



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

POTENTIAL STUDY ON WIND TURBINE GENERATION BY VEHICLES VORTEX ON HIGHWAYS

This report is submitted in accordance with the requirement of Universiti Teknikal
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Technology (Industrial Power) with Honours

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DECLARATION

I hereby, declare that this thesis entitled “Potential Study On Wind Turbine Generation By Vehicles Vortex On Highways” is the result of my own research except as cited in the references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as one of the requirements for the award of Bachelor's Degree of Electrical Engineering Technology (Industrial Power) with Honours. The following are the members of the supervisory committee:

.....

(Syahrul Hisham Bin Mohamad Abdul Rahman)

ABSTRAK

Tenaga angin merupakan salah satu tenaga yang boleh diperbaharui dan boleh mengurangkan pelepasan bahan pencemar kepada alam sekitar yang bersih. Turbin angin adalah teknologi yang menukarkan tenaga kinetik kepada tenaga elektrik. Kesukaran memilih lokasi angin yang kuat menyebabkan pelaburan yang lebih tinggi . Dalam laporan ini , masalah ini boleh diatasi dengan turbin angin yang terletak di lebuhraya untuk menawarkan sumber sekala dan mencukupi oleh kenderaan yang bergerak pantas. Turbin angin paksi menegak telah dipilih untuk diletakkan di kedua-dua belah lebuhraya untuk menawan semula tenaga angin dari kereta berkelajuan tinggi. Angin turbin dapat mengumpul kuasa angin dari semua arah tanpa pengesanan. Selain itu , kuasa yang dihasilkan boleh disimpan dalam sistem penyimpanan. Di peringkat global , tenaga angin boleh digunakan sebagai sumber tenaga yang boleh diperbaharui untuk mengadakan peruntukan bagi aplikasi elektrik seperti lampu jalan .

ABSTRACT

Wind energy is one of the renewable energy that can reduce the emission of pollutants to the clean environment. The wind turbine is a technology that converts kinetic energy into electrical power. The difficulty of choosing a steady strong wind location needs higher investment. In this report, the problem can be overcome by locating wind turbine on the highway, which can offer an intermittent and sufficient source of fast moving vehicles. Vertical axis wind turbine has selected to place on both sides of highway to recapture the wind energy from high speed vehicles. The wind turbines able to collect wind power from all directions without tracking. Additionally, the generated power can be stored in the storage system. Globally, the wind energy can be used as a renewable power source to provide for electrical application like streetlight.

DEDICATION

To my beloved family

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

AC	-	Alternating Current
ABS	-	Acrylonitrile Butadiene Styrene
BDP	-	Bachelor Degree Project
CAD	-	Computer-aided Design
CFD	-	Computational Fluid Dynamic
cm	-	Centimetre
DC	-	Direct Current
DFIG	-	Doubly-fed Induction Generator
GWh/yr	-	Gigawatt hour per year
HAWT	-	Horizontal Axis Wind Turbine
IEEE	-	Institute of Electrical and Electronics Engineers
IPC	-	Individual Pitch Control
km/h	-	Kilometer per hour
J kg ⁻¹	-	Joule per kilogram
kW	-	Kilowatt
mm	-	Milimetre
MPH	-	Miles per hour
m/s	-	Meter per second

MW	-	megawatt
OSIG	-	OptiSlip Induction Generator
PMSG	-	Permanent Magnet Synchronous Generator
PV	-	Photovoltaic
RPM	-	Revolutions per minute
SCIG	-	Squirrel Cage Induction Generator
STL	-	STereoLithography)
SUV	-	Sport Utility Vehicle
TKE	-	Turbulent Kinetic Energy
TSR	-	Tip Speed Ratio
VAWT	-	Vertical Axis Wind Turbine
WRIG	-	Wound Rotor Induction Generator
WRSG	-	Wound Rotor Synchronous Generator
2D	-	2-dimensional
3D	-	3-dimensional
£	-	British Pound
<	-	Less than
>	-	More than

CHAPTER 1

INTRODUCTION

1.0 Introduction

A wind turbine is also known as a windmill or wind machine. The wind turbine can be defined as the machine that uses to convert wind power to electrical power. According to (Farriz et al. 2010), the requirement of electricity from consumer for the past 100 years was depend only on fossil fuel. However, the combustion of fossil fuels will caused pollution to our green environment. The renewable energy like solar energy, wind power, geothermal and hydropower are the liberator that can replace consumption of fossil fuels to natural energy. Wind energy is one of the renewable sources in the world that free of pollution. The wind energy has the potential as an useful renewable energy in Malaysia to generate power supply. Location for wind turbine operation that can harvest the wind energy is almost at everywhere including onshore, offshore, and highways.

Generally, there are two types of wind turbine includes vertical axis and horizontal axis. Based on (Bruce Champagnie et al. 2013), horizontal axis wind turbine is capable to capture the wind in a fixed direction only; whereas for the vertical axis wind turbine are able to receive wind from any direction. The vertical axis wind turbine can be divided into 3 types of rotor. They consist of Savonius, H-Darrieus, and Helical designs. On the other hand, horizontal axis wind turbine is not suitable in this project because of less efficient to capture wind energy from the vehicle vortex on highway. The

aspect for the development of wind turbines on highway consists of a shape of blade, material of the blade and the height of the tower will be further explained in chapter 2.

In this project, SolidWorks software was used to design the model of wind turbine that suitable build on the highway.

1.1 Project Background

This project is about the study of energy harvesting through a wind turbine on the road from the literature review. The energy harvesting from a wind turbine is focusing on the vehicle vortex on highways for power generation. Since, the highway is the best place that provided continuous wind energy from vehicle vortex. Other than that, the modeling of the most suitable design of wind turbine that can be placed on the highway is by using SolidWorks software. This project will use the 3D printing for wind turbine fabrication. After that, the potential of the wind turbine design will be analyzed from different speed and output developed.

1.2 Problem Statement

Renewable energy is a non- run out source and it is energy produced from natural resources. The renewable energy resources consist of solar, wind, biomass, geothermal and hydroelectric energy. Thus, all of this energy can protect the environment from damage and avoid the atmospheric emission via non-renewable energy. Wind energy is one of the fastest and cheapest renewable energy. In the opposite way, wind energy is not available in every place. The building of wind farm required many steps before installed. Understand the wind resource is the most important aspect to consider because required 11-13mph of wind speed annually in neighborhood (S.M.Ali, A.S.Mahdi 2012). Other than that, the access to land is a big issue that will expect to repay for all development of wind energy on their land.

Wind energy sources can be located to both onshore and offshore. The offshore wind power is one of the most expensive energy technologies. Although offshore wind energy is one of the source of clean energy but it needs very high investment which is more expensive than fossil fuel generators. According to (Thomson & Gareth P Harrison 2015), the typical capital costs for onshore wind energy source at around £1350/kW while around £3000/kW for offshore. Hence, offshore wind energy bear higher risk compared to onshore wind energy.

The wind turbine is another issue to be considered. Horizontal axis and vertical axis wind turbine provide different efficiency. Horizontal axis wind turbine is more suitable to areas that have wind in basically one direction only (Elzarka et al. 2014). In contrast, vertical axis wind turbine has the flexibility of the design which is more efficient at inconsistent wind flow areas. As a result, the study of potential on wind turbine generation by vehicles vortex on highway has carried out to minimize the problem as stated.

1.3 Objectives

There have some objectives that need to be accomplished in this study. The objectives are stated as below:

- i. To study on approach of energy harvesting via wind turbine on the road.
- ii. To design the model of wind turbine for highway micro generation.
- iii. To analysis the potential wind turbine design for different speed and output developed.

1.4 Working Scope

In order to achieve the stated objectives, several work scopes had been identified. The work scopes are listed as below:

- i. The modeling of wind turbine design that suitable on highway by using SolidWorks software.
- ii. Fabrication of variable types of wind turbine model by using a 3D printer.
- iii. Do an experimental setup for variable type of wind turbine in order to get the characteristic result wind turbine power generation.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will focus on types of wind turbine, aspects of design for wind turbine and generators. The wind turbine is used to generate power from wind renewable energy where the working principle is opposite of electrical fan. Blades and tower of wind turbine are taking an important role in generating power supply. The generator is the main element in converting the mechanical energy into electrical power.

2.1 Renewable Energy

The energy that is collected from resources which are naturally recharged on a human timescale is known as renewable energy. Some of the examples like wind, sunlight, rain, waves, tides, and geothermal heat. The renewable energy is in-exhausted resources which are also called as green sources that can replace consumption of fossil fuel. Other than that, renewable energy is not only for our future, but it is something we can use it in everyday life. Globally, there has some renewable energy that is in use today. The type of renewable energy consists of hydropower, biomass, geothermal, solar, wind and so on.