UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FINAL YEAR PROJECT

BEKU 4792

TITLE : SMALL WIND ENERGY CONVERTER(SWEC)

NAME	CHE WAN MUHAMMAD RIDHUAN B CHE WAN RAZALEY
IC NO.	910823115371
MATRIX NO.	B011010133
COURSE	BACHELOR OF ELECTRICAL ENGINEERING (INDUSTRIAL POWER) - BEKP
SUPERVISOR NAME	MR. WAN MOHD BUKHARI B WAN DAUD

SMALL WIND ENERGY CONVERTER

CHE WAN MUHAMMAD RIDHUAN BIN CHE WAN RAZALEY

A project report submitted in partial fulfillment of the requirement for the award of Bachelor Of Electrical Engineering(Industrial Power)

Faculty of Electrical Engineering

Universiti Teknikal Malaysia Melaka

June 2014

I declare that the project report entitled "Small Wind Energy Converter" is the results from my own research except as cited in the references.

Signature : ....

Name : Che Wan Muhammad Ridhuan B Che Wan Razaley

Date : 18 June 2014

I hereby declare that I have read through this report and found that is comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)

Signature : ………..……………………………..

Name : WAN MOHD BUKHARI B WAN DAUD

Date : 18 June 2014

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

ACKNOWLEDGEMENT

In the name of Allah, the Most Beneficent and The Most Merciful. It is a deepest sense gratitude of the Almighty that give me strengh and ability to complete this Final Year Project report.

A special gratitude i give to my final year project supervisor , Mr. Wan Mohd Bukhari B Wan Daud , whose give me a valuable guidance and support and helped me to coordinate my project especially in writing this report.

A special thanks goes to my family for their moral support to me in the process to complete this project. Besides that, i would also like to acknowledge with much appreciation to all my friends who help me in order to complete my Final Year Project.

Futhermore i would also like to express my gratitude to staff of Univesiti Teknikal Malaysia Melaka (UTeM) , who gave me the permission to use all required equipment and necessary materials in laboratory to complete my Final Year Project.

ABSTRACT

Wind power capacity has experienced tremendous growth in the past decade, thanks to wind power's environmental benefits, technological advance, and government incentives. Small wind energy which being used as a source to produce electric energy become significant nowadays. This study presents the recent developments in small wind energy conversion systems, and their social and environmental benefits. This report also provides a review of the interconnection issues of distributed resources including wind power with electric power systems. The overall studies are about the prototype of small wind converter energy. This prototype has been design with the direct current(DC) motor as a wind turbine that will produce a electricity using the concept of direct current(DC concept). The output used in this prototype are some load and a liquid crystal display(LCD). The purpose of using the LCD is to show the voltage level in the power storage and to record the increasing of the voltage level when the turbine is twisting. Futhermore, there is a support circuit design using arduino uno board, interfaced with a Grapical Unit Interface(GUI) in a computer to control a DC motor in the case of no primary source. The recorded results shows that the efficiency for the support system is between 91 percent to 94 percent. The results of this efficiency is refer to the measrement thats has gain from the results of the support systems thats has been build in this protype .

ABSTRAK

Kapasiti kuasa angin telah mengalami pertumbuhan yang besar dalam satu dekad yang lalu, terima kasih kepada faedah kuasa alam sekitar iaitu angin, kemajuan teknologi dan insentif kerajaan. Penggunaan tenaga angin kecil sebagai sumber untuk menghasilkan tenaga elektrik menjadi penting pada masa kini. Kajian ini membentangkan perkembangan terkini dalam sistem penukaran tenaga angin kecil, faedah dari aspek sosial dan kepada alam sekitar. Laporan ini juga menunjukkan kajian semula tentang isu-isu sambungan sumber diedarkan termasuklah sumber angin dan sumber elektrik. Kesuluruhan laporan ini membentangkan tentang prototaip penukaran tenaga angin kecil. Reka bentuk prototaip ini direkabentuk menggunakan motor arus terus sebagai turbin angin yang akan menghasilkan tenaga elektrik dengan menggunakan konsep motor arus terus. Keluaran yang digunakan dalam prototaip ini adalah beban dan paparan LCD (liquid crsytal display). Tujuan penggunaan LCD sebagai keluaran adalah untuk menunjukkan tahap voltan di dalam penyimpanan kuasa dan untuk merekodkan kenaikan tahap voltan apabila turbin berpusing. Tambahan lagi, litar sokongan direka dengan menggunakan papan arduino uno R3 yang akan berkomunikasi dengan graphical unit interface(GUI) di dalam komputer untuk mengawal motor arus terus jika tiada sumber utama iaitu angin. Keputusan yang direkodkan menunjukkan bahawa kecekapan sistem sokongan ialah antara 91 peratus dan 94 peratus. Data kecekapan yang direkodkan adalah berdasarkan data yang diperolehi daripada pengukuran yang telah dilakukan dalam sistem sokongan yang telah dibina untuk prototaip projek ini.

CHAPTER 1

INTRODUCTION

1.1 Project Background

Wind power is generated by moving air. As the sun heats the land, the air above also warms and rises. Cold air then replaces the rising air. This creates the winds that we feel most days of the year. The diagram below shows how this 'system' works. Air tends to warm at a faster rate over land because the land retains its heat. Over the sea the air warms more slowly as heated by the sun and slowly cooled by the cold water. If you visit the seaside or coastal area you will probably find that the weather is more breezy or windy than inland. This is because the warm air rises over the land and cold air over the sea replaces it.

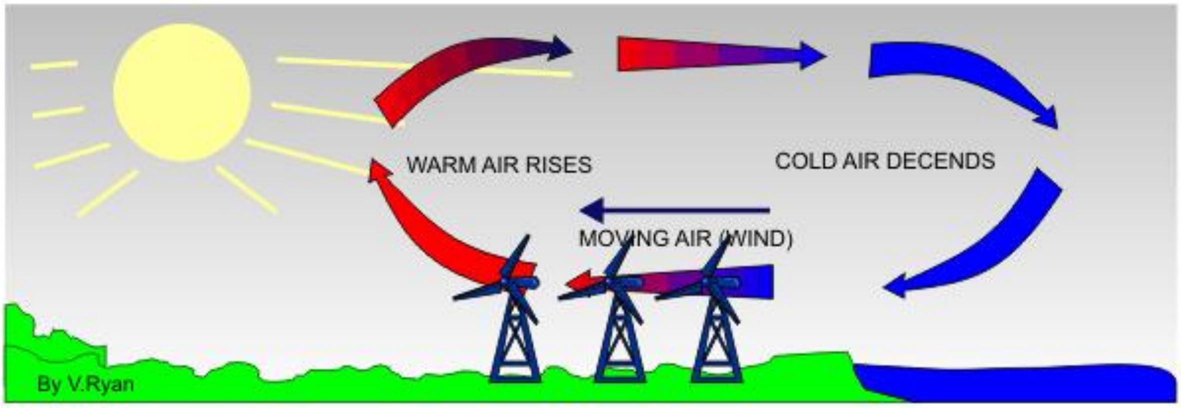

Figure 1 : Wind Turbine Concept

In east coasts of Malaysia, there have been a big potential to build wind power station. Since that there have enough wind moving for wind turbine. The wind turbine can be build at sea because dont't have enough space on land. Nowadays, lots of researchers try to find any alternative energy which is safe, friendly, renewal and useful in our daily life. Wind is one of the solutions which if we use it wisely the wind will be our alternative energy support for our life. Large wind turbine technology is already one of the larger future energy supplies and small wind turbines have a big potential. What is needed for a common use of wind are turbines that meet a specification that is flexible enough for general application and be possible to mount almost everywhere and plug-in to the grid. Wind turbines on the market are often larger, mounted on high towers and need plenty of space around them for safety and efficiency. The only way is therefore to specify flexible wind turbines which need a small space, cheap, low risk to install and high efficiency.

1.2 Problem Statement

Due to the wind is one of the renewable energy that have a high potiential to be developed as a source of electrical energy. In addition, wind energy can reduce greenhouse effect when its compared with other sources of electricity such as hydro, coal, gas plant or other renewable energy that can be use to generate an electrical energy. This project about the development a small wind energy converter consists of DC motor as a wind turbine, lcd display(to measure a voltage in the power storage) and the arduino uno board that located in a support curcuit. This project has been devolep because the wind energy has a high potential and the small wind energy require a the detail development because it has high potential to be developed in our country.

1.3 Objective

The objective of this project is to build a small wind turbine which produce a rated power(1 Watt – 5 Watt) and to built a support systems using arduino controller for emergency situation (if there is zero wind).

1.4 Project Scopes

In this study, the development of a small scale wind turbine involved several scopes of work. The detail of the scopes was stated in the Table 1 .

Table 1 : Scopes of work

SPECIFICATION	RESULT
Power produce	Rated power(1 Watt – 5 Watt)
Voltage produce	Rated voltage
Support system efficiency	>91%
Total Grid currentTHD	<5%
Type of current produce	Direct current (DC)
Application	Small appliances
Support circuit component	Arduino uno board, breadboard computer(host).

1.5 Significant Of The Study

The overall study is about how to build the small wind energy converter with the support circuit that will make sure there are always has a supply from the turbine to the power storage. In this study the battery is used in the prototype small wind energy converter as a power storage. The support system was build using the arduino board and the computer as a host to control the input level to the turbine. In case there are no primary source to rotate the turbine, the input level speed for turbine will be control by the webserver that located in the computer and then the speed will be sent to the arduino board. Then , the arduino board will control the speed of turbine in order to generate electricity at the output terminal. Althought the support system use a small power to run the circuit system but the support system will provide a huge power to the turbine and it will produce a large power at the power storageThis systems has a high efficiency. The small wind energy converter has a high potiential in the renewable energy field. The small wind energy converter has many benefit compare to the the huge wind converter. It’s more relative small, the cost to build it up is more cheaper than huge wind converter and no need a plenty space. The continued study in small wind energy converter is very important to make sure the electricity can be generated from the safe, friendly, renewal and useful in our daily life.

1.6 Thesis Out Line

There are five chapters in this report that consists of introduction, literature review, methodology, results and discussion and lastly the conclusion. The first chapter is introduction. This chapter was explained in detail about the concept of the wind, the objective and the problem statement of the study, project scope and the significant of the study. The second chapter is literature review. The related pass research about the wind energy conversion is stated in this chapter. The related researches are come from the international research's source. That's mean the related research in this chapter are from in the country and overseas. The next chapter are completely explain about how to build the prototype of the small wind energy converter from the basic till the end.All the recorded results for this study are stated in the next chapter that is chapter 4. In this chapter, all the results for the small wind energy converter are showed. Lastly, the conclusion about this study has been conclude in the chapter 5.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Wind is one of the renewable energy that can be used to produce electricity. The using of wind as a source to generate a electric energy become more significant nowadays. There are a lot of the benefit by using a wind as a main source to produce electric. This chapter will study the recent development on small wind energy converter , their social and environment benefit and interconnection issues of distributed resources including wind power with electric power systems.

2.2 Wind Speed Prediction

A.Kusiak, et.al [1] agree that one of the important aspect in handling the wind turbine energy converter is wind speed prediction. Wind speed is an important thing that must be consider because the power produced by the wind converter is totally depend on the wind speed. Determining the power generated by wind turbine at future times is important for unit commitment planning and maintenance scheduling. Wind speed must be predicted to estimate wind power generation capacity. Prediction of wind speed at three time scale, short, medium and long term is discussed. Short-term prediction aims at estimating wind speed in the time intervals such as 10 seconds or 10 minutes. Medium-term wind speed prediction studies usually focused on hourly predictions and long-term wind speed prediction involves days. Short-term wind speed prediction is important to control of wind turbines. Medium-term wind speed prediction support units commitment planning. Long-term wind speed prediction is used in determining generation mix and scheduled maintenance of power systems. Various approaches to wind speed prediction at different time scales have been developed in the past two decades.

2.3 Power Curve Of A Single Wind Turbine

Wind speed is the most influential factor on the power generated by a wind turbine. The theoritical power [2] that can be extracted from the wind is expresses by equation (1) :

$$P=0.5\pi R^2 Cp(\lambda,\beta)V^3 \quad (1)$$

Where P is the theoritical power captured by the rotor of a wind turbine, *p* is the air density, R is the radius of the rotor (blade's length) determining its sweeping area, Cp(λ,β) is the power coefficient and V is the wind speed. The air density *p* at the turbine's hub height remains usually constant over a long-time horizon. Thus the most important operation parameters impacting the generated power area Cp(λ,β) and V. The power coefficient indicates the efficiency of a turbine capturing the wind energy and its is optimized by the control system[3].

To analyze the perfomance of wind turbines, the SCADA data collected at a wind farm has been used. Table 2 shows data set 1 with the beginning time stamp "1/1/07 12:00AM" and ending time stamp "1/31/07 11:50 PM". Data set 1was divided into two data subsets, data set 2 and data set 3. Data set 2 contains 3476 data points and was used to develop a data-driven model estimating the power curve. Data set 3 inlcudes 871 data points and was used to test perfomance of the model learned from data 2.

Table 2 : Description of the data set

Data Set	Start Time Stamp	End Time Stamp	Description
1	1/1/07 12:00 AM	1/31/07 11:50 PM	Total Data Set : 4347 Observation.
2	1/1/07 12:00 AM	1/25/07 6:20 PM	Training Data Set : 3476 Observation.
3	1/25/07 6.30 PM	1/31/06 11:50 PM	Test Data Set : 871 Observation.

A wind turbine is expected to produce a certain amount of energy given by the wind speed. In fact, all regions outsides of the logistic curve represent either power loss or power gain. The data points in region away from the logitic-curve region usually represent an anomaly leading to, for example, decrease perfomance[3].

2.4 Social And Economic Benefit Of Wind Energy Technology

Wind benefits brought by (Resources, Energy and Tourism) RET have been extensively evaluated, as well as economic costs and its contribution to energy security. However, a thorough discussion of the socio-economic impacts of these technologies is still limited. This discussion becomes even more important in periods of low economic growth [4,5]. One of the the social and economic benefits are technological innovation and industrial development distributed generation and universal access to energy regional and local development, especially in rural areas and job creation. According to Laitner et al. [6], assessments on the performance of climate and energy policies usually do not take into account the dynamics of technological innovation, and often associate reductions in energy consumption and GHG emissions with economic losses.

Frankhauser et al. [4] argue that technological innovation and the creation of new opportunities for investments and economic growth are both consequences of climate policies. Technological change and innovation, in the long term, increase the demand for labour and skills. The writer also emphasize the role of good policies aimed at motivating technological innovation. In this context, the pioneers in the development of clean technologies have the potential for regional leadership. The author also use the case of Germany, which today stands out as a leader in the export of clean technologies. RET are capital intensive, and most of the investment is concentrated in the initial phase of the project – the cost of wind turbines and other equipment can account for about 75% of the total investment of a wind farm [7]. Thus, implementation of renewable energy projects tends to offer an opportunity for developing equipment industries for domestic consumption and even for export [4,8,9].

Usually in the development country, the energy consumption per capital is usually much lower because the former are undergoing development . The inclusion of renewable energy and energy efficient technologies early in the development process accelerates the efficient use of resources, called leapfrogging, enabling development processes with lower environmental impacts [10]. The adoption of renewable energy development projects can meet the development goals without going through the intensity of fossil fuel consumption that marked the growth in developed countries [11]. The convergence between the fields of energy planning and economic development is present in various energy policies. Such convergence is known as energy-based economic development, whose main goals are to increase self-sufficiency and energy diversification, contributing to economic and industrial growth and development; to increase entrepreneurship and encourage technological innovation; and to increase the level of employment and training [12]. The presence of renewable energy projects in rural areas, especially those characterized by low economic development, can bring benefits to the community. High unemployment rates, lack of alternative economic development, and high rates of migration of economically active population, offer a worthwhile environment for investment in RET. Compared to traditional power plants, renewable energy units are often smaller, modular and decentralized and, therefore, they are often located in rural areas with low population density. Due to this feature, the construction of these plants demands high amounts of labour, and creates the potential for training and employment of rural populations in several locations [13].

Besides generating temporary jobs in construction, there are fewer but long lasting job opportunities in the operation and maintenance (O&M) of power plants. The deployment of renewable energy projects offers an alternative or complement to agricultural activities, and contributes to rural development [7]. Even though the number of jobs created in one location is not significant for the country, it might be regionally meaningful [14]. A study by Bergmann et al. [8] in Scotland showed that the rural population awareness regarding RET social benefits has increased, and is significantly higher than that from urban population. Another important aspect is land leasing by wind farms. Because wind turbines occupy only a small fraction of the area, the revenue from land renting can be invested in other productive activities in the property [7,15]. Futhermore the landowners and the workers in construction and O&M, other stakeholders benefit from renewable energy projects. During the construction stage there is an increase in demand of goods andservices, such as lodging and meals, due to the crew involved in the work. Suppliers ofgoods and services within communities can benefit from the project's installation, whichincreases total income of the community and creates temporary job opportunities.Depending on the project, other compensations such as school reforms and publicinfrastructure improvements also take place [7]. A summary of regional and local development benefits brought by investment inrenewable energy sources is illustrated in Figure 2.

Despite the potential to bring numerous benefits to the local and regional development, the incentive to renewable energy should not be considered as a development policy, but if applied in conjunction with other social policies, it can contribute to the local development of these communities [14]. Job creation is a key issue for the evaluation of economic development in a region. A concept that has been gaining ground in discussions of social and economic benefits in a low carbon economy is that of green jobs. According to UNEP [3], green jobs are those that contribute to preserving or restoring environmental quality. These jobs are located in diverse industries and include jobs in energy efficiency, clean technologies, efficient use of natural resources, and activities in low-GHG emissions. A discussion of job creation in RET, which gained momentum in the early year 2000, began due to uncertainties about the effectiveness of public policies for renewable energy and its effects on the economy, especially those based on heavy governmental subsidies. In addition to quantifying jobs and socio-economic impacts either locally or nation-wide, training and technological bottlenecks faced by the renewable energy sector also deserve attention. Studies with companies in the wind sector in the European Union have identified a lack of qualified professionals, especially for positions that require ahigher training level [16,17].

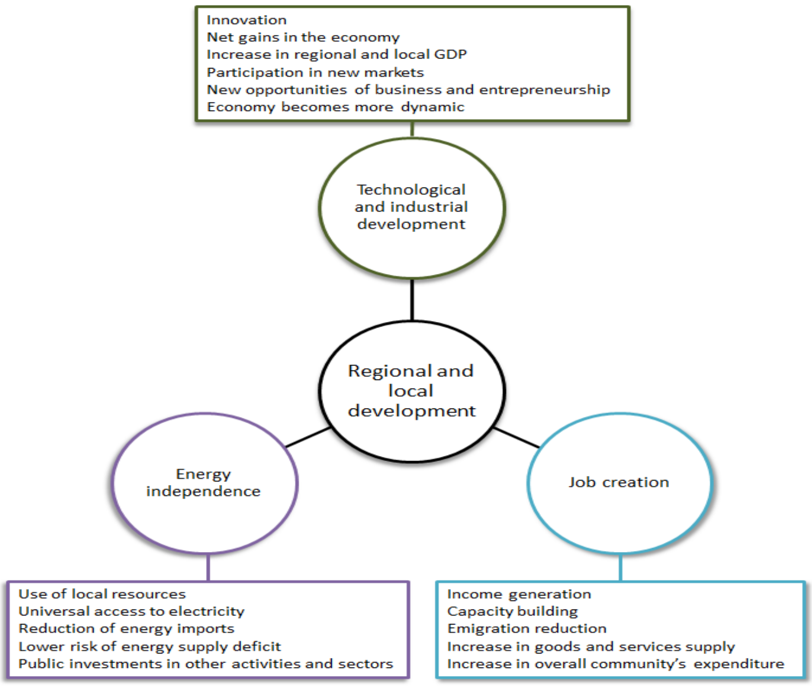

Figure 2: Regional and local aspects of RET. Own elaboration from [7,12,15,18]

Jobs generated by wind power and other RET can be grouped into three part according to their location, temporal nature, and level of expertise. The first part refers to jobs generated in technological development, and includes R&D and equipment manufacturing. The second part refers to jobs in installation and decommissioning of plants, and comprises planning, project management, transportation and power plant construction and decommissioning. The third part is operation and maintenance (O&M), and includes, besides the actual O&M of the plant, energy distribution and commercialization. The characteristics are summarized in Table 3.

Table 3 : Classification and characteristics of employment in RET [18]

Category	Volume Of Job Creation	Location	Temporal nature	Specialization level demanded
Technological devolepment	Medium	From non-local to local	Stable	Very high
Installation	High	From local to non-local	Temporary	High
Operation and maintenance	Low	Local	Stable	Medium

Employees' training is a key issue for renewable energy development [18]. At the same time, most of the local jobs generated by wind power is temporary for example during the installation of the project, policies aiming to maintain the stream of new projects each year should be considered.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, a brief discussion on methodology approach performed in the study. It will be divided into several sections to give a detail explanation about the methodology of the development of small wind energy converter.

3.2 Flow Of Project

The flow of this project is showed in Figure 3. At first, after the selection of the final year project topic done, the researchers about the small wind converter energy topic and literature review done first in order to understand more details about the overall keypoint of this study. This research focused about the wind speed prediction, power produce by using a wind converter energy and benefits of the wind energy converter to social and economics and all the research is done with refer to the latest research. Figure 3 shows in detail about the flow of the project in the Final Year Project.

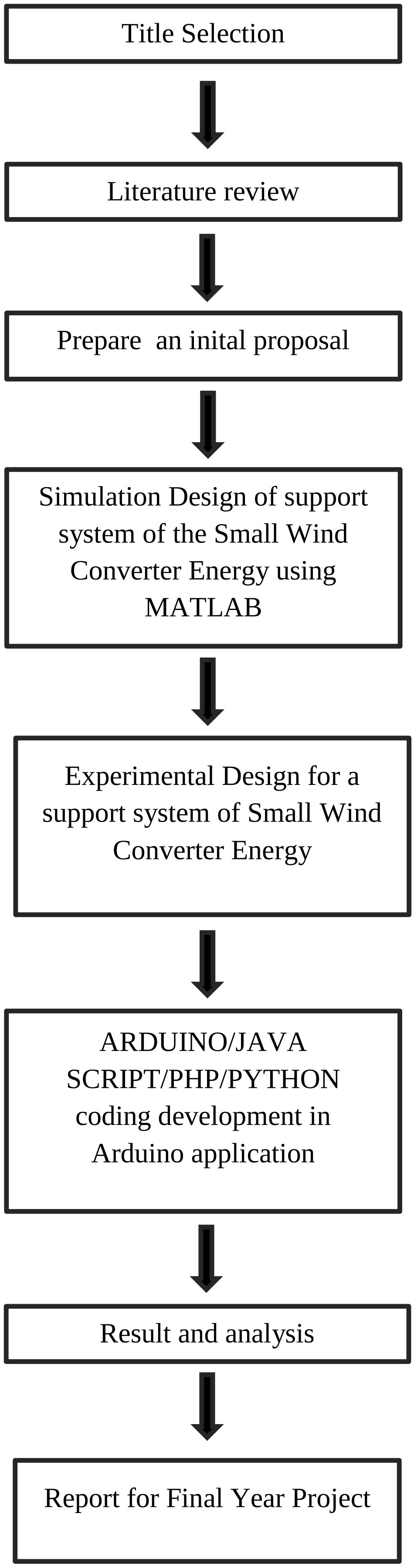

Figure 3 : Methodology flowchart