UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF WIND TURBINE GENERATOR TRAINER SET USING PIC SYSTEM

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for 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: **Development of Wind Turbine Generator Trainer Set Using PIC System**

SESI PENGAJIAN: **2014/15 Semester 7**

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Engineering Technology (Industrial Power) (Hons). The member of the supervisory is as follow:

……

(Project Supervisor)

ABSTRACT

The aim of this project is to testing the extent to which production electrical energy as a result of wind speed, magnetic field strength, and the number of turns on the coil. This process is also known as the process of converting the kinetic energy into electrical energy. Therefore, this report relates to the objectives of the project, problem statement, project scope, procedures, literature review, methodology and proposals relating to the project to ensure the produce of "Development of wind turbine generator set using system trainer PIC" running smoothly and efficiently.

In addition, the produce of this project will be able to solve the problem lack of understanding of students on the basic concept of generator and how it operates. There are advantages of this project is to it easier the learning process so that students better understand what is being taught by educators. Therefore, the project can go further in the commercialization for higher level education if made improvements. Expected with the existence of this project will be able to benefit and useful to students in the future.

ABSTRAK

Tujuan projek ini adalah untuk menguji sejauh mana penghasilan tenaga elektrik hasil daripada kelajuan angin, kekuatan medan magnet, dan bilangan lilitan pada gegelung. Proses ini juga dikenali sebagai proses mengubah tenaga kinetik kepada tenaga elektrik. Oleh itu laporan ini berkaitan dengan objektif projek, pernyataan masalah, skop projek, prosedur, kajian literatur, metadologi dan cadangan berkaitan dengan projek untuk memastikan penghasilan "Pembangunan penjana turbin angin trainer yang ditetapkan menggunakan sistem PIC" berjalan dengan lancar dan cekap .

Selain itu, dengan penghasilan projek ini akan dapat menangani masalah kurang faham pelajar keatas konsep asas generator dan bagaimana ianya berfungsi. Kelebihan yang terdapat pada projek ini ialah untuk memudahkan proses pembelajaran supaya pelajar lebih memahami apa yang diajar oleh para pendidik. Oleh itu, projek ini boleh pergi lebih jauh dalam pengkomersilan seperti diperingkat pengajian tinggi jika dilakukan penambahbaikan. Diharap dengan terhasilnya projek ini nanti dapat memberi kebaikan dan manfaat kepada pelajar pada masa depan kelak.

DEDICATIONS

Specially dedicate to my family, beloved supervisor and friends.
For being the wonderful you, enough said,
Thank you.

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First and foremost, I would like to say Alhamdulillah because finally I have done my final book report (BETU 4774) and successfully finish my final project. Lots of thanks to all the person who are already give's contribution and cooperation to complete this project.

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V_{wind}	=	Velocity of wind
V_{multi}	=	Voltage from multimeter
V_{rotor}	=	Velocity of rotor
P_{AC}	=	AC Power
P_{DC}	=	DC Power
I_{AC}	=	AC current
C_p	=	Power Coefficient
V_{DC}	=	DC Voltage
V_{AC}	=	AC Voltage
I_{DC}	=	DC current
V_{range}	=	AC Voltage range
PMSG	=	Permanent Magnet Synchronous Generator

CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter will provide the detail about background project, problem statement that lead to this project, the objective of the project, the scope and limitation of the this project and who can get the benefit and knowledge from the this project.

1.1 Background

Wind turbine is also known as windmill, a device that converts kinetic energy of wind into mechanical energy to rotate the electric generator. The mechanical energy is then converted into electricity. The history of the use of wind energy started in the 17th century BC and spread in various countries such as Persia, Babylonia, Egypt, China, and in European continent with various forms of design. There are two categories of wind turbine blade design namely lift and drag type.

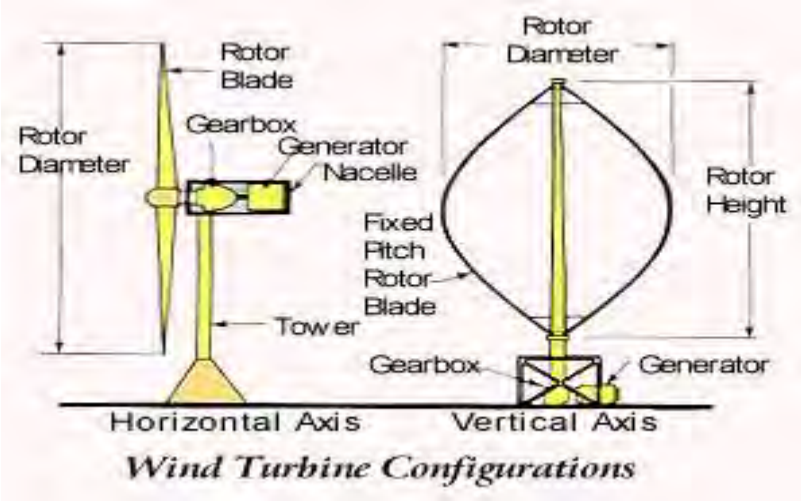

Figure 1.1: Type of Blade Design

The drag type is the first type of wind turbine that constructed using vertical axis design. This type uses the force of the wind to push the blade. A savonius is a simple example of drag type blade design, where the wind is resisted by blade. Based on the design, it usually creates higher torque with rotation slower a speed than the design of the lift type. This type of blade design is rarely used for energy generation on large scale because it has low energy efficiency.

The lift type is a familiar type of wind turbine created using horizontal axis design. The blade design is similar with an airplane wing, where the air blows on both sides of the blade causes it takes the air long to travel throughout the leading edge to create a higher air pressure and lower air pressure at the edge of the tailings. The differences of pressure around the blades is “pulled” and “pushed”. Besides that, if high pressure, blade is pulled. While, if low pressure, blade is pushed. Lift type blades have higher rotational speed compared to drag type. This causes the blade design suitable for generating electricity on larger scale.

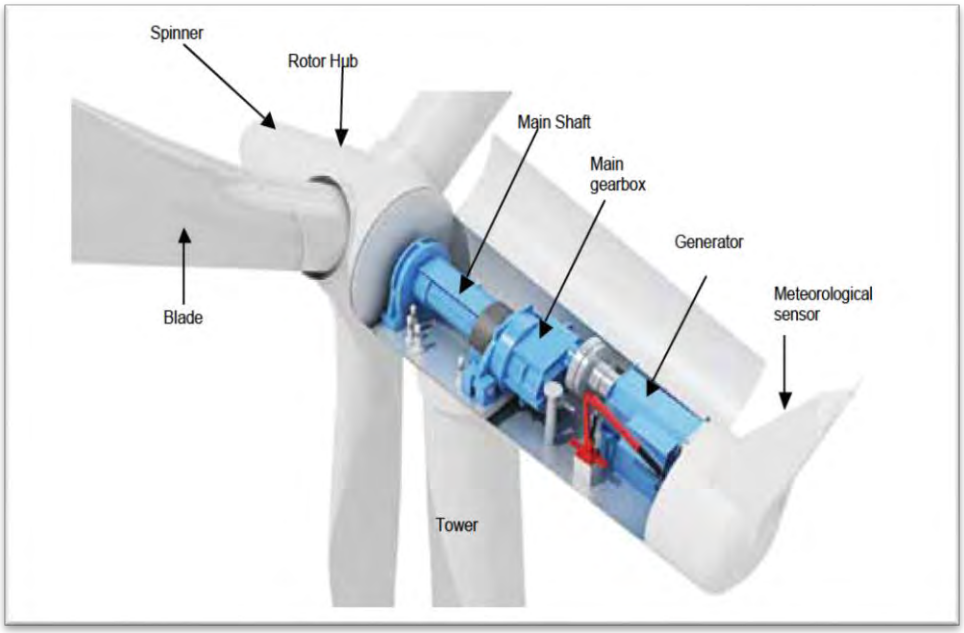

Figure 1.2: Wind Turbine Structure

Figure 1.2 shows that rotating blades are connected to the shaft which is connected to the generator. The generator uses the turning motion to rotate a magnetic rotor inside the generator housing that is surrounded by winding copper

wire (often wrapped around iron cores). The rotational rotor excites "electromagnetic induction" through the wire that generates an electrical current. The output voltage for wind generator is AC voltage because there are two commutator rings attached to the generator. The function of two commutator rings is to convert DC voltage to AC voltage.

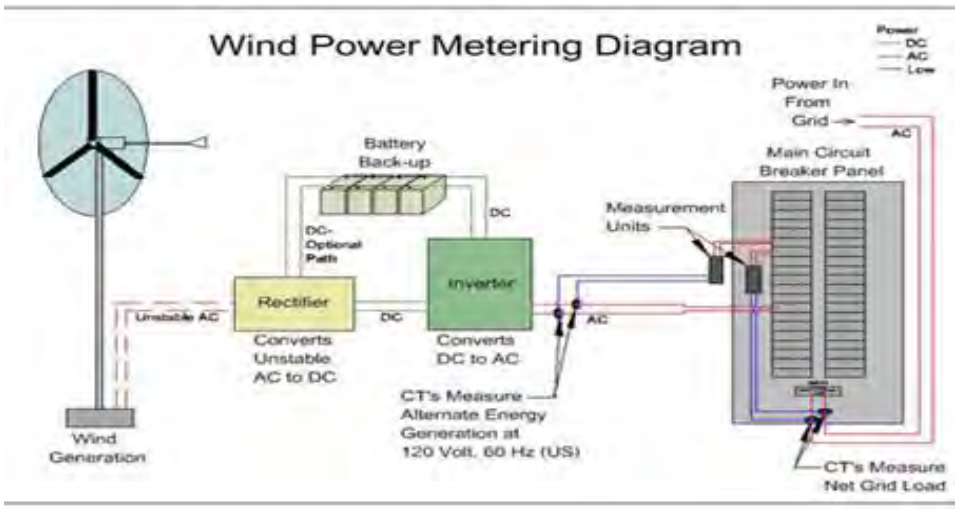

Figure 1.3: Wind Power Metering Diagram

Generally, wind energy resource potential in Equatorial countries is low. In Malaysia, the highest potential source of wind energy is in Sabah and Sarawak, followed by East Coast. On the West side, the potential is the lowest. The highest daily average wind speed in Malaysia is 3.8 m/s recorded in Mersing, Johor. Due to this, a low voltage will be generated. Hence, the development of wind turbine in Malaysia is less viable. The concept and operation of wind turbine generator at higher education level is less emphasis because it is difficult to be explained without existence of wind turbine system in Malaysia.

1.2 Problem Statement

The purpose of doing experiments on wind turbine is to investigate the relationship between wind speeds, coil winding, the number of magnetic and also the resulting output voltage.A permanent-magnet AC (PMAC) machine is an AC machine whose poles are made of permanent magnets. The PMAC machine does not required field winding. It can be similar to corresponding permanent-magnet DC

machine. Permanent magnet AC machines are especially common in smaller fractional and sub fractional horsepower sizes, where the expense and space of a separate field circuit cannot be justified. The formula for permanent magnet AC (PMAC) is:

$$V = -NA\,[dB/dt]$$

The voltage produced by the generator depends on the area circumscribed by the coil, a magnetic field strength, B and number of coils, N. For better understanding of above theory, a wind turbine system for lab session is required. So, with existence wind turbine generator trainer set, students are able to learn electromagnet theoretically and practically.

1.3 Objective

Three objectives that have been identified for are this project:

1. To study the effect of permanent magnet with copper windings.
2. To produce AC voltage from wind turbine generator using fixed levels of wind speed.
3. To display the DC voltage using PIC system.

1.4 Project Scope

The main scopes of this project are as follows:

1. Focus on the effect of permanent magnet with copper windings.
2. To explain the operation of wind turbine generator theoretically and practically.
3. Use PIC system to display DC voltage from wind turbine generator.

4. The design of this project is permanent magnet AC generator only.
5. To build stand-alone wind turbine generator trainer set.
6. To convert AC to DC voltage.

Not covered in this research:

1. To generate DC voltage.
2. The wind turbine generator trainer set to synchronous with grid network.

1.5 Project Significant

The expectation of this project is for student to better understand on the main structure of wind turbine as well as its function. For this project, the student will learn about effect permanent magnet on the rotor and the field winding on the stator. The project of wind turbine generator is the field winding and permanent magnet can be change compared the structure AC generator of stator and rotor is fixed. Overall, this project is a trainer for student understanding about the concept of wind turbine AC generator.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter will discuss the mainly idea of the research from varieties of source. All the fundamental facts that are needed in this research have been searched through the internet, books, journal and articles. Overall this chapter, basically to elaborate and explain in detail all the information related to this project based on these reliable sources.

2.1 Permanent Magnet AC (PMAC) Generator

In this research, availability and decreasing cost of high energy permanent magnet (PM) materials such as neodymium-iron-boron (NdFeB), and has stimulated development and research of permanent-magnet machines, notably the PM hybrid motors, synchronous motors and brushless d.c. These machines are built from small to medium sizes and have the following features such as light weight, simple mechanical construction, small size, absence of moving contacts, easy maintenance, high reliability and efficiency (Tudorache, T. et al.,2015). Stator has a rare earth permanent magnets such as Samarium Cobalt or Neodymium, which consists of a dc machine, to generate very strong flux of the stator field and commutator is connected through the brush to a wound armature, and instead wound coils (P. Wannakarn and T. Tanmaneeprasert et al.,2011).

The Permanent Magnet Synchronous Generator is more used in the last decade as an electric generator for wind power systems. The PMSG used for variable speed wind turbines requires typically an electronic converter to adjust the energy parameters so as to be ready for stored into batteries and being injected into the grid.

The AC voltage produced by a permanent magnet AC machine is controlled by the following three factors:

- The magnetic field produced by the stator. This depends to the physical size of the generator and types of the permanent magnets used and the strength.

Figure 2.1: Figure: Rotors of Flux Permanent Magnet Generator.
(P. Wannakarn and T. Tanmaneeprasert et al.,2011)

- Besides that, the number of turns on the armature that produced. This value is constant with the physical size of the generator and by the size of wire conductor and armature. The higher the output voltage while the more turns will be used. Similarly, the larger the wire diameter, the higher the current.