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Design of Small Wind Generator to Provide Transformed and Cost Efficient Electricity In Rural Area of Bangladesh

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Abstract:

Many countries of the world have taken a number of steps towards the development of renewable energy and implementation of Energy Efficiency measures. In Bangladesh 75.99% power plant is based on Gas .This is very alarming for our country. Bangladesh is presently facing shortage of power and there are always load shading in some parts of the country. Wind and solar energy are the alternative energy source that can be used to supplement the conventional energy sources particularly in Bangladesh. We have 17 district in the coastal area. Small wind generator will be very effective in this area. Bangladesh government has taken pilot project based on wind, solar and hybrid solutions. In this work our aim was to design of A Small Wind Generator Which Provide Transformed and Cost Efficient Electricity in Rural Area. This system has been designed for remote area of Bangladesh where electricity has not yet reached. This small wind turbine can be operated in the coastal & inland river-island villages of Bangladesh. Wind resource in Bangladesh is not quite enough. Only lighting & irrigation purpose this energy can used.

Keywords*: Wind Turbine, Renewable Energy, Cost Efficient Electricity, Energy Efficiency*

1.Introduction

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity, windmills for mechanical power, wind pumps for water pumping or drainage, or sails to propel ships. At the end of 2010, worldwide nameplate capacity of wind-powered generators was 197 GW [1].

The average wind speed of Bangladesh is low. So we need low capacity wind generator having 100 to 500 watt to utilize the wind energy of Bangladesh. Wind speed remains high in May to July and low during the other months of the year. The energy demand of a Bangladeshi family is not high. The maximum energy demand of each family in the village is about 100 watt to 500 watt daily. So small capacity generator is very essential to our village people for lighting purpose instead of kerosene lamp. But in the local market and micro-capacity generator is not available. The generator which is available in the local market is a little bit bigger and its cost is high. Therefore maximum family cannot afford this generator. If it is possible to develop a small wind generator of 500 watt with local technology, the rural people can use this system at low cost and the dependency on conventional fuel will be reduced. The demand of kerosene oil will be reduce if the poor people use this system. We have constructed our desired wind generator of 500 watts.

We have planned this project for the sake of the village people that we have mentioned earlier. We know that the wind blows over Bangladesh from March to October with a monthly average speed of 3m/s to 8m/s. during the months starting from late October to February wind speed remains either calm or too low. It means a hybrid system must be required to the system for the external energy from October to February in a year. Our objective is to constructed the vertical axis wind generator.

2.Picking The Best Location For Wind Turbine

Where we choose to build our wind turbine is important. If it is nearby houses, tree lines and soils obstruct the full force of the wind from our wind turbine, we will not be able to generate as much power.

The other important things to keep in mind[2]:

- Wind speeds are always higher at the top of a hill, on a shoreline, and in places clear of trees and other structures.
- Be courteous. Keep the turbine as far away from neighbors as possible. 250-300 m away is typical.

- Check with the local government for any other bylaws and regulations about zoning.

Wind speeds tend to be higher on the top of a ridge or hill, and for that reason it is a good idea to locate wind turbines at hilly locations just remember to keep our turbine away for high turbulence. Neighbours must also be taken into consideration when picking a spot to build our turbine. The further our Wind Turbine site is from neighbouring houses, the better.

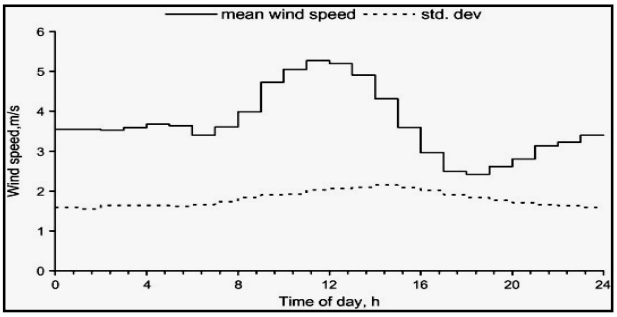

Figure 1: the day's average measurements made by anemometer

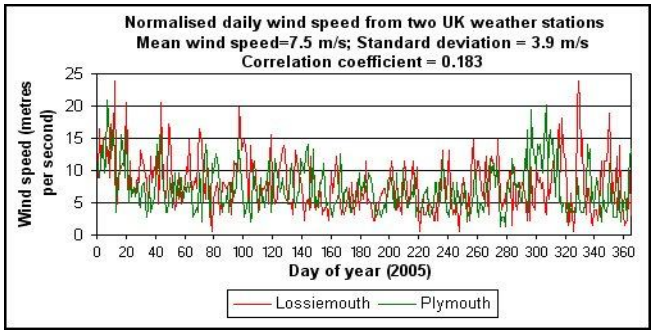

Figure 2: The day's average measurements made by anemometers

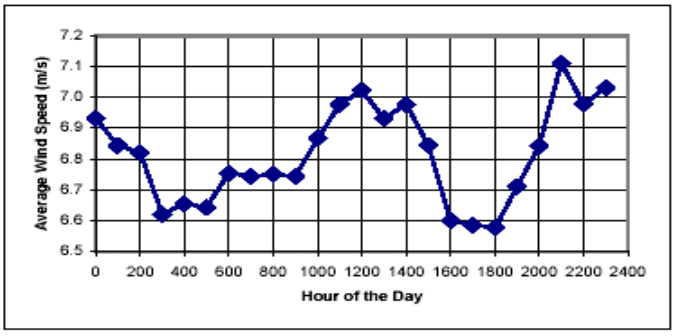

Figure 3: the year's average measurements made by anemometers.

3.Types Of Wind Turbine

There are two basic types of wind turbines[4]. They are:

- Horizontal axis wind turbines
- Vertical axis wind turbines

4.Horizontal Axis Wind Turbines

Horizontal axis turbines (more common) need to be aimed directly at the wind. Because of this, they came with a tail vane that will continuously point them in the direction of the wind.

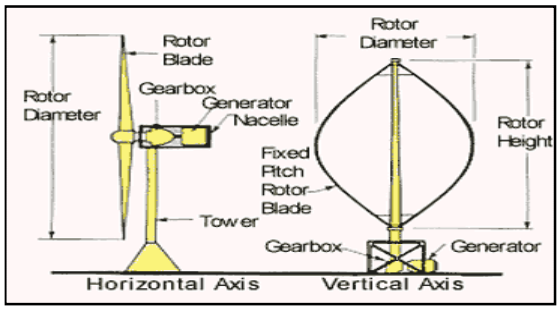

Figure 4: Types of Wind Turbine

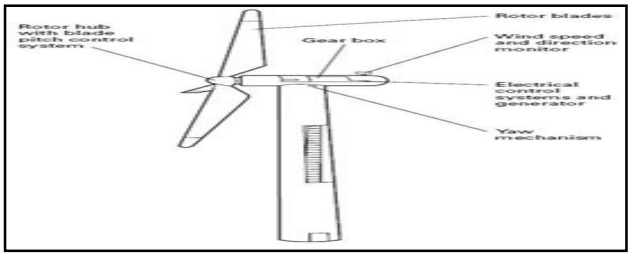

Figure 5: Horizontal axis wind turbines

5.Vertical Axis Wind Turbines

Vertical axis turbines work whatever direction the wind is blowing but require a lot more ground space to support their guy wires than horizontal axis wind turbines.

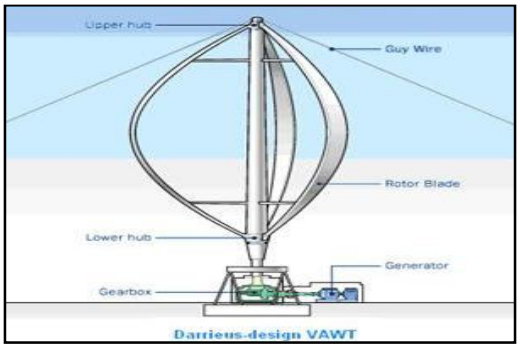

Figure 6: Vertical axis wind turbines

6.Components Of Wind Energy System

The basic components of a typical wind energy system are shown below[3]:

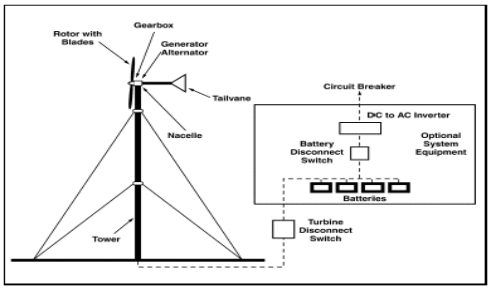

Figure 7: Setup of wind turbine

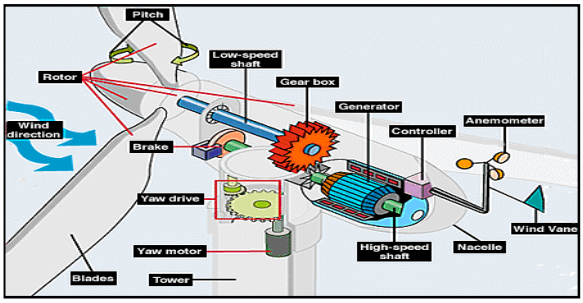

Figure 8: Components of Wind energy system

7.Speed Power Relation

This is an important fact, how much power our wind turbine will is produce is the height of its tower. The power available in the wind is proportional to the cube of its speed. This means that if wind speed doubles, the power available to the wind generator increases by a factor of 8(2*2*2). Since wind speed increases with height, increases with the tower height can mean enormous increase in the amount of electricity generated by the wind turbine[3].

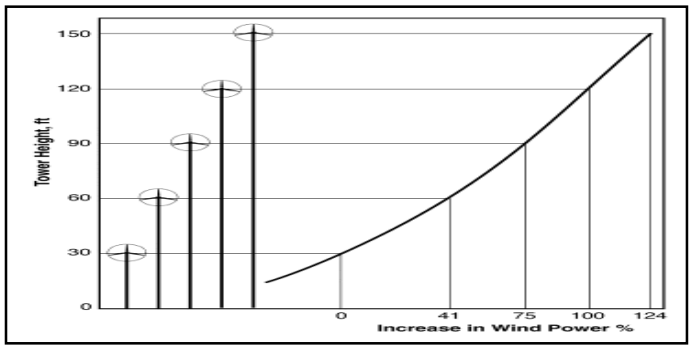

Figure 9: Relationship between wind speed & wind power

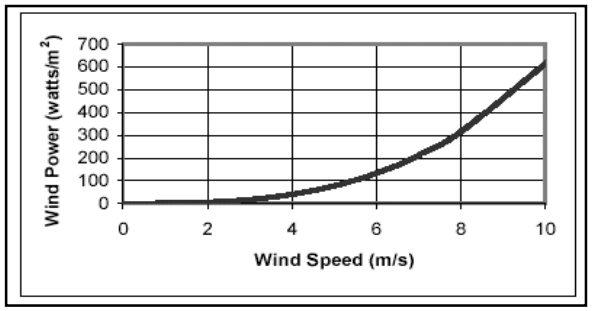

Figure 10: Wind speeds increase with height

8. Towers Height [8]

It has been recommended that towers be 24-37 m (80-120 ft) [2] height. Installing a wind turbine on a tower that is too short is like installing a solar panel in a shady area. At a minimum, mount a wind turbine height enough on a tower that the tips of the rotor blades remain at least 9 m (30 ft) above any obstacle within 90m (300 ft).

9.Choosing A Appropriate Wind Turbine Size

To get the preliminary estimate of the performance of a particular wind turbine,

$$AEO=1.64\ d2\ v3$$

Where

AEO=Annual energy output, kW/year

d=rotor diameter, meters

V= Annual average wind speed/s

By making our home or farm more energy efficient and reducing the size of our peak demand electrical loads, we can reduce the size of wind turbine we'll need, thereby decreasing the purchase cost.

10.Wind Turbine Noise

No matter the size of the wind turbine of the turbine, the potential for turbine noise to bother other people always exists. Even if a wind turbine does not emit enough sound to violet any noise regulations, the noise is produces may still be objectionable to other people.

- Aerodynamic noises may be made by the flow of air over and past the blades of the turbine. Such noises tend to increase with the speed of the rotor. For blade noise, lower blade tip speed results in lower noise levels. Of particular concern is the interaction of wind turbine blades with atmospheric turbulence, which results in a character "whooshing" sound.

- Mechanical noises may also be produced by components of a wind turbine. Normal wear and tear, poor component designs or lack of preventive maintenance may all be factors affecting the amount of mechanical noise produced.

11.Loud Of Wind Turbine

At the distance of 250 m, a typical wind turbine produces a sound pressure level of about 45 db(A) (decibels) [3]

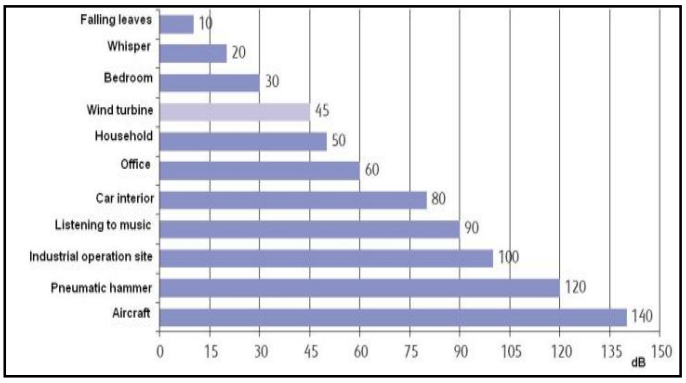

Figure 11: Comparison of decibel levels from a hypothetical wind turbine (from 250m away) with other sources of noise

Figure shows, this sound level is below the background noise level produced in a home or office. Most small wind turbines, in fact, make less noise than a residential air conditioner.

12.Small Wind Turbines

The blade rotates at an average range of 175-500 revolutions per minute with some as high as 150 rpm. Large turbine blades rotate in the range of at 50-15 rpm at constant speed, although an increasing number of machines operate at a veritable speed.

13.Maintenance

A wind turbine requires periodic Maintenance such as oiling and greasing, and regular safety inspections. Check bolts and electrical connections annually; tighten if necessary. Once a year check wind turbines for corrosion and the guy wires supporting the tower for proper tension.

If the turbine blades are wood, paint to protect from the elements. Apply a durable leading edge tape to protect the blades from abrasion due to dust and insects in the air. If the paint checks or the leading edge type tears away, the exposed wood will quickly

erode. Moisture penetrating into the wood causes the rotor became unbalanced, stressing the wind generator. Inspect wooden blades annually, and do any repairs immediately.

15.Safety Concern

All wind turbines have a maximum wind speed, called the survival speed, at which they will not operate above. When winds over this maximum occur, they have an internal brake and lock to prevent them from going faster than this survival speed. For turbines operating in cold winter conditions, be prepared to de-ice as required, and store batteries in an insulated place. Mounting turbines on rooftops is generally not recommended unless a wind turbine is very small[1 kW of rated output or less].Wind turbines tend to vibrate and transmit the vibration to the structure on which they are mounted .As a result ,turbines mounted on a rooftop could lead to both.

16.Design, Fabrication And Experiment

1 Main parts of wind generator

Structure:- a.. MS angle, b. MS plate,

c. MS shaft, d. MS pipe

Blade:-

a. Plastic pipe, b. MS angle, c. MS flat bar, d. MS pipe, e. MS plate

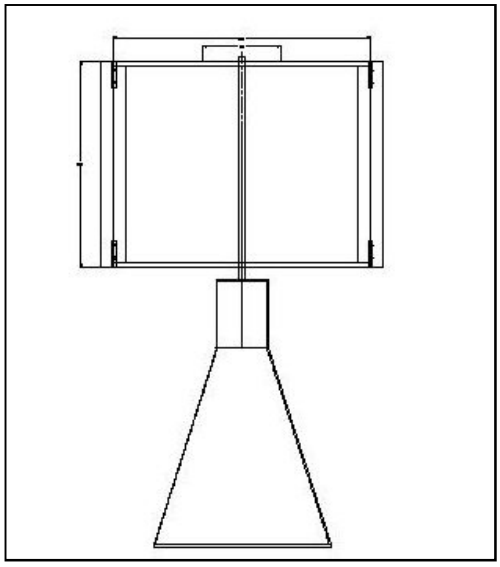

Figure 12: AutoCAD Drawing of Turbine

Wind generator:-

a. Permanent magnet, b. Copper wire,

c. Magnetic core, d.12V DC Battery

Power drive:-

a. Two pairs of wheel, b.Two pulleys

c. V-belt

Alternative blade: - Cloth

17.Measurement Of The Parts Of The Wind Generator

17.1.Structure

a. MS angle:

- 1.5 " * 1.5" * 20'
- Four pieces

b. MS plate

- Bottom plate size: 4' * 4' * 1/8"
- Top plate size: 1' * 1' * 1/8"

c. MS shaft

- Diameter: 1"
- Height : 4'

d. MS pipe

- Diameter: 1"
- Height: 16'

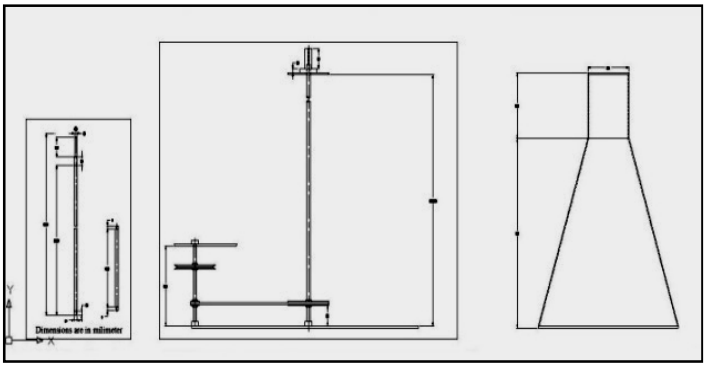

Figure 13: AutoCAD Drawing of Turbine

17.2. Blade

a. Plastic pipe

- Diameter: 6"
- Height: 4'
- Eight pieces

b. MS angle

- 1" * 1" * 1/16 * 3'
- Sixteen pieces

c. MS flat bar

- 1" * 16"
- Sixteen pieces

d. MS pipe

- Diameter: 1"
- Height: 4'
- One piece

e. MS plate

- Diameter: 18"
- Thickness: ¼"
- Two pieces

17.3.Wind generator

a. Permanent magnet

- 3" * 2" * 2"
- Sixteen pieces

b. Copper wire

- Gauge 16

c. Magnetic core

- Diameter : 8"
- Thickness: 3"
- Slot: 32

d. 12V DC battery:

- 7.2 Ah

17.4.Power drive

e. Two pairs of wheel

- Diameter: 12"
- Two pieces

f. Two pulleys

- Diameter: 2.5"
- Two pieces

g. V-belt:

- Two pieces

17.5.Alternative Blade

h. Cloth

- Length: 4'
- Width : 15"

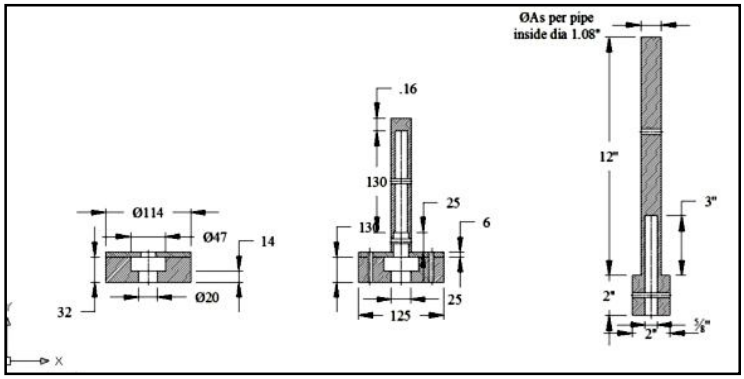

Figure 14 (a): AutoCAD drawing of Turbine

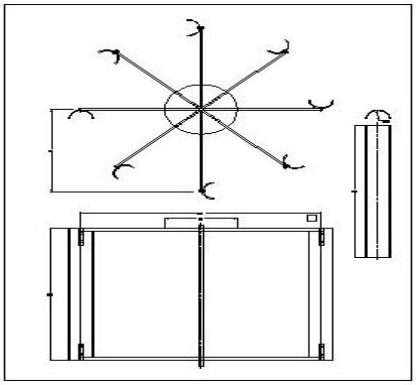

Figure 14(b): AutoCAD drawing of Turbine

18.Costing Of The Whole System

Sl No	Name of the Equipment	Costing Amount
1.	Structure	Taka 5,000
2.	Blade (Plastic Pipe + Others)	Taka (2,500 + 500)
3.	Wind generator	Taka 6,000
4.	Power Drive	Taka 2,000
		Total Amount = Taka 16,000

Table 1: Approximate cost of our designed Wind generator

19.Construction Of The Wind Generator

- The structure at which the wind generator is installed has four MS angles at four sides. The two MS plates are placed at top and the bottom of the MS angles. At the bottom plate the generator and the power drive are installed. The shaft is placed in the middle of the MS angle through the middle of the MS plates. The shaft is the device which drives the generator.
- Most turbines have either two or three blades. But as we have constructed a vertical wind generator so plastic pipes are used as blades in our project. We have used eight pipes of 6 inches diameter. We have cut a 20 feet long pipe in the blade size of four feet. There are also two MS plates to hold the pipe which have a thickness of ¼ inches. The blades are attached with the flat bars. It helps the pipes to remain rigid with the structure. Wind blowing over the blades causes the blades to lift and rotate.
- An electrical generator is a machine which converts mechanical energy into electrical energy. The energy conversion is based on the production of dynamically induces e.m.f. the rotor consists of a number of poles, around which coils are wound. When a DC current is flowing through the coils magnetic poles are created, the number of poles is even and will usually have a value between

2 and 24. On the stator, normally three coils are wound in such a way that, when a three phase current system flows through these coils a rotating magnetic field is generated. When the stator of the synchronous machine is connected to a voltage system with fixed frequency, the shaft will rotate at a fixed speed. Vice versa applied that when a rotor is rotated at a fixed speed, the generator supplies a voltage of a fixed frequency.

- The wind turns the blade, which spin a shaft, which connects to a generator and makes electricity. The generator we have used is placed in the bottom plate of the structure. It has a rating of 1500 rpm. But we have to use a generator with 450 rpm and 10Nm torque so we can generate 500 watts electricity. There are 16 gauges of copper coils as the number of permanent magnets is 16. There is a 12V DC battery with the rating of 7.2Ah.
- The power drive is also placed at the bottom plate of the structure. There are two pairs of wheel and two pulleys which are covered with V-belt. If the blade rotates once a time, the shaft will rotate 25 times. But it is not required. We need the shaft to rotate hundred times at one rotation of the blade. The cloth can be used as an alternative blade in this wind generator.

20.Conclusion

In our project the main objectives are as follows. To study the design and performance of small wind generator. To optimize the design of the wind generator. This project has some social-economic importance. The energy crisis is increasing day by day. Government of Bangladesh cannot provide electricity in many river islands, and haor areas and vast open space in Bangladesh. If a small wind generator can be developed, many people in those areas will be benefited. Electricity from this generator can be supplied to 3 to 4 cluster families. The expected outcome of this project is that the people in river islands and vast bared land will get electricity from this wind generator. They can run energy saving/ LED lights and small fans (12V DC, 12 watts). The cost of wind turbine and along with installation cost is so high that it is not still feasible if we procure it from abroad. To minimize the cost we will develope the generator, tower and blades with our own technology with the help of BCSIR. If it is hybrid with solar panel or bio gas or diesel engine an economic hybrid wind turbine can be operated in Bangladesh.

21.Acknowledgement

We are grateful to our teachers for their kind concern to this paper. Thanks to all our students of our department for their co operation in this paper. Also Thanks to EnergyPac, BanglaCat, PriceClubfor providing us data. We got technical support from BCSIR, Dhaka. Also Thanks to the.m

22.Reference

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