LIFTING WATER FROM WELL USING
WIND ENERGY GENERATOR

By

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FINAL REPORT

Submitted to the Electrical & Electronics Engineering Programme

in Partial Fulfillment of the Requirements

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Electrical & Electronics Engineering Programme
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Approved:

____

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December 2009

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Izhan Bin Ibrahim

ABSTRACT

Nowadays, there are a lot of techniques used in rural areas to lift the water from a deep well. One of the common techniques is by using an electrical pump. To use the electrical pump, the area must be provided by electrical supply. Unfortunately, there is a limited electrical supplied in rural areas. So, one of the best way to solve the problem is by using wind generator to produce electricity since wind is available everywhere in the world. Therefore, the main objective of this project is to use wind energy sources to generate electricity used for lifting the water from well that can make it ease to the people in rural area using the water well. The wind energy water pump consist turbo generator, batteries as power storage, charge controller, and electrical water pump. The scope of studies of this project includes research and gathering information from the all sources available, to design and construct the system, and to test the system in the form of available software and hardware. Methodology used for this project are designing and choosing the right components for the system. The report contains five main chapters, namely Introduction, Literature Review, Methodology, Result and Discussion and Conclusion.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my deeply sincere gratitude to my supervisor, Dr. Taj Muhammad Baloch who has helped me a lot through out this semester. Not to forget, I would also like to express my gratitude to my previous supervisor, Dr. Abdallah Belal Adam who has help to study and understand the basic idea of this project. It is a very big challenge for me to understand and implement this project. This project would not be successful without their guidance, encouragement, and their enormous help in giving idea to implement this project. Their brilliant idea is the core knowledge for me in order to implement this project.

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

Groundwater is located beneath the ground surface in soil pore spaces and in the fractures of lithologic formations. A unit of broken rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. One of the sources of getting the groundwater is from water well [1].

Water well is an excavation or structure created in the ground by digging, driving, boring or drilling to access water in underground aquifers. The well water is drawn via an electric submersible pump or a mechanical pump. It can also be drawn up using containers, such as buckets that are raised mechanically or by hand. There are three main types of water wells which are 'Dug well', 'Driven well', and 'Drilled Well'. For electrical pump, the most suitable electrical source is from wind generator because it is clean and cheap [2].

Wind generator is a device that generates electrical power from wind energy. The main part of the wind generator is wind turbine. Wind turbine is a rotating machine which converts the kinetic energy of wind into mechanical energy. Wind turbines can be classified into two types based by the axis in which the turbine rotates. Vertical-axis turbines are less frequently used [3]. The wind turbine is coupled with generator which in turn generates electricity at rate depending of speed of turbine and wind flow. The power generated can be stored and used to run electrical pump.

1.2 Problem Statement

To access the groundwater, people need to have water well to lift the water from a certain depth. Water lifting from water well is heavy task for communities staying in places where other potential water pumping power sources is constrained, where financial resources are not available for investment, operation and maintenance are limited and where there is a relatively limited domestic water requirement. Many water-lifting devices have been implemented to lift water to a height that allows users easy access to water. The solution for that situation is to find new potential water pumping power source where it can be used even by people staying at rural areas. One of the best power sources is by using Wind Energy. There are a lot of advantages of using Wind Energy such as ample, renewable, cheap, and also reducing toxic gas emissions.

1.3 Objectives

- To design wind turbine generator.
- To construct charge controller for the system.
- To construct water detector for the system.
- To construct the prototype of wind energy water lifting system.

1.4 Scope of Study

The scopes of study of this project will emphasis on designing and creating a prototype for the lifting water using wind energy generator that consists of the following activities:

1. Research via reference books/journals from library or internet on wind generator.
2. Gather internal and external information from literature study and internet surfing.
3. Design and construct the system that will accommodate the requirement.
4. Test the system in the form of available software and hardware to evaluate the level of achievement accomplished at the end of the project.

CHAPTER 2
LITERATURE REVIEW

2.1 Overview of the System

Basically, there are three main parts of the system involved in designing wind energy generator which are input part, output part and system part. The input part is a wind turbine generator that generates electrical energy to the system. The output part is an electrical water pump that pumps up the water from the well. The system includes battery bank, charge controller, and water level detector. Wind generator will produce DC input and supply to the DC motor that is used to pump water. The battery bank is used to store the energy and it is controlled by charger controller. A water level detector is used to control the water level in water storage.

2.2 Wind Turbine

A wind generator is a device that generates electrical power from wind energy. Wind turbine is a rotating machine which converts the kinetic energy in 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 used in converting to electricity, the machine is called a wind generator, wind turbine, wind power unit (WPU) or wind energy converter (WEC). Wind turbines can be separated into two types based which are horizontal axis and vertical-axis turbines. A horizontal axis turbine is used for this project because it is the most efficient. [4].

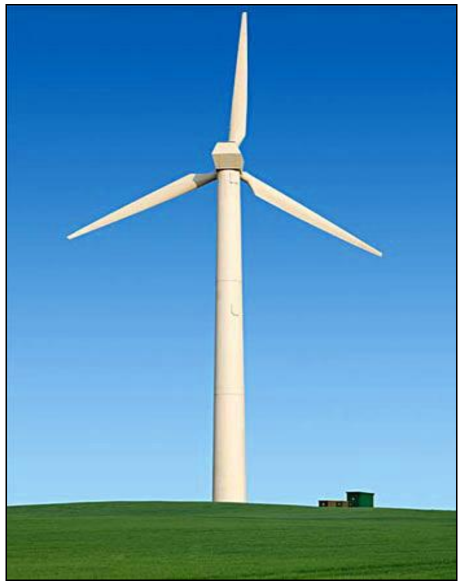

Figure 1 : Horizontal axis wind turbine

2.3 DC Generator

An electric motor uses electrical energy to produce mechanical energy, usually through the interaction of magnetic fields and current-carrying conductors. The reverse process, producing electrical energy from mechanical energy, is accomplished by a generator or dynamo. Electric motors can be run as generators and vice versa, although this is not always practical.

A DC motor is designed to run on DC electric power. Most common DC motor types are the brushed and brushless types, which use internal and external commutation respectively to create an AC current from the DC source so that they are not purely DC machines in a strict sense. Brushed DC motor design generates an AC in a wound rotor, or armature, with a split ring commutator, and either a wound or permanent magnet stator.

A rotor consists of one or more coils of wire wound around a core on a shaft; an electrical power source is connected to the rotor coil through the commutator and its brushes, causing current to flow in it, producing electromagnetism. The commutator causes the current in the coils to be switched as the rotor turns, keeping the magnetic poles of the rotor from ever fully aligning with the magnetic poles of the stator field, so that the rotor never stops but rather keeps rotating indefinitely as long as power is applied and is sufficient for the motor to overcome the shaft torque load and internal losses due to friction, etc. [5]

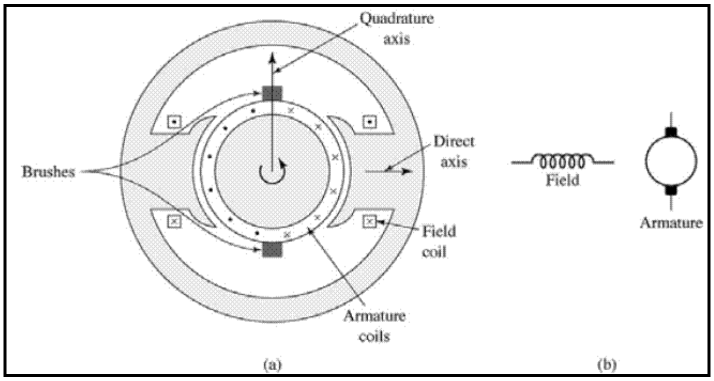

Figure 2 : Schematic representations of a dc machine

2.4 Battery Bank

Main function of battery is to converts the electrical energy from wind generator into chemical energy by means of a specific chemical reaction. When the water pump needs to use electricity, the battery reverses the chemical reaction and releases electricity. Batteries come in all shapes and sizes. For this system, lead acid batteries 12V 3.2 AH with maximum charging current is 1.0 A is used [6].

Figure 3 : 12V 3.2AH lead acid batteries

2.5 Water Pump

Pump is a device used to move fluids, such as gases, liquids or slurries. A pump displaces a volume by physical or mechanical action. One common misconception about pumps is the thought that they create pressure. Pumps alone do not create pressure; they only displace fluid, causing a flow. Adding resistance to flow causes pressure. To overcome this problem, the pump is placed below water in well level. 12V DC water pump is used for the project [8].

Figure 4 : 12V DC water pump

2.6 Water Level Detector

Water detector is a circuit consist a sensor to detect present of water. Probe is used as water sensor in the water detector circuit. In this project, water detector is placed in water storage tank so that it can detect when water is in a full level.

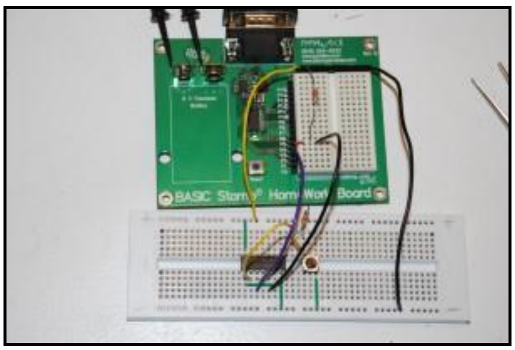

Figure 5 : Water level detector circuit

2.7 Charge Controller

The general principal behind the controller is that it monitors the voltage of the battery in the system and either sends power from the turbine into the battery to recharge it, or dumps the power from the turbine into a secondary load if the batteries are fully charged. In this project, voltage indicator is modified as a charge controller [7].

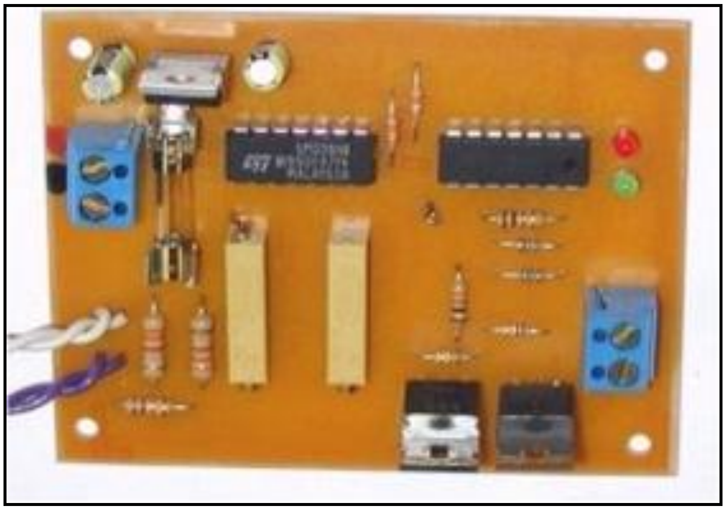

Figure 6 : Charge controller circuit

2.8 Betz' Law

According to the Betz' Law, it can only convert less than 16/27 (or 59%) of the kinetic energy in the wind to mechanical energy using a wind turbine. This limit has no effect with inefficiencies in the generator, but in the very nature of wind turbines themselves. Wind turbines extract energy by slowing down the wind. For a wind turbine to be 100% efficient it would need to stop 100% of the wind but then the rotor would have to be a solid disk and it would not turn and no kinetic energy would be converted. The more kinetic energy a wind turbine pulls out of the wind, the more the wind will be slowed down as it leaves the left side of the turbine.

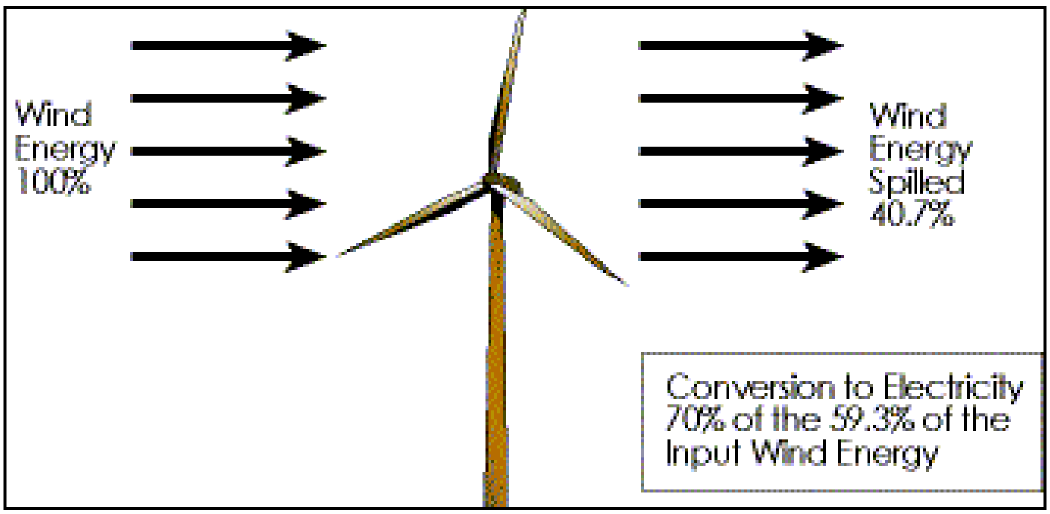

Figure 7 : Illustration of Betz' law

CHAPTER 3

METHODOLOGY

3.1 Design Approach

The project flow is shown in Figure 8 below:-

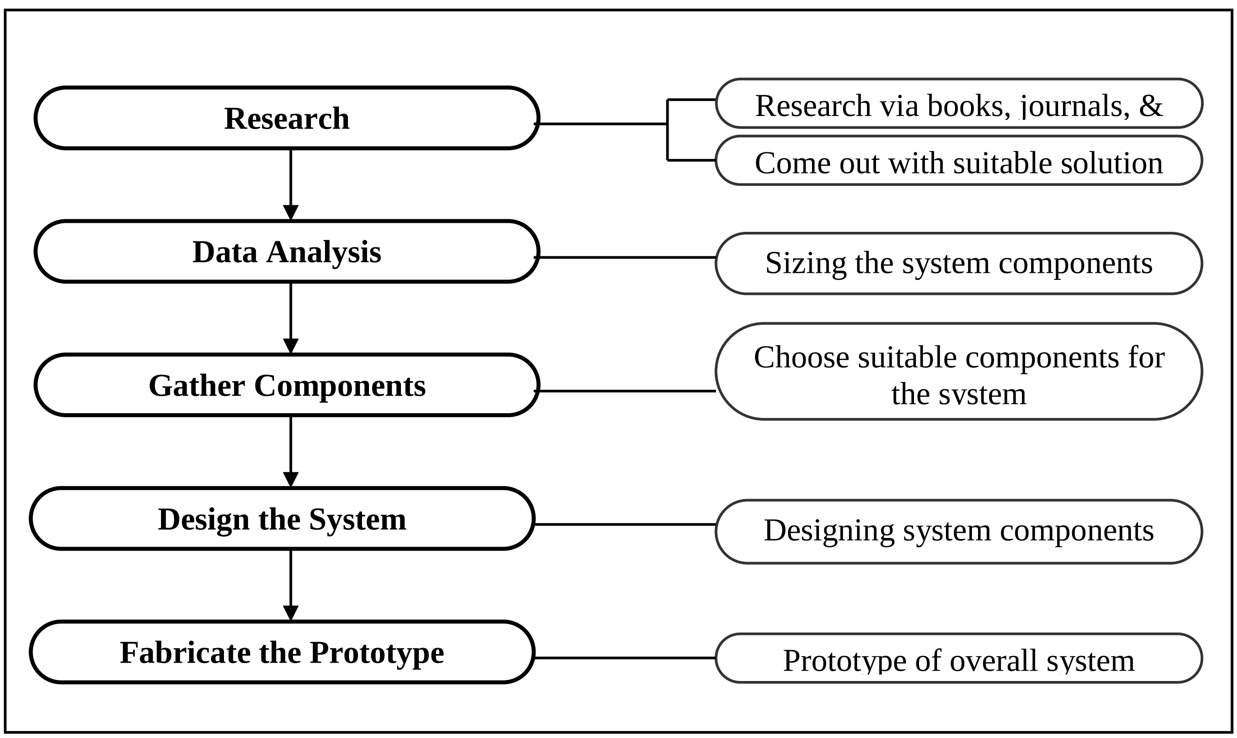

Figure 8 : Project flow

General design of the system is based on the block diagram as shown in Figure 9.

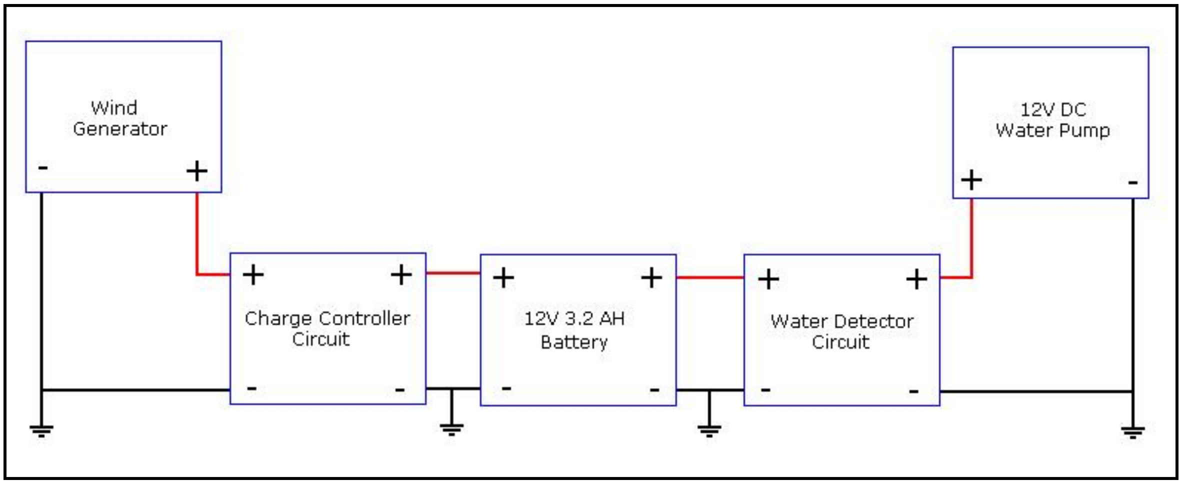

Figure 9 : System's block diagram

3.2 Designing Wind Turbine

There are 4 things need to design in wind turbine part:-

1. A generator (motor used for wind turbine)
2. Blades
3. A mounting
4. A tower

3.2.1 Generator

When motor is used as generators, motors generally have to be driven far faster than their rated speed to produce anything near their rated voltage. The best motor for the system is a motor that is rated for high DC voltage, low rpms and high current. The motor will be used for the generator is 24V DC geared motor.

Figure 10 : 24V DC Generator

3.2.2 Blades

There are 3 in total blades are used in the system. The blades are made using black PVC pipe with 24” of length and 4” of width. The blades is attach to 5” diameter of hub.

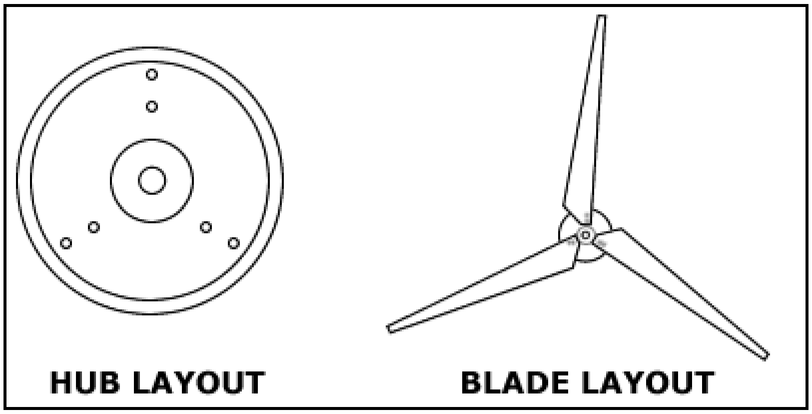

Figure 11 : Hub and blades layout

3.2.3 Mounting

The mounting is made from 2x4x36" of wood. Then an 8.5x14" of aluminum tail is attached to the mounting. The mounting is used to keeps wind turbine turned into the wind direction.

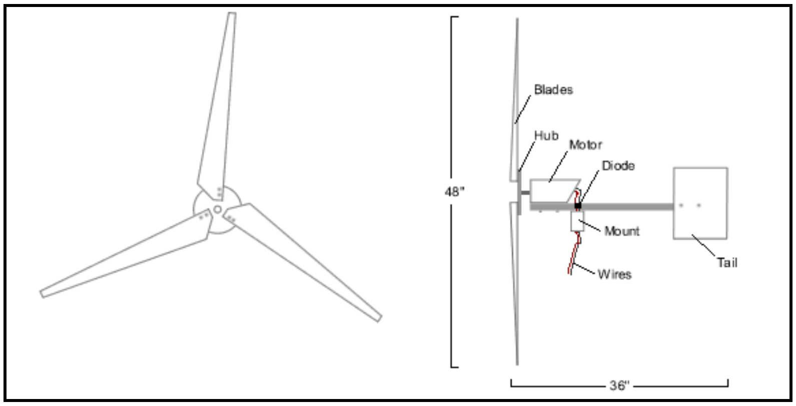

Figure 12 : Front and side view of wind turbine

3.2.4 Tower

The main purpose of the tower is to get the wind turbine up into the wind. The tower is one of the most important components in the wind generator system. It must be strong, stable, easily raised and lowered, and well anchored. The higher the tower is, the more wind the generator will be exposed to. The tower design layout is shown in Figure 13.

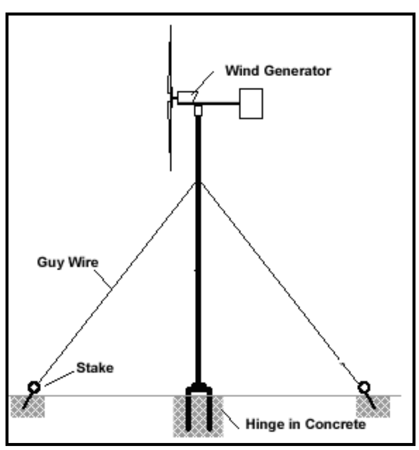

Figure 13 : Tower layout

3.3 Designing Water Level Detector

Water level detector is constructed using LM555 IC, probe and a relay. Probe is used to detect present of water. Relay is set to NC (normally close) so that when the probe senses water, the relay condition change to NO (normally open). When it changes to NO condition, the current from battery is cut causing the water pump disconnected.

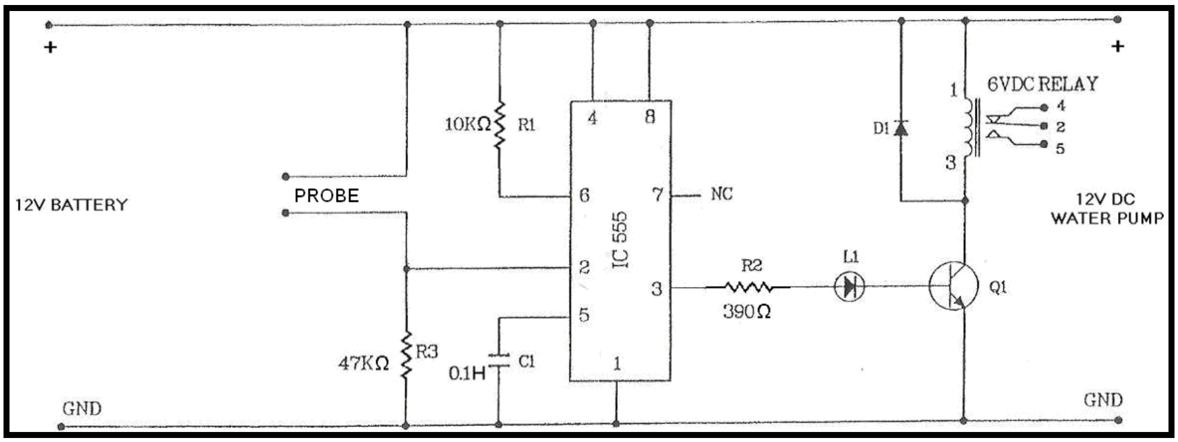

Figure 14 : Water detector schematic diagram

3.4 Designing Charge Controller

In the system, charge controller was constructed based on voltage indicator circuit. The main component in voltage indicator circuit is the LM3914 IC. The LM3914 IC is a monolithic integrated circuit that senses analog voltage levels and drives 10 LEDs, providing a linear analog display. Each LED indicates voltage levels of the battery range from 10V to 14.5V. Modification of the voltage indicator circuit is made with the addition of relay that highlighted in Figure 15. Voltage supply is cut when the battery voltage reached 13V to avoid battery overcharging that may cause damage to the battery. After tested the charge controller circuit, the circuit is printed on the printed circuit board (PCB). The layout of the board is shown in Figure 16.

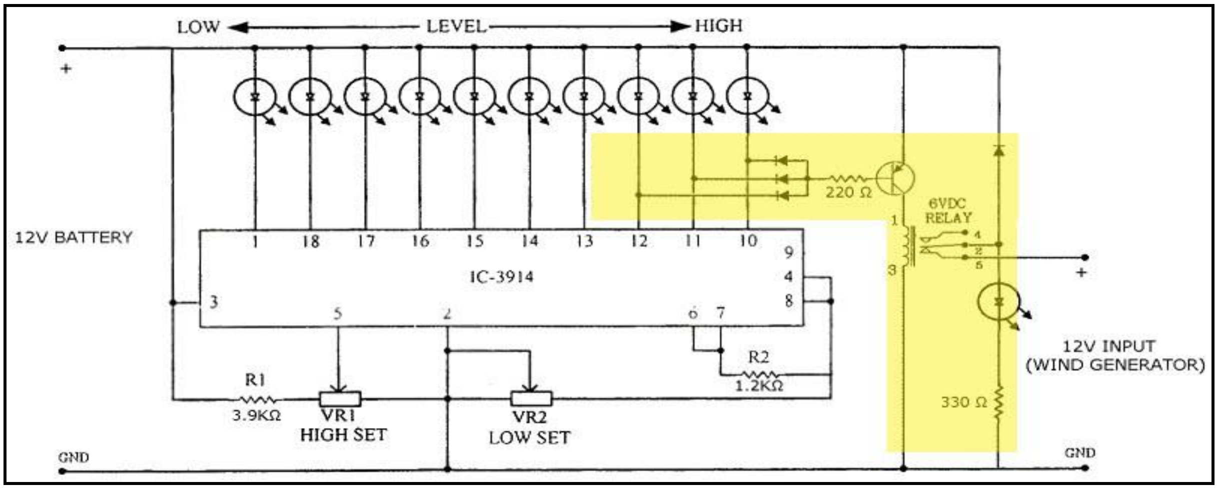

Figure 15 : Charge controller schematic diagram

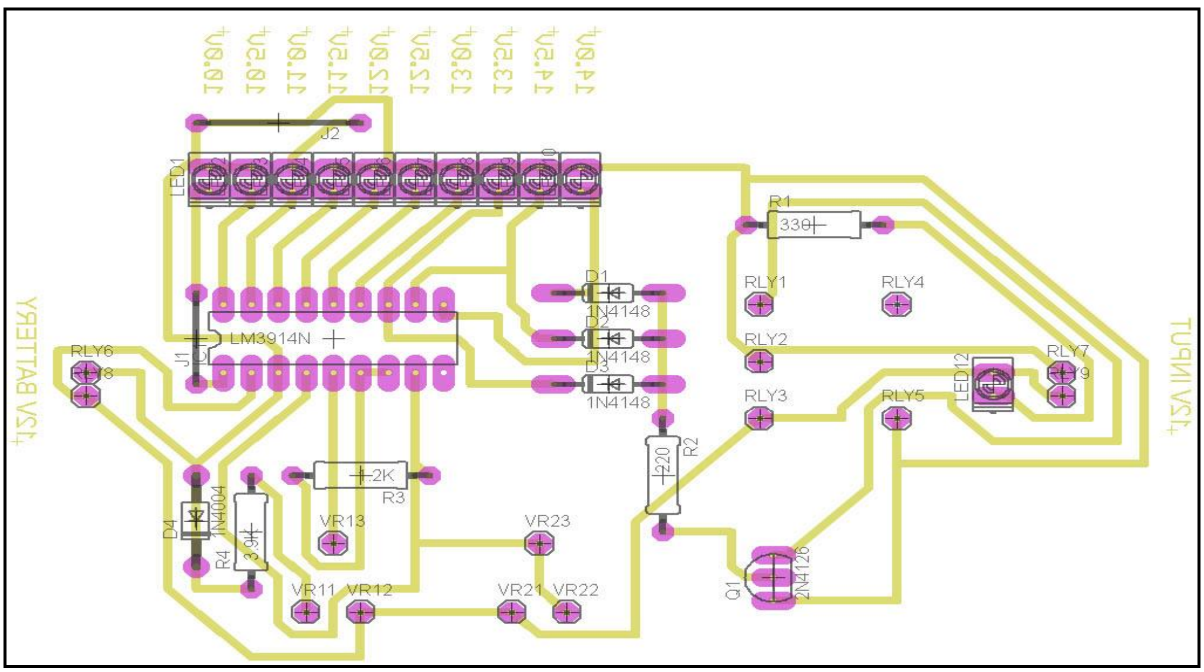

Figure 16 : Charge controller's PCB layout

3.5 Tools

3.5.1 Software

1. Microsoft Office
2. Microsoft Paint
3. AutoCAD
4. Adobe Photoshop
5. Pspice

3.5.2 Hardware & Materials

1. Electrical water pump
2. Power storage (Battery bank)
3. Ammeter
4. 24V DC geared motor
5. Saw
6. Screw driver
7. Screw & washer
8. 33” length of square wood
9. Cable Tie
10. Iron tighten
11. L-shape connector
12. 40” of metal rod
13. Aluminum plate
14. 6” of metal hub
15. 6” of PVC pipe

CHAPTER 4
RESULTS AND DISCUSSION

4.1 Constructing Wind Turbine

4.1.1 Design steps

First step is to cut the PVC pipe in horizontal into three piece follows the blade's design. Then do a little extra smoothing and shaping using belt sander and palm sander on the cut edges to try to make blades into better airfoils.

Figure 17 : Blades made from 6" PVC

A 6" of metal hub is prepared by using a piece of hard metal. 6 holes are needed on the hub to attach the hub with the blades using screws and bolt. The holes were drilled as shown in Figure 18:-

Figure 18 : 6“ metal hub

After that, the center of the hub is weld to the geared motor. 12/24 DC Geared motor used to replace 30 V DC Ametek motor since 30 V DC Ametek is not available in Malaysia.

Figure 19 : Welded metal hub and geared motor

The next step is to assemble the blades onto the metal hub. Screw, bolt and washer are needed to attach the metal hub with the blades. Make sure all the screws and bolts are tightening so that the blades are not broken when operating in high speed wind.

Figure 20 : Assembled PVC blades and metal hub

The last step is to assemble the entire components including 33” square wood, aluminum and metal rod as mounting. Below is the final design of the wind turbine that has been made.

Figure 21 : Assembled wind turbine

4.1.2 Output of wind generator

After wind turbine has been assembled, several experiments were carried out to test the turbine efficiency. The wind turbine was placed in open area to expose it to the wind. The experiment has been done for five days. Multimeter has been used to measure the output voltage and current of the wind turbine. Results of the experiment as attached in Table 1:-

Table 1 The output readings of the wind turbine.

	Vmax (V)	**Vmin (V)**	**Imax (mA)**	**Imin (mA)**
Day 1	8.00	0.50	50	20
	11.00	2.64	50	20
	6.11	2.85	50	10
Day 2	6.32	1.02	50	10
	4.66	1.85	50	10
	6.54	1.64	80	10
Day 3	7.50	0.50	50	10
	6.34	1.32	50	20
	6.12	1.20	60	10
Day 4	6.52	0.62	50	10
	7.12	1.02	50	10
	7.23	1.02	50	20
Day 5	8.49	1.32	50	10
	8.32	2.24	60	20
	8.52	1.53	50	10
Average	**7.25**	**1.42**	**53**	**13**

The average minimum reading of the turbine is 1.42V and 13mA and the average maximum reading is 7.25V and 53mA when maximum wind blows. The wind speed cannot be measure because tachometer is not available in laboratory.

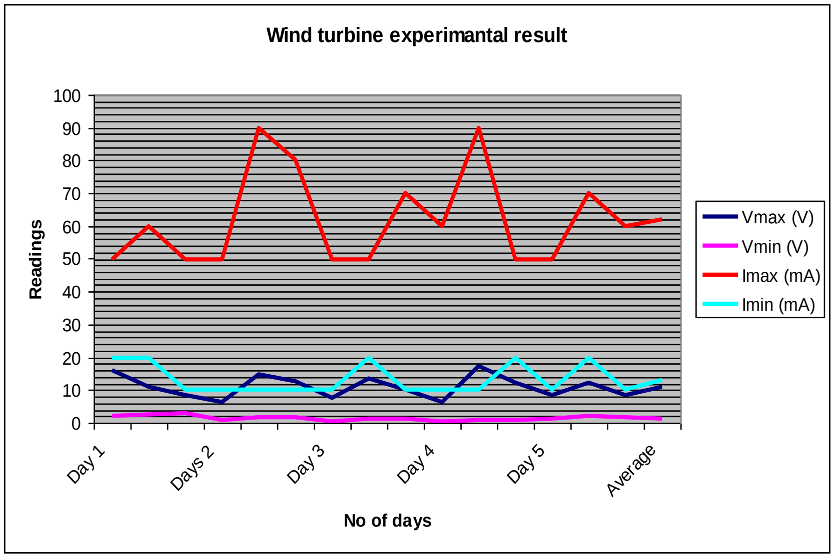

Figure 22 : Output reading of wind generator graph

4.2 Wind Power Calculation

The amount of power available in the wind is determined by the equation [9]:

$$\mathbf{P = \frac{1}{2}\, r\, A\, v^3}$$

w = power

r = air density

A = rotor area

v = wind speed

Air density, r in average is **1.2475 Kg/m^3**.

π =3.14

Radius of wind turbine is 24 " = **0.61 m**

Rotor area, **$A=3.14x\ (0.61\ m)^2 = 1.169\ m^2$**

For wind speed, **v=20km/h = 5.55 m/s,** the wind power is:

$$\mathbf{P = \frac{1}{2} \times (1.2475\ Kg/m^3) \times (1.169\ m^2) \times (5.55\ m/s)^3 = 124.65W}$$

Wind power density is a term commonly used to describe the wind power available per unit area swept by the blades, or w/A.

$$\mathbf{W.P.D. = 124.65\ W/\ 1.169\ m^2 = 106.63\ w/\ m^2}$$

4.3 Full system design

After considering all factors and requirements, the full design of the system is shown in Figure 16. The wind turbine placing will be at a higher position to expose it to the wind. Fuse is used to open the circuit when over voltage that may cause damage to the battery. Charge controller is placed in between battery and wind generator since it is responsible to cut a current generated by wind turbine generator when the battery is fully charged. Water detector is used to detect water level in water storage tank. The DC water pump is placed below the ground water supply and responsible to lift up the water to the water storage tank.

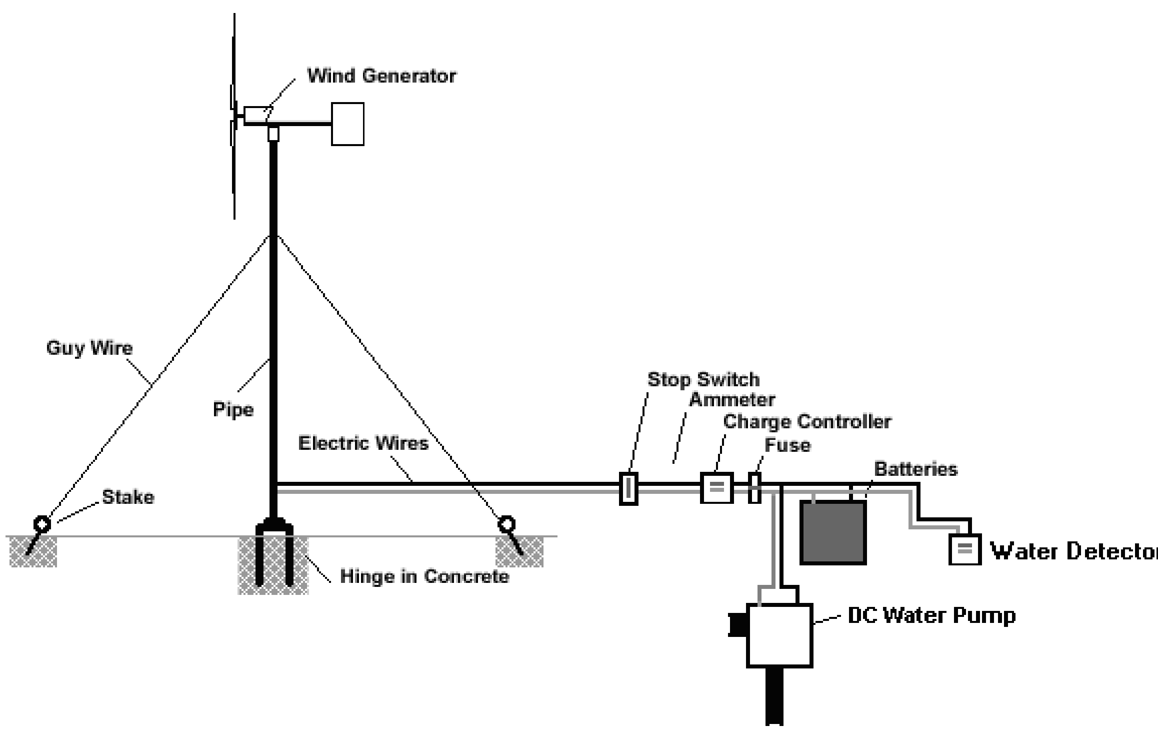

Figure 23 : Full system design

4.4 Discussion

The major problem found in this project was availability of components. Components like electric DC motor for wind turbine are unavailable in Malaysia. For alternative, 24 V DC geared motor is used to replace the Ametek 30 V motor. It is found that the 24 V DC geared motor cannot produce much power as required by the water pump. As a solution, the previous 230V AC water pump has been changed to 12 V DC water pump. The advantages using DC water pump are it requires less power than the previous AC water pump and there no need to use inverter in the system that consume a lot of power from the battery.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As a conclusion, the project is found to be successful although there are some difficulties need to overcome. Most of the work done in time frame. The project fulfils the three out of for objectives where:-

- Wind turbine is successfully designed with maximum efficiency modification.
- Charge controller circuit for the system is well constructed and printed on PCB.
- Come out with working water detector circuit to sense water level on water storage.

All the information's on the subject of the project are provided in report are well organized. The system is designed and the data is calculated precisely to get the desired outcome. Almost 90 percents of the project is done through out this two semesters Although there are some problems need to be faced regarding the connection and hardware, the student tries to overcome the problem by finding alternative solution.

5.2 Recommendation

There are still many aspects and areas in the utilization wind generator as an energy source to lift water from a well that must be studied to a greater extent. Here, some of the studies of horizontal axis wind turbine generator recommended to be conducted in the future. These studies would greatly help to improvise the system and its components.

5.2.1 Blades

The thinner the blades, the more aerodynamic efficiency, and it will increase the speed which leads to produce higher voltage.

5.2.2 Generator

In this project, student is currently using 24V DC motor as a generator. It is not a proper motor to use as a generator. The best generator should be an asynchronous motor because the rotational speed of the asynchronous motor is slower than the equivalent rotation speed. More ratio gearboxes should be inserted between the rotor hub and the generator. This also reduces the generator cost and weight.

5.2.3 Tower

The height of the tower becomes important when dealing the place where the wind blowing slowly. The wind blows faster at higher altitudes because of the drag of the surface (sea or land) and the viscosity of the air.

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APPENDICES

APPENDIX A

FYP I PROJECT MILESTONE

No. Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Selection of Project Topic	■													
-Propose Topic														
-Topic assigned to students														
2 Preliminary Research Work		■	■											
-Introduction -Objective -List of references/literature														
-Project planning														
3 Submission of Preliminary Report				●										
4 Project Work				■	■	■	■							
-Reference/Literature														
-Practical/Laboratory Work														
5 Submission of Progress Report 6 Project work continue -Practical/Laboratory Work								● ■	■	■	■			
7 Submission of Interim Report Final Draft												●		
8 Submission of Interim Report														●
9 Oral Presentation														●

APPENDIX B

FYP II PROJECT MILESTONE

No.	Detail/ Week	1	2	3	4	5	6	7	8	9		10	11	12	13	14
1	Project Work Continue	■	■	■	■	■	■	■								
2	Submission of Progress Report								●							
3	Seminar									■		■	■			
4	Project work continue								■	■	Mid- Semester Break	■	■			
5	Poster Exhibition											●				
6	Submission of Dissertation (soft bound)															●
7	Oral Presentation															●
8	Submission of Project Dissertation (Hard Bound)															●

Indication:

●	Suggested milestone
■	Process