PORTABLE WIND POWER SYSTEM

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MAY 2010

" I hereby declared that this PSM report is a result of my own work, as clearly stated in the sources of reverences and sources is explained and stated . "

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Date : 12th May 2010

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ABSTRACT

Wind energy as a power source is attractive as an alternative to fossil fuels, because it is plentiful, renewable, widely distributed, clean, and produces no greenhouse gas emissions. However, converting wind energy to electrical power will meet several problems. Beside of its massive power, the properties of wind explain that it is very unstable energy and so thus the power produce. To overcome this, a smarter system needed in order for the generator to withstands the problem. This project wills attempt to implement this concept of electricity generation but in smaller scale. To get necessary wind energy, wind turbine will be implant in vehicles along with generator, electronic control system and energy storage such as battery banks. Converting wind power to electricity will involve two major processes that are generates and process. The fundamental idea of the project is to process, store and use electrical energy produce from conversion and generation of wind energy. At the end of the project, the system will be able to perform these tasks. As for the output, the power store should be able to empower Direct Current (DC) loads.

ABSTRAK

Tenaga angin sebagai sumber tenaga adalah sungguh menarik sebagai satu alternatif kepada bahan api seperti minyak, kerana sifatnya yang banyak, boleh diperbaharui, bersih dan tidak menghasilkan kesan rumah hijau. Bagaimanapun, penukaran tenaga angin kepada tenaga elektrik mempunyai beberapa masalah. Selain dari kuasanya yang besar tenaga angin sangat tidak stabil dan begitu juga kuasa yang terhasil. Untuk mengatasinya, satu system pintar diperlukan untuk menampung kuasanya. Projek ini akan cuba mengimplikasikan konsep penghasilan tenaga elektrik ini tetapi di dalam skala yang lebih kecil. Untuk mendapatkan sumber angin yang mencukupi, turbin angin akan dipasangkan di dalam kenderaan bersama-sama generator pengawal cas elekrtik dan simpanan tenaga seperti bateri. Penukaran tenaga angin kepada tenaga elektik melibatkan dua proses utama iaitu penghasilan tenaga dan pemprosesan tenaga. Teras utama projek ini adalah untuk memproses, menyimpan dan menggunakan tenaga elektrik dan dihasilkan melalui penukaran tenaga ini yang juga proses yang kedua daripada proses keseluruhan. Pada penghujung projek ini, system ini akan dapat melakukan kesemua tugasan ini. Sebagai hasilnya, tenaga elektrik yang disimpan mampu memberi kuasa kepada barangan elektrik berarus terus.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLE

CHAPTER 1:

INTRODUCTION

The law of conservative energy states that energy neither can be created nor can be destroy. In most situations, it changes its form from one type to another. There are many forms of energy (kinetic, light, heat, electrical, potential) and most of it has been used in daily life. For the past centuries, human have been working on changing energy form to satisfy human needs. As the result, many facilities invented through energy conversion. One of the examples is vehicles move through conversion of combustion energy of fuel to kinetics energy. The recent engineering and technologies are focusing on using electrical energy as power source. But the current methods of producing electrical energy have lot of disadvantages and one of it is its cost and effect on global warming.

Wind power is believed to be one of alternative ways of producing electrical energy but it has yet being explored in Malaysia. Denmark is world leader in using wind power as one of the main source to produce electricity. However in Malaysia there has not been any active research on wind power vast potential. Alternative ways suggested by the government to use nuclear power to produce electricity seem to be risky for a very cautious country to national safety like Malaysia. Wind energy as a power source is attractive as an alternative to fossil fuels, because it is plentiful, renewable, widely distributed, clean, and produces no greenhouse gas emissions.

This project wills attempt to implement this concept of electricity generation but in smaller scale. Wind turbine will be build along with generator, electronic control system and energy storage such as battery banks. As for the output, the power store should be able to empower Direct Current (DC) loads. Converting wind power to electricity will involve two major processes that are generates and process. The fundamental idea of the project is to process, store and use electrical energy produce from conversion and generation of wind energy which is the second part of the wind power.

1.1 Problem statement

Converting wind energy to electrical power will meet several problems. Beside of its massive power, the properties of wind explain that it is very unstable energy and so thus the power produce. Exceed energy can damage wind turbine and components in electrical control system. To overcome this, a smarter system needed in order for the generator to withstands. It is a system which is able to monitor wind velocity and alarms the control system if the wind exceed generator limit for further action. The selection of battery is also a vital part of the project because it has a risk to be damage if not properly secure. The battery use must be the most suitable to cope with instability of power generates. Other than that, it is necessary for the battery to have enough capacity to store power generates because its durability is important to empower frequent-use appliances in vehicle.

Charge controllers or electronic control system intended for solar panels work by monitoring the battery voltage, and once it reaches full charge, the controller simply shorts the solar panel leads together. This doesn't harm the solar panels, but it does waste whatever power they're generating. The energy ends up heating the transistors in the controller. This type of controller is not ideal for a wind generator, since shorting the output of the generator while it's spinning at high speed will generate a huge current spike, possibly destroying the controller and perhaps even the generator in the process. On the other hand, simply unhooking the generator from the batteries is not a good idea either, since with no load on it, the generator might over speed in a strong wind and destroys

itself. One of the ways to resolve this matter is to dump the power to high-wattage resistors. But it cause heat to be release and might not be suitable in vehicle.

1.2 Objectives

There are four objective of this project:

1. To convert wind energy to electricity.
2. To build charge controller to monitor the system.
3. To simulate electronic circuit to obtain expected data.
4. To build prototype and successfully use electrical energy for DC load.

1.3 Scope

The scopes of the project are:

1. Electricity generated from wind turbine flow through blocking diode to electronic control system.
2. 6V SPDT relay sends the turbine power either to the battery bank or to the dump.
3. The incoming voltage divided in half by pair of resistor. Dual operational amplifier compare voltage to decide whether to send power to be recharge or to the dump.
4. The trip points for full-charge is 7.4 V and discharge is 5.9 V
5. The battery bank consists of sealed lead-acid batteries of 4.5 Amp-hours to store power generated.

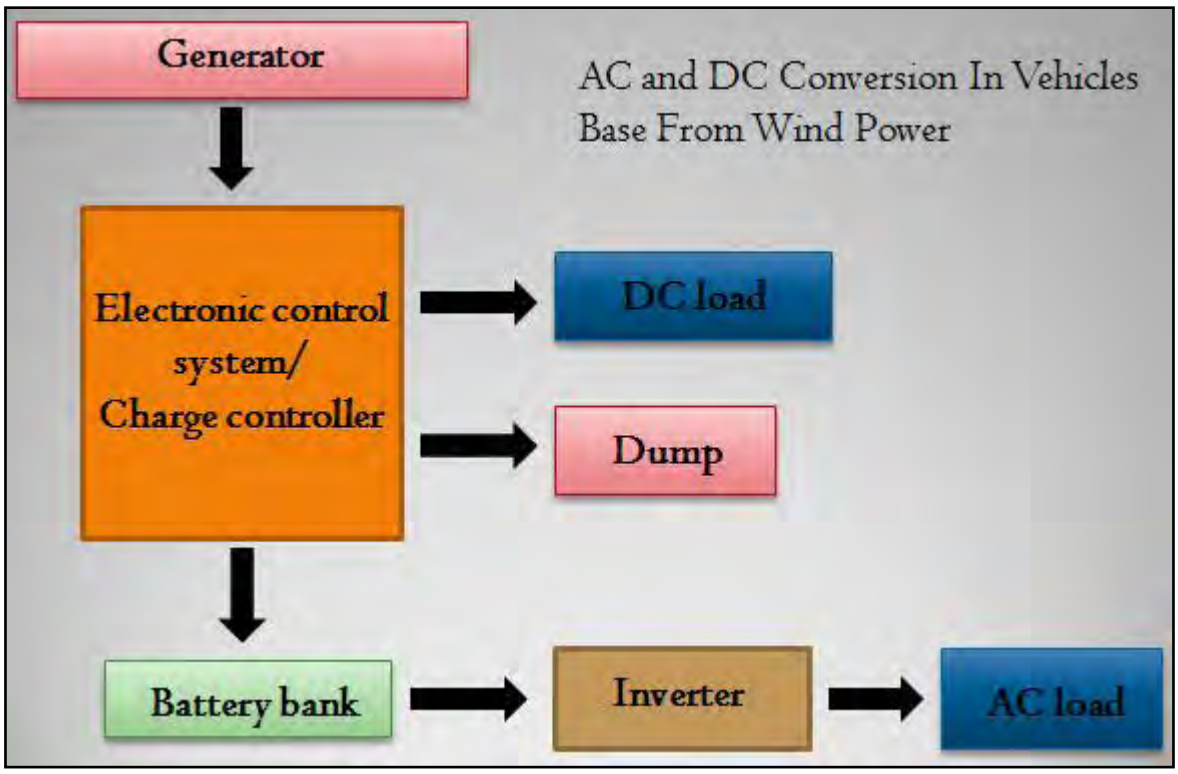

Figure 1.1: Project block diagram

1.4 Outline of thesis

This thesis consists of five chapters. The first chapter discussed about the background, scope and the objective. Chapter 2 discussed more on theory and literature reviews that have been done. It will discuss on components of the hardware and software used in this project. This project also discusses about another alternative power as a source of electricity. Methodology of hardware and software development of this project will be discussed in Chapter 3. Then in the chapter 4 will present the result and outcome about the whole of the project. Chapter 5 discussed the discussion and conclusion of this progress report.

CHAPTER 2

LITERATURE VIEW

2.1 Theory of wind

Wind is simply air in motion. It is caused by the uneven heating of the Earth's surface by the sun. Because the Earth's surface is made of very different types of land and water, it absorbs the sun's heat at different rates. During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating wind. At night, the winds are reversed because the air cools more rapidly over land than over water. In the same way, the atmospheric winds that circle the earth are created because the land near the Earth's equator is heated more by the sun than the land near the North and South Poles.

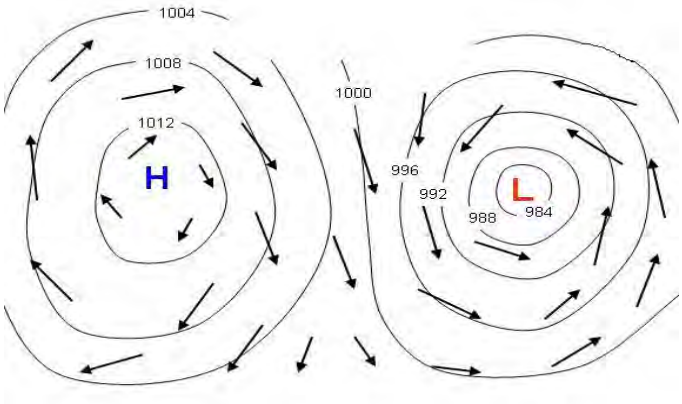

Figure 2.1: Formation of wind as a result of pressure difference

The above figure shows the formation of air movement as a result of pressure difference. To describe the process of wind formation, the blue ―H" represents high pressure and the red ―L" is lower pressure. On the figure above, pressure is indicated by drawing isolines, called isobars, at regular 4 mb(millibar) intervals. The highest pressure in the figure is 1012 mb and the lowest is 984 mb. This difference in pressure causes the air move from higher to lower pressure region. This motion can be in any direction, but in most cases the horizontal component of wind flow greatly exceeds the flow that occurs vertically. Colder region result higher air pressure and warmer region cause lower pressure. Figure 2.2 below shows formation of wind through temperature difference.

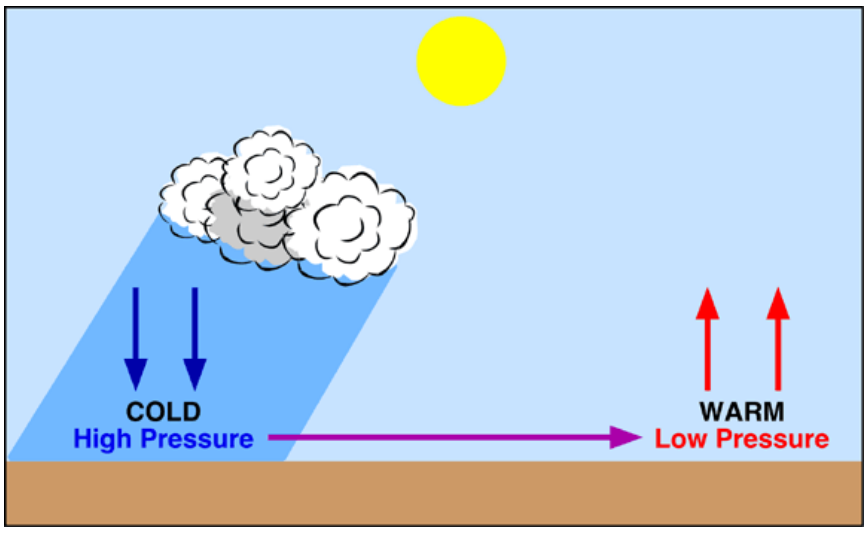

Figure 2.2: Formation of wind as a result of localized temperature differences.

A wind is named for the direction from which it blows. The upward movement of air is known as an updraft; movement downward, as a downdraft. Meanwhile, a wind blowing from southeast to northwest is a southeast wind and so on. The direction from which wind blows is called windward. The direction toward which it blows is leeward. An object is upwind from a person when it is between the person and the source of the wind. The person is downwind from the object. Wind is a renewable energy source because the wind will blow as long as the sun shines. The direction that wind takes is always influenced by the rotation of the earth.

2.2 Wind power

The terms wind energy or wind power describes the process by which the wind is used to generate mechanical power or electricity. The most common technique to convert wind power is by using a wind turbine. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity. Air is a fluid like any other except that its particles are in gas form instead of liquid. And when air moves quickly, in the form of wind, those particles are moving quickly. Motion means kinetic energy, which can be captured, just like the energy in moving water can be captured by the turbine.

The strength of wind varies, and an average value for a given location does not alone indicate the amount of energy a wind turbine could produce there. Different locations will have different wind speed distributions. The motion of wind can be in any direction, but in most cases the horizontal component of wind flow greatly exceeds the flow that occurs vertically. Since wind speed influence by the difference of temperature between two regions, wind speed tends to be at its greatest during the daytime when the greatest spatial extremes in atmospheric temperature and pressure exist.

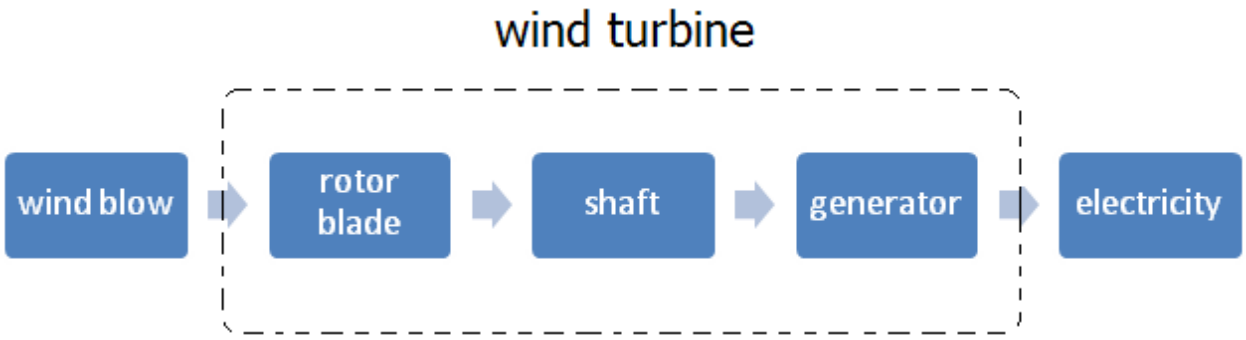

Figure 2.3: Wind power block diagram.

2.3 Wind Turbine

A wind turbine is a rotating machine which converts the kinetic energy of wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is usually called a windmill. If the mechanical energy is instead converted to electricity, the machine is called a wind generator, wind turbine, wind power unit (WPU), wind energy converter (WEC), or aero generator. Wind turbines require locations with constantly high wind speeds. With a wind resource assessment it is possible to estimate the amount of energy the wind turbine will produce.

Like old fashioned windmills, today‘s wind turbines (also called wind machines) use blades to collect the wind‘s kinetic energy. The wind flows over the blades creating lift, like the effect on airplane wings, which causes them to turn. The blades are connected to a drive shaft that turns an electric generator to produce electricity.

2.3.1 Types of Wind Turbines

Modern wind turbines fall into two basic groups: the horizontal-axis variety and the vertical-axis design, like the eggbeater-style Darrieus model, named after its French inventor. Horizontal-axis wind turbines typically either have two or three blades. These three-bladed wind turbines are operated "upwind," with the blades facing into the wind.

Figure 2.4: Vertical (left) and horizontal (right) wind turbine

2.3.2 Inside the Wind Turbine

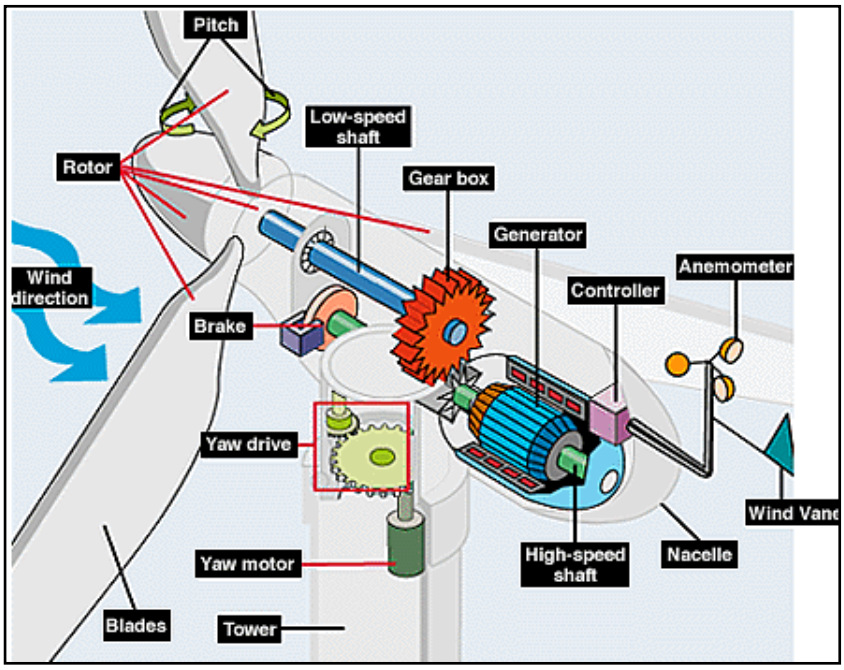

Figure 2.5: Wind turbine structure

Anemometer:

Measures the wind speed and transmits wind speed data to the controller.

Blades:

Most turbines have either two or three blades. Wind blowing over the blades causes the blades to "lift" and rotate.

Brake:

A disc brake, which can be applied mechanically, electrically, or hydraulically to stop the rotor in emergencies.

Controller:

The controller starts up the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts off the machine at about 55 mph. Turbines do not operate at wind speeds above about 55 mph because they might be damaged by the high winds.

Gear box:

Gears connect the low-speed shaft to the high-speed shaft and increase the rotational speeds from about 30 to 60 rotations per minute (rpm) to about 1000 to 1800 rpm, the rotational speed required by most generators to produce electricity.

Generator:

Usually an off-the-shelf induction generator that produces 60-cycle AC electricity.

High-speed shaft:

Drives the generator.

Low-speed shaft:

The rotor turns the low-speed shaft at about 30 to 60 rotations per minute.

Nacelle:

The nacelle sits atop the tower and contains the gear box, low- and high-speed shafts, generator, controller, and brake. Some nacelles are large enough for a helicopter to land on.

Pitch:

Blades are turned, or pitched, out of the wind to control the rotor speed and keep the rotor from turning in winds that are too high or too low to produce electricity.

Rotor:

The blades and the hub together are called the rotor.

Tower:

Towers are made from tubular steel (shown here), concrete, or steel lattice. Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity.

Wind direction:

This is an "upwind" turbine, so-called because it operates facing into the wind. Other turbines are designed to run "downwind," facing away from the wind.

Wind vane:

Measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.

Yaw drive:

Upwind turbines face into the wind; the yaw drive is used to keep the rotor facing into the wind as the wind direction changes. Downwind turbines don't require a yaw drive, the wind blows the rotor downwind.

Yaw motor:

Powers the yaw drive.

2.4 Wind-Electric system types

2.4.1 Off-Grid Wind-Electric Systems

Off-grid wind-electric systems are battery based. People generally choose these systems because their home or other energy use is not connected to the grid, and connection would be expensive. Others prefer the independence of off-grid systems, or live where utilities and governments make it difficult to tie a renewable energy system to the grid.

Off-grid systems are limited in capacity by the size of the generating sources (wind turbine, solar-electric array, fuel-fired generator, etc.), the resources available, and the battery bank size. Off-grid homeowners have to learn to live within the limitations of their system capacity. The following illustration includes the primary components of any off-grid wind-electric system with battery backup.

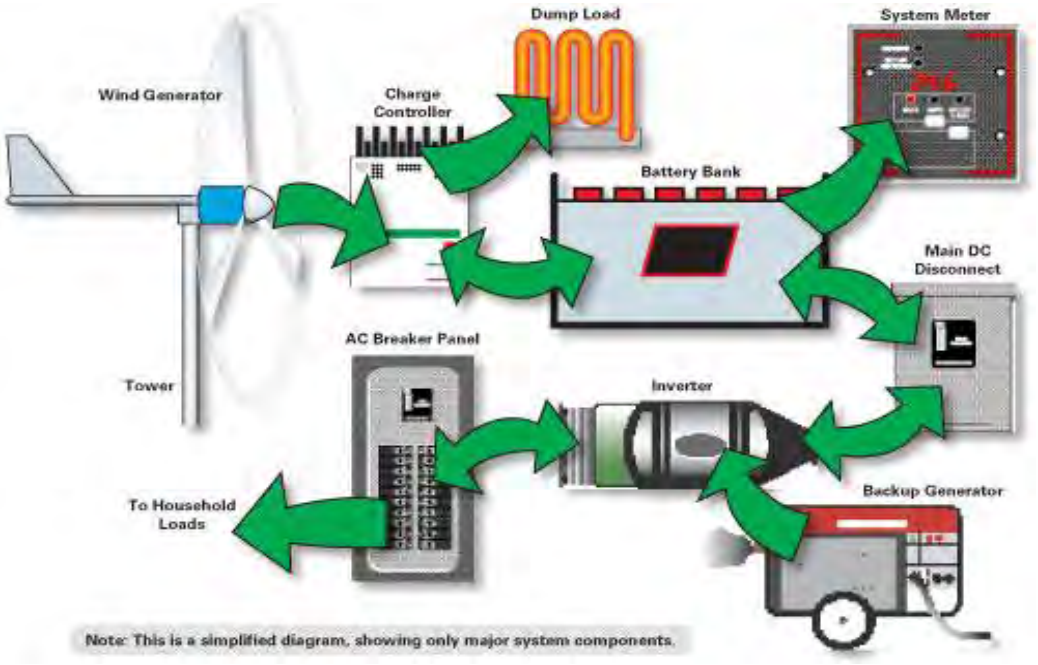

Figure 2.6: Off-Grid Wind-Electric Systems