Review on Concept of Multiple Generator in Vertical Axis Wind Turbine

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Abstract— Globally buildings are responsible for approximately 40% of the total world annual energy consumption. Most of these energy is for the provision of lighting, cooling, heating, and air conditioning. As we know the conventional fuel like coal has been turning toward end also due to their adverse effect on environment renewable energy is alternate solution to this problem. The principle objective of this project is to design a vertical axis wind turbine system that operates on high and low wind speed to provide electricity to each house.

Keywords: Vertical Axis Wind Turbine, VAWT, Multiple Generator

I. INTRODUCTION

Energy is the vital input for economic and social development of a country. There is a strong positive correlation between energy use and quality of life. At global level per capita income of a country is directly proportional to the per capita energy consumption. Indias energy demand has grown at 3.6% pa over the last 10 years. About 72% of electricity in India is generated by the coal. Due to shortage of coal and their harmful emission CO2, NOx etc. renewable energy is widely used nowadays.

This paper discussed about such a renewable energy source i.e wind energy. Wind is available in large quantity if this is used properly then it can be utilized in electricity generation effectively in small as well as large scale. A wind turbine is a turbo machine that transfer fluid energy to mechanical energy through the use of blades and shaft and convert it into electricity through the use of generator.

A. Wind Energy Scenario

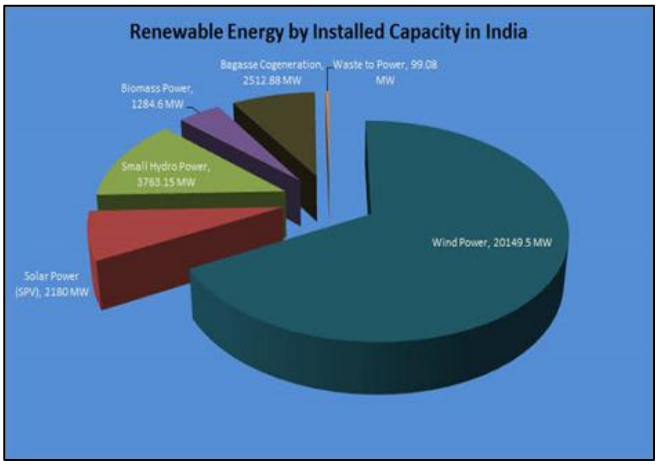


Fig. 1: Wind power density in India

India is a large consumer of coal, which makes up more than 57% of its total consumption. However, more than 1/3 of energy consumed comes from renewable resources, predominantly from India is

Surpassed only by Germany as one of the world's fastest growing markets for wind Energy. By the mid-1990s, the subcontinent was installing more wind generating capacity than North America, Denmark, Britain, and the Netherlands. The ten machines near Okha in the province of Gujarat were some of the first wind turbines installed in India. These 15-meter Vestas wind turbines overlook the Arabian Sea. In2006, there is an installed capacity of 4,430 MW; however, ten times that potential, or 46,092M.

B. Wind Turbine

Wind turbine is classified depending on their axis of rotation i.e horizontal axis wind turbine (HAWT) and vertical axis wind turbine (VAWT). Due to their axis symmetry design VAWT obviates expensive yaw control system require in HAWT and allows the gearbox and generator to be located on ground this reduces the load on turbine this reduces the load on turbine thereby reducing the material cost.

	VAWT	HAWT
Tower sway	Small	Large
Yaw mechanism	No	Yes
Self-starting	No	Yes
Overall formation	Simple	Complex
Generator location	On ground	Not On ground
Height from ground	Small	Large
Blade's operation space	Small	Large
Noise produced	Less	Relatively high
Wind direction	Independent	Dependent
Obstruction for birds	Less	High
Ideal efficiency	More than 70%	50–60%

Table 1: Comparison between VAWT and HAWT

II. WORKING PRINCIPLE

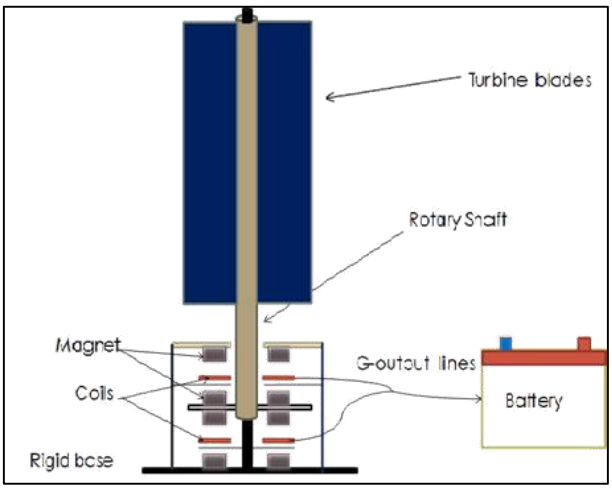


Fig. 2: Block diagram presentation of VAWT

Multistage wind turbine unit consists of following parts; Rotor, shaft, bearing, pipe, magnetic circuit, battery, etc. Multistage wind turbine is as similar as simple wind turbine except that it has two rows of magnetic disc which rotates and

creates the magnetic field. The wind striking to the rotor rotates the shaft which is attached to the disk which has magnet on both the faces. According to the Faradays Laws when coil are present in the magnetic field it cuts the flux and induced EMF, which in turn produces the output that is used to charge one heavy duty battery. As a result, the house is serves simultaneously by the wind and the utility.

The benefits of multi staging are:

1) It will help to increase power output
2) No need to increase the size of rotor
3) There is no maximum load on the turbine
4) Both the stators are of weight independent on the turbine rotor.
5) More than two stage can be used to maximize output

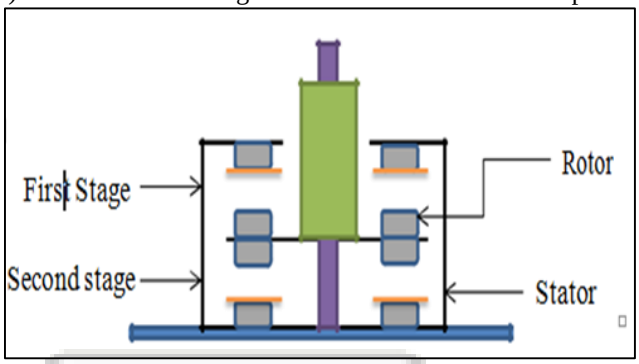


Fig. 3: Multistage Generator

III. DESIGN PARAMETER

A. Forces Encountered on rotor:

There are two forces exerted by the wind on rotor viz. drag and lift force. Drag is the component of total force in the direction of motion. Lift is the total force in the perpendicular direction of motion. The output of wind turbine depends on speed with which shaft rotates which in turn depend on the rotor driven by the drag force.

There are two main type of rotor used in VAWT

Darrius and Savonius rotor.

The rotor that relies solely on drag to produce a force that turns the turbine shaft is Savonius rotor.

B. Savonius Rotor:

A Finish engineer Savonius introduced this rotor in 1920. He has reformed the design of Flattener's rotor by dividing a cylinder into two half along its axis and relocating the two semi cylindrical surfaces sideways. It consists of two scoops where one side catches moving air more than other causing the turbine to spin.

This design does not allows the turbine to spin faster than the oncoming wind.

Standard wind equation is

$$Pa=1/2\ pAV^3$$

Where Pa is available power of wind

V is velocity of wind

P is density of air

The power coefficient is given by

$$Cp= Pm/Pa$$

Pm is the mechanical power at shaft

$$Pm= Cpx1/2\ p\ A\ V^3$$

This paper produces an investigational exploration of a Savonius rotor wind turbine adapted for household electricity generation.

Fig. 4: Savonius rotor

C. Generator

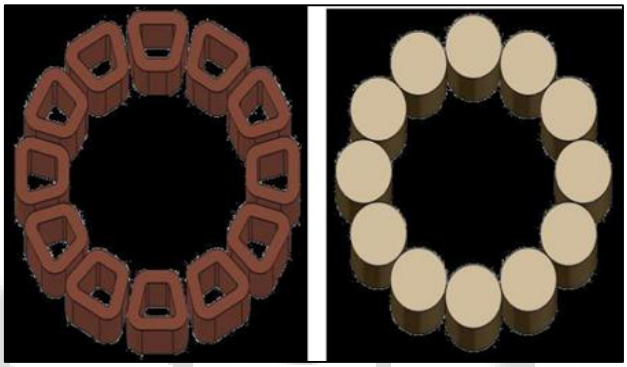


Fig. 5: Coils and magnet for PM handmade generator

Generator or alternator are used in all wind turbine to produce electricity as DC or AC output. For VAWT it is always better to use a light generator because of the fact that it needs to be rotates totally. Increasing weight increases the necessary wind speed required to self start.

Handmade permanent magnets PM is preferred since they are very small in width & broad in diameter. It has two similar magnets arrange in a row which double the power with same size of rotor and space.

Output depends on magnetic field, diameter of magnets and coil, numbers of rotation and also air in between coils and magnets.

IV. ANALYSIS

Every analysis involves four main steps:

A. Preliminary Decisions

1) What type of analysis: Static, dynamic, modal, cfd, etc.?
2) What to model: Part or Assembly?
3) Which elements: Surface or Solid Bodies?

B. Pre-processing

1) Attach the model geometry
2) Define and assign material properties to parts
3) Mesh the geometry
4) Loads and supports
5) Request results

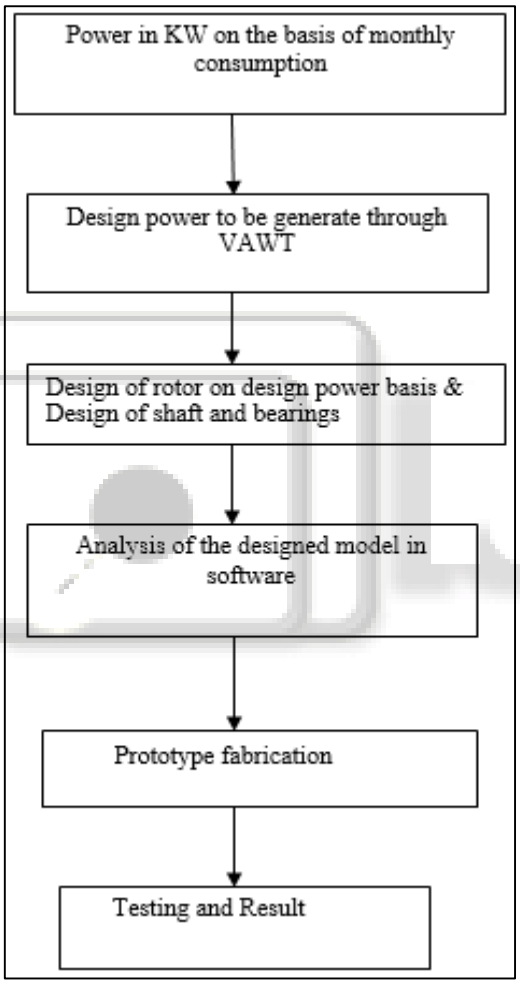
C. Solve the Model

D. Post processing

1) Review results
2) Check the validity of the solution

The complete model design and assembly of parts can be made easily with CAD tools like Pro-E, catia, solid edge. It is better to analyze model before directly going to manufacturing as failure in analysis on manufacturing model incur cost. Analysis is done to check the effectiveness of model in various engineering point of view such as stress, strain, flow. The CAD tools like Ansys, Nastran are used for this purpose.

V. APPLIED PROCEDURE



VI. CONCLUSION

Among the renewable energy sources VAWT has low initial and running cost i.e economical.

The problem of VAWT is poor self starting torque, low coefficient of power etc. to minimize this following conclusion can be drawn from present review.

1) Efficient design of blade curvature so that more wind strike the rotor
2) The concept of multi stage generator can give nearly double power with same size of rotor.
3) It can be Alternative to the invertors which use the electric source to charge themselves.
4) Gear arrangement can be beneficial in case of low rpm, due to varying wind conditions.
5) It also add the advantage of low terrain region where wind speed is high i.e geographical advantage

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