



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**A STUDY OF HARVESTING POTENTIAL WIND ENERGY  
BASED ON TURBULENCE EFFECT ON THE SIDE OF THE  
MPV (MULTI-PURPOSE VEHICLE) USING CFD SIMULATION**

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours

by

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**BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA**

**TAJUK: A study of harvesting potential wind energy based on turbulence effect on the side of the MPV (Multi-Purpose Vehicle) using CFD simulation**

**SESI PENGAJIAN: 2014/15 Semester 2**

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

.....

(Project Supervisor)

## **ABSTRACT**

Energy resources in our modern world are fast depleting. More energy consumption is required for daily uses. As fossil energy are quickly drained every day without concern from user, a preferable energy that should be cheap and originate from an unending or infinite sources will come in mind. Hence, a renewable energy is much required at the moment. Thus researching a renewable energy which could be harvested is essential. The purpose of this study is to produce the MVP model of Proton Exora in 3D CAD to simulate an airflow of a model and to calculate the potential of wind energy generated by a certain speed. To complement this approach, the MVP model of Proton Exora were produce. The model were then imported to Hypermesh for meshing process. The meshing model were then imported into Virtual Wind Tunnel for analysis section. Analyses were done by simulating the model into three different velocities i.e. 80 km/h, 100 km/h and 120 km/h. Simulation computed the velocity field of flow around the model. The wind speed dispersed based on the velocity evaluation location were then used to calculate the potential energy harvested which is wind power. It proves that the increment of vehicle speed increase affect the wind speed generated and the potential energy can be calculated.

## ABSTRAK

Sumber tenaga dalam dunia moden kita adalah semakin berkurangan dengan pantas. Penggunaan tenaga yang lebih amat diperlukan untuk kegunaan harian. Dengan tenaga fosil yang semakin berkurangan setiap hari tanpa disedari oleh pengguna, tenaga yang murah dan berasal dari sumber yang tidak berkesudahan atau tidak terbatas akan bermain dalam fikiran. Oleh itu, tenaga yang boleh diperbaharui adalah lebih diperlukan pada masa ini. Dengan itu penyelidikan tenaga boleh diperbaharui yang boleh dituai adalah penting. Tujuan kajian ini adalah untuk menghasilkan model MVP Proton Exora dalam bentuk CAD tiga dimensi untuk disimulasikan aliran udara model tersebut dan untuk mengira potensi tenaga angin yang dihasilkan oleh kelajuan tertentu. Untuk melengkapkan pendekatan ini, model MPV Proton Exora telah dihasilkan. Model tersebut seterusnya di import masuk ke dalam perisian *Hypermesh* untuk tujuan proses *meshing*. Seterusnya hasil dari *meshing* akan dimport masuk kedalam perisian *Virtual Wind Tunnel* untuk sesi analisis angin. Hasil yang diperolehi daripada simulasi tersebut digunakan untuk mengira potensi tenaga angin yang dituai. Dapat disimpulkan bahawa penjaan kuasa angin adalah boleh dilakukan dengan data yang dikumpul dalam simulasi CFD. Analisis yang dilakukan oleh simulasi model dengan tiga kelajuan berbeza iaitu 80 km/j, 100 km/j dan 120 km/j. Simulasi pengiraan medan aliran halaju sekitar model. Kelajuan angin tersebar berasaskan penilaian lokasi halaju kemudiannya digunakan untuk mengira tenaga keupayaan dituai itulah kuasa angin. Ia membuktikan bahawa kenaikan kelajuan kenderaan mempengaruhi kelajuan angin yang dihasilkan dan potensi tenaga boleh dikira.

## **DEDICATIONS**

This thesis dedicate to my parents, supervisor and my friends for supporting me all the way.



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# TABLE OF CONTENTS

DECLARATION .....	v
APPROVAL.....	vi
ABSTRACT.....	vii
ABSTRAK .....	viii
DEDICATIONS.....	ix
ACKNOWLEDGMENTS .....	x
TABLE OF CONTENTS.....	xi
LIST OF FIGURES .....	xv
LIST OF TABLE .....	xvi
LIST OF SYMBOLS AND ABBREVIATIONS .....	xvii
CHAPTER 1 .....	1
1.0 Background of study .....	1
1.1 Problem Statement .....	2
1.2 Objectives.....	3
1.3 Scope of Study.....	3
CHAPTER 2 .....	4
2.0 Energy Harvesting.....	4
2.0.1 Non-Renewable Energy Sources .....	5
2.0.2 Renewable Energy Sources.....	5
2.1 Renewable Energy Sources .....	6

2.1.1	Biomass Energy .....	6
2.1.2	Hydro .....	7
2.1.3	Renewable Energy Sources.....	8
2.1.4	Geothermal.....	9
2.1.5	Wind.....	10
2.2	Wind Energy Resources in Malaysia .....	11
2.3	Wind .....	13
2.3.1	Wind Turbine .....	13
2.3.2	Wind Mill.....	15
2.3.3	Access Wind.....	16
2.4	Passenger Car .....	18
2.5	Commercial Vehicle.....	20
2.6	AUTOCAD .....	20
2.7	SOLIDWORK .....	20
2.8	CATIA.....	21
2.9	Altair Hyperwork v13.0 .....	21
2.10	Hyperwork Virtual Wind Tunnel (VWT) Computational Fluid Dynamics .....	22
CHAPTER 3 .....		23
3.0	Introduction .....	23
3.1	Starting the project .....	25
3.2	Development of Vision System.....	25
3.3	Literature Review .....	25
3.4	Problem Definition.....	26

3.5	Study about the CATIA and Hyperwork v13.0.....	26
3.6	3D Modelling (CATIA).....	26
3.7	Flow Analysis Using Hyperwork v13.0 software .....	28
3.8	Determining the estimated distance of the wind speed evaluation for a vehicle from the highway divider .....	31
3.9	Getting analysis result based on specified parameter (based on CFD result) .....	34
3.10	Calculate potential wind energy (based on CFD result).....	35
3.11	Compilation .....	36
CHAPTER 4 .....		37
4.0	Introduction .....	37
4.1	Highway Analysis .....	37
4.2	Relationship between Table and Graph.....	39
4.3	Plotted Graph.....	41
4.4	Analytical method for amount of wind energy generated.....	44
CHAPTER 5 .....		47
5.0	Conclusion.....	47
5.1	Recommendation.....	48
REFERENCES.....		49
APPENDIX A .....		55
APPENDIX B .....		56
APPENDIX C .....		57
APPENDIX D .....		58
APPENDIX E .....		59



## LIST OF FIGURES

Figure 2.1: Sources of Biomass .....	7
Figure 2.2: Solar Panel of SunPower Corporation in Richmond, California.....	9
Figure 2.3: Frequency percentage verses wind speed at PJ weather station (year 2007) .....	12
Figure 2.4: Cycloturbines Vertical Axis Wind Turbine (VAWT).....	14
Figure 2.5: Horizontal Axis Wind Turbine (HAWT) (Anon., 2006).....	14
Figure 2.6: All the wind turbine type (Nalathambi, 2014).....	15
Figure 2.7: A computer simulation of highway wind turbine, India (Bruce Champagnie, 2013) .....	17
Figure 2.8: A Jersey Barriers at Rao Tula Marg, New Delhi (Ngupta, 2012) .....	17
Figure 2.9: A MPV (Proton Exora).....	18
Figure 2.10: Summary of the registered commercial vehicle in Malaysia for the year 1980 to YTD March 2014 (Association, 2008) .....	18
Figure 2.11: Statistic of vehicle on each states in Malaysia (PROTO, 2012).....	19
Figure 2.12: Hyperworks result for flow simulation (SAE, 2012) .....	22
Figure 3.1: Reseach Flow Chart .....	24
Figure 3.2: A MPV model (Proton Exora) drawn using CATIA.....	27
Figure 3.3: A dimension specifications (in mm) of MPV (Proton Exora).....	27
Figure 3.4: Meshing of the model.....	29
Figure 3.5: Virtual Wind Tunnel.....	31
Figure 3.6: Dual carriage roadway highway dimension .....	32
Figure 3.7: The location of wind velocity evaluation .....	34
Figure 3.8: Hyperwork simulation result .....	35
Figure 4.1: The air flow path along the symmetry plane for a moving MPV on the highway road at the speed of 33 m/s.....	38
Figure 4.2: The contour of air flow path along the symmetry plane for a moving MPV on the highway road at the speed of 33 m/s .....	38
Figure 4.3: The vector graphics of air flow path along the symmetry plane for a moving MPV on the highway road at the speed of 33 m/s .....	39
Figure 4.4: Show the graph of velocity distribution from vehicle (MPV) over distance at the speed 33 m/s.....	42
Figure 4.5: Show the graph of velocity distribution from vehicle (MPV) over distance at the speed 28 m/s .....	42
Figure 4.6: Show the graph of velocity distribution from vehicle (MPV) over distance at the speed 22 m/s .....	43

## LIST OF TABLE

Table 3.1: The width of a lane for Malaysian roadways (open road) (Albani, 2013)	32
Table 3.2: The design speed for roads at rural places (open road) (Albani, 2013)....	33
Table 4.1: Show the velocity distribution from the vehicle (MPV) over distance at the speed of 33m/s.....	40
Table 4.2: Show the velocity distribution from the vehicle (MPV) over distance at the speed of 28 m/s.....	40
Table 4.3: Show the velocity distribution from the vehicle (MPV) over distance at the speed of 22 m/s.....	40
Table 4.4: Corresponding estimated location velocity evaluation based on safety allowance.....	43
Table 4.5: Result of power of wind (open road highway) .....	45

## LIST OF SYMBOLS AND ABBREVIATIONS

SBM	=	Shape-Based Matching
MPV	=	Multiple Purpose Vehicle
CFD	=	Computational Fluid Dynamic
CAD	=	Computer Aided Design
3D	=	Three Dimensional
CATIA	=	Computer Aided Three-dimensional Interactive Application
CAE	=	Computer Aided Engineering
FEA	=	Finite Element Analysis
LDRs	=	Coordinate Measuring Machine
P	=	Initial Graphics Exchange Specification
p	=	Stereo Lithography
A	=	Maximum Material Condition
V	=	Velocity
PJ	=	Petaling Jaya
VAWT	=	Vertical Axis Wind Turbine
HAWT	=	Horizontal Axis Wind Turbine
YTD	=	Year To Date
RTD	=	Road Transport Department
FTK	=	Fakulti Teknologi Kejuruteraan
MM	=	Milimeter
Km/h	=	Kilometer per hour
m/s	=	Meter per second



VWT	=	Virtual Wind Tunnel
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# CHAPTER 1

## INTRODUCTION

### 1.0 Background of study

In this modern age, more energy consumption is required for daily uses. As fossil energy are quickly drained every day without concern from user, a preferable energy that should be cheap and originate from an unending or infinite sources will come in mind. With increasing in environment concern, and the limit to fossil fuel sources, wind power have been the main awareness as a renewable energy sources which is more convenient and friendly energy.

As a fossil fuel will decayed one day, this wind energy conservation may be the leading energy contribution in the future. Renewable energy from wind is safe and does not lead to any harm either to human or environmental pollution. Energy harvested from wind power could produce a kinetic energy such as electrical and mechanical energy.

In Malaysia, the wind power is not as strong as the other country as Malaysia had been categorized in a region where the wind sources are minimal which a wind sources naturally does come followed by a season. Thus, one way to get enough wind power is from a highway by taking advantages from a moving vehicle. One idea is exploiting the energy from induced wind produce by highway vehicle motion (Abas Abd Wahab, 2000). By utilizing the moving vehicle, the wind produce can be collected to rotate a suitable wind turbine that can be installed along the highway divider. Thus, one of a promising vehicle which is MPV is a top priority for this research. The idea of using MPV to generate potential energy is interesting. Generating a potential energy by harnessing wind energy produces from a moving vehicle is an excellent idea by manipulating its wide front surface area and through to its side as the impact will create a turbulence flow of wind. This method of power production is a one way into proceeding into a new era of a new important energy sources as it is infinite. As the turbine is expensive, Computational Fluid Dynamic

(CFD) software become a replacement to investigate the wind speed produce by a trailer truck.

## 1.1 Problem Statement

Generally wind in the highway road are very strong because of the vehicle that moving along the road. The speed of the wind is higher due to the high speed of the vehicle. The wind produce naturally turbulence that gives rapid or random changes in the direction of the wind because of the surface areas that resistance to wind and through to the side of the vehicles that make an unpredictable flow of wind which is wind turbulence. This unused energy are yet to be taken advantage. As the fossil fuel sources are depleting, this is the new way to take advantages of access wind from a moving vehicles.

Energy can be enhanced from the wind of a moving vehicle. The amount of energy which can be harvested from the moving vehicle are based on the wind speed produced. In other word, the faster the vehicle moving, the stronger the wind speed produced, the wind power produced will be greater. That mean the speed of wind will generate a large amount of wind pressure. Even a small amount of wind speed can have a big impact on the amount of energy which a wind turbine can generate. For example, Malaysia highway always crowded with vehicles moving along the road. Even a motorcycle rider will feel the wind impact from a moving vehicle if they overtake side by side. This show that the wind impact is strong enough which is released from a moving vehicles. Therefore, it is a challenge for us to take advantage of that clean and renewable energy.

Therefore, in order to harvest potential wind energy produce, CFD simulation have been a great software in which the wind speed data that generated from the vehicle can be collected. It will helps to determine wind speed without the need to purchase a set of wind turbine as it is expensive. Previous study stated that the airflow can be achieved using CFD software and help in determining the airflow around a moving vehicles (Nalathambi, 2014). Thus the appropriate data concerning air flow analysis on moving vehicle will be obtained from this study and can be used for further study (Nalathambi, 2014).

## **1.2 Objectives**

The aim of this research is to study of harvesting potential wind energy based on turbulence effect on the side of the MPV using CFD simulation. Therefore this research objective is as below;

- 1) To produce a 3D CAD model of a MPV (Proton Exora).
- 2) To simulate an airflow on MPV (Proton Exora) model based on certain speed.
- 3) To analyze the potential wind energy produced.

## **1.3 Scope of Study**

There are 3 scopes being studied in this research in order to achieve the objective. There are as follows;

- 1) Development of 3D CAD model of a Proton Exora using CATIA software.
- 2) Simulating an airflow around Proton Exora using Hyperworks CFD software based on speed 80 km/h, 100 km/h, and 120 km/h.
- 3) Analyzing the potential wind energy harvested produced by the wind velocity of a moving vehicle.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.0 Energy Harvesting**

Access to energy is a tactical importance around the world. According to (Bekaye, 2012) about 1.6 billion people still dependent on ‘traditional biomass’ and coal as their main source of energy consumption because of the lack or unavailability access to modern energy. As the fossil fuel are depleting every second, lack of access to a new, clean, cheap and reliable energy become a major problem into achieving the Millennium Development Goals (Nations, 2015).

The importance of sustainable energy development, (Nations, 2012) state that 2012 is an International Year of Sustainable Energy by following the three objective that have been established for 2030 which is:

- Universal access to modern energy services
- A 40% reduction in world energy intensity
- A 30% increase in use of renewable energy in the world

By achieving this three objective, a world with a clean, affordable and access to free and safe energy will be top in our understanding into energy harvesting. This is a crucial part as seen in the world now that has been flooded with billions of people that will make sure the need of energy is exploded. As the non-renewable energy is in a critical state of depleting, renewable energy has become the major energy sources for the world.

### **2.0.1 Non-Renewable Energy Sources**

Non-renewable energy sources also known as the energy that cannot be produce or finite resources are natural resources that have been formed over millions year ago in the earth for example earth minerals and metal ores, nuclear fuels and fossil fuels. This resources are called as non-renewable because as they are being used faster, they are created slower. That means it will depleted before it can be formed again.

According to the scientists, the major contributor to the climate changes over recent years are caused by the use of non-renewable energy sources as it produce greenhouse gas emission. Greenhouse gases are known as gases that trap heat in the atmosphere which can caused earth temperature to be imbalance. So as we know, when the earth temperature in a state of imbalance, global warming will take place, and it will melts the glacier in Antarctica and this means a great disaster will put earth in a critical condition.

So we ought to know that it effect are already been investigated by a scientists. Thus we can lessen our dependence on non-renewable energy sources by changing into harnessing energy more from renewable energy sources.

### **2.0.2 Renewable Energy Sources**

Renewable energy is the term used to describe energy that comes from infinite sources which is can be use countless of time without worrying that the resources will be depleted. Also known as renewing and virtually limitless. Among these sources are biomass, hydro, solar, geothermal and wind.

During the course of history, the sources have been practically fully harnessed and use to produce energy either kinetic energy, potential energy and so on. By harnessing this clean and friendly energy, it will help to improve the quality of the earth environment thus beneficial to human, animal and flora and fauna.

Today technological advancement show that more efficient way of harnessing renewable energy sources have been developed. This shows that the using of renewable energy are gaining more popularity as it safe to use and more friendly energy compared to non-renewable energy. In contrast, renewable energy offer us alternative which is far more good than non-renewable energy as the disadvantages of using non-renewable is larger as we can see. Thus taking a step ahead of harnessing this renewable energy will changed the course of energy needed all around the world.

## **2.1 Renewable Energy Sources**

### **2.1.1 Biomass Energy**

Biomass is the term used for all organic matter on earth and that including plants and animals. Waste from this organic matter can be used as a source of renewable energy which is divided into two:

- Biofuel (ethanol) and biogas (methane) can be produce from human sewage.
- Wood can be burned and used to generate hear and electricity.



Figure 2.1: Sources of Biomass

Biogas and biofuel are created from biomass. This two type of energy contain ethanol which is from biogas and methane is from biofuel. Methane are produce from organic material such as animals, plants and food when they decomposed. Methane can be capture on landfill and can be used to generate electricity (Development, 2014). The benefit from capturing methane is it can help reduce carbon dioxide which is one factor of climate change.

As for biofuel, ethanol can be capture from wood. This ethanol can be combined with petrol car and used as a fuel for car engines. When ethanol and petrol combined, it form a new type of fuel which is called biodiesel. Biodiesel can be used as fuel for diesel engines. So by using biodiesel as a fuel to power combustion engines, it help reduces the amount of greenhouse gas produced because biodiesel made from a plant that help absorb the carbon dioxide release.

Using biomass to generate electricity can greatly reduce our reliance on power station that use non-renewable energy sources and discharge large volumes of greenhouse gasses into the atmosphere. In contrast, biomass is still in development as not all of the vehicle or machine can be fueled by biomass.

### 2.1.2 Hydro