | Watts per Square Meter |
| µF | – | Micro Farad |
| µm | – | Micrometer |
| % | – | Percentage |

# CHAPTER 1
# INTRODUCTION

## 1.0 Introduction

This chapter will focus on the objectives and the background of the project. This project will be about the development of an off-grid hybrid wind and solar power generation for residential buildings by comparing stand-alone and hybrid system which system is more suitable to be implemented. Not only that, work scope will be listed as a bench mark to help achieve the objectives.

## 1.1 Problem Statement

It is believed that global warming has the largest impact on affecting earth's biodiversity, influencing both the circulation and plenitude of species and it has been in a discussion issue for some period of time and it is a worldwide issue. The most known component known by society that causes a temperature to rise quickly is carbon dioxide ($CO_2$). People have increased air $CO_2$ concentration since the advance in technology started. It is realized that burning of fossil infuses extra $CO_2$ into the air and other unhealthy gasses into the air. Utilizing diesel generators, burning fossil fuels and steam turbines to produce power contributes most to boots global warming. This thusly expands the ‘greenhouse effect", a procedure in which causes the temperature of the planet surface to increase. On the other hand, because of the seasonal changes and because there is day and night, standalone wind and standalone solar energy system are not that reliable compare to the combination of both power systems.

The limited supply and the ecological expenses from fossil fuel have made a requirement for renewable energy sources. The arrangement of using renewable energy sources is the most effective solution to minimize the danger and impacts of environmental change (Leggett and Ball 2012). Specialists trust that wind and solar oriented energy hold the most potential and will be the essential energy sources later on (Leggett and Ball 2012).

There are many options for renewable energy; wind and solar energy are one of them. Malacca, a state in Malaysia is an area not really suitable for harvesting wind energy alone, because this area has a low average of wind speed. The University Technical Malaysia Malacca (UTeM), has collected years of data for wind and solar that can be used to assess the viability of generating electricity from wind and solar.

## 1.2 Objectives

(a) To design a solar and wind hybrid energy circuit using Proteus 8
(b) To analyze the performance of the generated power from the design using the data obtain
(c) To develop a model of the hybrid wind and solar energy system

## 1.3 Work-scope

This project will involve several steps in work scope in order to achieve the stated objectives. The work scopes are listed as below:

(a) Simulate the off-grid hybrid power generation system using PROTEUS.
(b) Design electrical and mechanical parts of the hybrid system.
(c) Analysis of output power generated from hybrid system compare with stand-alone system.
(d) Build a model base on the design.

## 1.4 Expected Result

Data of wind speed has been collected and the average wind speed per day is 2.27m/s and it has been discussed in section 2.7.4 (page 40-41) that the most suitable type of wind turbine type is vertical type. On the other hand, Mono-crystalline type of solar panel has been chosen to be use because based on the comparison in table 2.8; mono-crystalline type has the highest efficiency and does not require a large area to install the system. From the literature review, it is proven that the combination of wind and solar which is called hybrid energy system is more reliable compare to stand alone energy system.

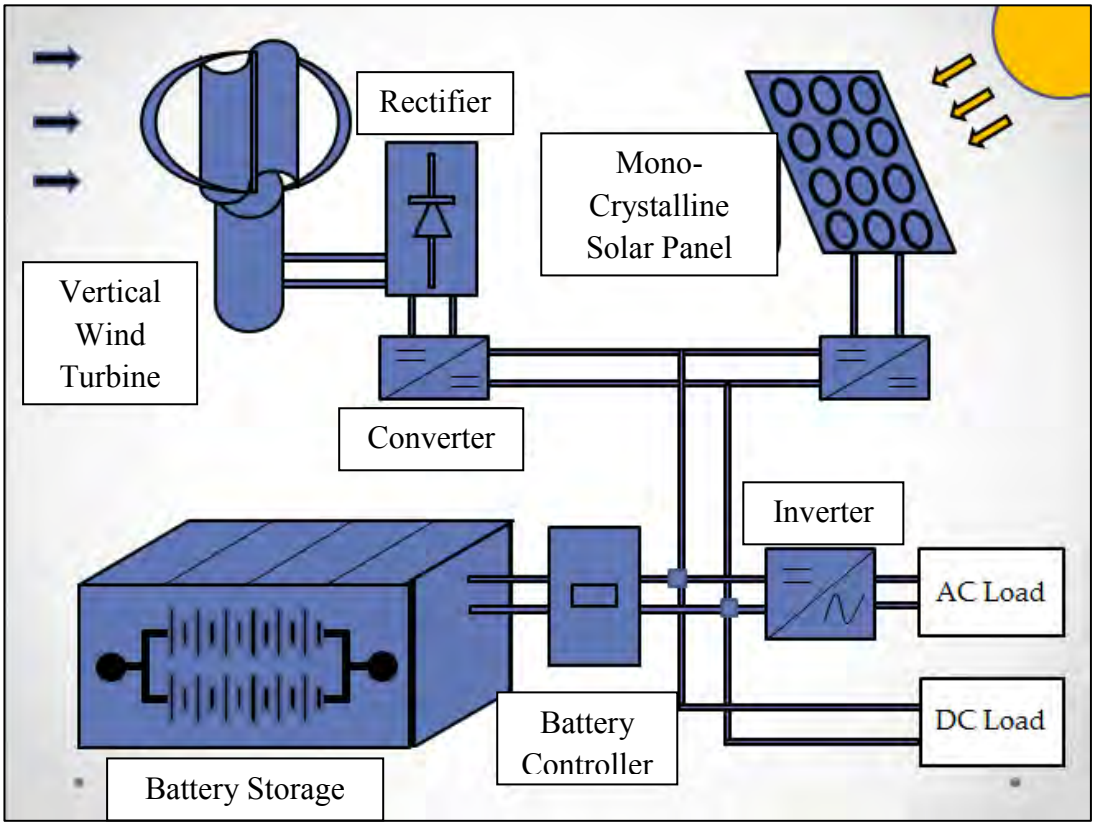


**Figure 3.5: Expected Project Design**

(Source: Designed by Ting Yong Jian)

# CHAPTER 2
# LITERATURE REVIEW

## 2.0 Introduction

This chapter will discuss about the project that had been acknowledged by other researchers. Other countries that have larger land, higher wind speed and solar ray intensity have established a hybrid wind and solar off-grid system as a mean of power source for residential area. This project will explain about the hybrid wind and solar off-grid system. Although the literature covers a wide variety of such theories, this review will focus based on the basics of wind and solar system, method of analysis and also gap in literature. On the other hand, other information from past researchers will also be included in this chapter for readers to understand more about the project.

## 2.1 Researchers Review

The need for renewable energy sources stems from the recognition of the finite supply of fossil fuels, rising cost of fossil fuels, and the pollution caused by fossil fuels. Despite these issues, fossil fuels still dominate the energy market, accounting for over 80% of energy production globally (Hedberg 2010). Both the physical environment and the social environment are greatly impacted by the consumption and production of energy from fossil fuels. Overwhelming evidence supports the fact that production and use of fossil fuels is unsustainable and has major environmental costs (Hedberg 2010). Fossil fuels are a limited nonrenewable resource and experts predict that within the next few centuries most will be depleted. In addition to a diminishing supply, fossil fuels face the problem of damage to the

environment. A leading cause of climate change is the accumulation of carbon dioxide in the atmosphere from the burning of fossil fuels (Mostafaeipour 2011).

Energy from fossil fuel is limited and non-renewable which implies that these energy assets are turning out to be more rare and costly (Rahim et al. 2012). Regardless of the expansion in lack and cost, the worldwide interest for energy will keep on rising. "It is normal that overall essential energy interest will increment by 45%, and interest for power will raise by 80% somewhere around 2006 and 2030" (Santos-Alamillos et al. 2012). In created nations there is a normal 1% yearly energy development rate and a normal 5% yearly energy development rate for creating nations (Rahim et al. 2012).

One of the real energy chances that human progress appearances is top fossil fuel. Crest fossil fuel alludes to fossil fuel creation expanding to a crest and afterward step by step declining to where it can no more take care of demand. Interest might be met at costs that are too high to meet the far reaching fossil fuel utilize that is right now watched today (Leggett and Ball 2012). Scientists talk about the "conceivable most dire outcome imaginable for crest fossil fuel" which is the soonest anticipated crest bolstered by a considerable measure of associate investigated writing (Leggett and Ball 2012). Research done by Leggett and Ball (2012) demonstrate that all fuel sorts aside from coal are relied upon to top before 2030 with a normal of 2028. Rahim et al clarify that "when worldwide energy creation is essentially and consistently commanded by fossil energizes, a energy emergency will happen later on" (Rahim et al. 2012). They assert that keeping in mind the end goal to turn away a energy emergency renewable energy assets should be produced in each nation.

There is considerable writing on renewable energy sources and backing for expanding execution of renewable energy techniques. There is an agreement that renewable energy choices are the main response to guarantee a long haul energy arrangement. Renewable energy leaves future eras with a non-exhausting energy source and in addition a more advantageous environment.

## 2.2 Previous Studies on Hybrid Wind and Solar Systems.

### 2.2.1 Examples That Worked

The utilization of hybrid system in remote or rural areas are famous now a days as renewable energy are becoming more and more popular and advance at this era (Nema et al. 2009). The developing prominence for hybrid stem in remote regions is rapidly increasing because of the expansions in renewable energy innovations and the increasing cost of petroleum and petroleum items. There are various studies that have taken similar discoveries. This study is made at Texas Hill Country. One crossover wind and sun oriented attainability study talked about the current worldwide energy emergency and raised around 1.5 billion individuals overall still do not have electricity supply. This study concentrated on remote populaces and the potential effect hybrid wind and sun powered energy system can benefit these individuals. These populations survive with the source from diesel generators, regardless of the wide nearby accessibility of renewable energy assets. This study investigated the viability of effectiveness of wind and solar system that uses a battery storage method. The outcomes demonstrated that for the specific remote island concentrated on, the hybrid renewable energy system not only can replace diesel generator but also cost effective and is able to supply long term power for this particular area (Ma et al. 2014).

### 2.2.2 Examples That Did Not Work

Not one of the researchers found out that a hybrid wind and solar energy system have a poor performed compare to a single source system. Researchers that did not support hybrid wind and solar systems started the research because of cost rather than production. In some cases, the additional benefits of the hybrid system, was not worth the added cost of the system. One study located conducted by Kershman et al. (2005) in Libya researched various small scale energy generation systems designed to power a desalination plant. The energy systems studied include

national grid connected solar, wind, hybrid wind and solar, and power from the local grid connected diesel generator, hybrid generator and solar and hybrid generator and wind. The study found that there was an increase in energy production from the hybrid wind and solar system, but the individual wind and solar components of the hybrid system did not perform as well as their counterparts in the wind only and solar only systems. Additionally, this study found that compared to most of the other systems analyzed the significantly higher investment rate of the hybrid system lead to a higher cost of energy from this system (Kershman et al. 2005).

## 2.3 Wind and Solar Energy Generation

### 2.3.1 Wind Energy

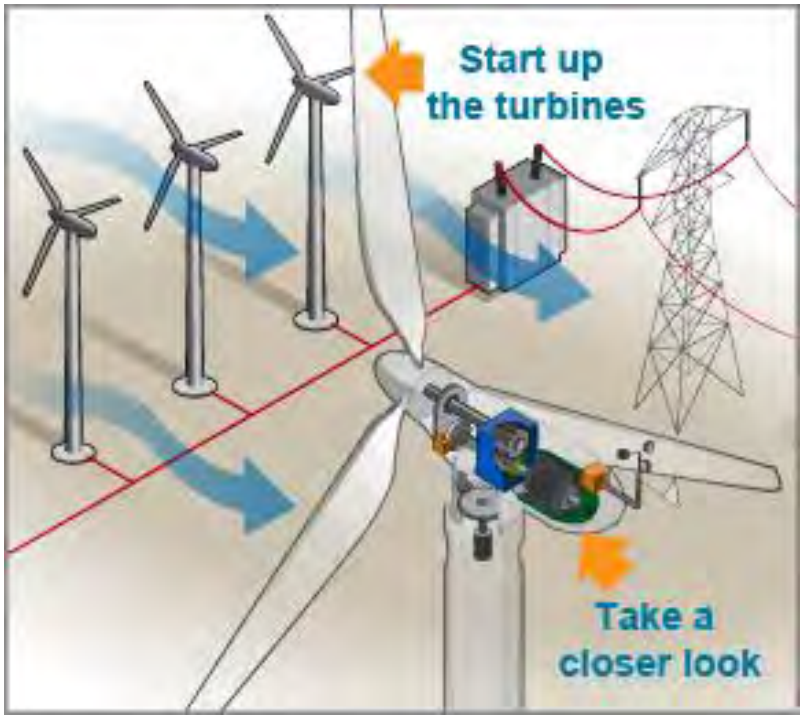


**Figure 2.3: Wind Turbine**

(Source: http://energy.gov/eere/wind/how-do-wind-turbines-work)

Generally, wind machines were utilized to do work, for example, pumping water and granulating grain and different materials. It is only recently that wind energy has been utilized to create power on a bigger scale. In spite of the fact that the

application has developed, the advanced wind turbine is comparative on a fundamental level to its predecessors. Materials, for example, metal and fiberglass have replaced the old wooden plans and the cutting edge turbines are much bigger, sleeker, and calmer (Pasqualetti 2004).

In principle, the Earth holds enough wind potential to meet the energy requests of the world. Verging on each nation has destinations accessible with wind speeds adequate for energy generation. Different requirements, for example, subsidizing, natural concerns, scene of reasonable locales, and accessible innovation make the plausibility of overall wind energy advancement troublesome. Notwithstanding these imperatives, wind is a variable that is greatly variable and arbitrary (Sesto and Casale 1998).

Continued expansion of wind power depends on a variety of factors, including fossil fuel prices, federal tax credits, state renewable energy programs, technology improvements, access to transmission grids, and public concern about environmental impacts.

### 2.3.2 Environmental Impacts

**(a) Air Emissions**

**(i)** Emissions connected with creating power from wind innovation are insignificant on the grounds that no fills are combusted.

**(b) Water Resource Use**

**(i)** Wind turbines don't require the utilization of water aside from potentially in areas with almost no precipitation, for cleaning purposes as it were.

**(c) Water Discharges**

**(i)** Wind turbines do not discharge any water while creating electricity.