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Conceptualization and Manufacturing of a Domestic Wind Turbine

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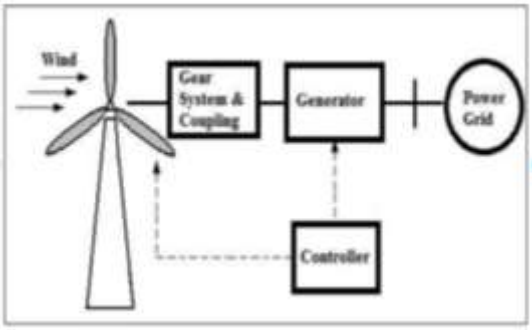
Abstract

The constant rise in demand for energy necessitates that everyone have access to it, even during power outages. As a result, people are turning to renewable energy sources. The method is quite difficult because of its reversibility. Because of non-conventional energy sources, wind is one of the most significant renewable energy sources that pulls and ignites the dwellings. Because wind provides electricity in a cubic relationship with wind speed, people's awareness of wind energy has grown, and it is also free and emits no greenhouse emissions. We explore wind energy for power generation at the household level of consumption at an optimal rate in this study so that people profit from its utilisation.

Keywords: *Electricity, Wind Turbine, Renewable energy sources, Power outages*

INTRODUCTION

Because wind is an essentially limitless resource, it is a feasible option. The amazing thing about wind is that it generates electricity in the cube of wind speed, meaning that as the wind speed increases, the amount of power available grows cubically. The sweep area of the wind turbine, which influences energy generation, is the second most essential aspect after the wind itself.



Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT) are the two main types of wind turbines (VAWT). In comparison to the Vertical Axis Wind Turbine, the Horizontal Axis Wind Turbine is the most often utilised and efficient. Horizontal Axis with three blades is effective for generating domestic electricity. Perhaps this resource provides enormous economic benefit to the environment.

BACKGROUND AND PURPOSE OF STUDY

Due to the depletion of fossil fuels, the world's potential is to develop a system of non-conventional energy sources that is both affordable and efficient for everyone. Many scholars have identified a specific application for these renewable resources and have developed a thesis based on their observations:

Renewable energy technologies will become increasingly competitive with traditional energy technologies over the next several decades, thanks to their continually improving performance and cost, as well as growing recognition of their environmental, economic, and social values, so that by the middle of the twenty-first century, renewable energy, in its various forms, should be supplying half of the world's energy needs. The amount of energy available for conversion is primarily determined by wind speed and turbine swept area. With the use of software, a 1kW @ 11m/s, 1meter diameter wind turbine is developed. The power and efficiency of wind turbine blades were tested using a software tool at various tip-speed-ratios.

Wind energy is free and does not emit any greenhouse emissions. This makes it an excellent source of energy for any growing country. The sector of wind energy offers a lot of room for innovation, which translates to real-world applications and a lot of money. As the economy evolves, it is critical for India to guarantee that every Indian has access to a variety of opportunities, quality jobs, and environmentally responsible livelihoods. We'll need more resources for that. Clean, sustainable, renewable - and, most importantly, local - energy sources are required to realise India's potential in the next years, and wind energy will undoubtedly play a significant role in determining India's future. Wind power has become the world's largest source of renewable energy. From the aforementioned scenario, we can deduce that a wind turbine should be designed with people's economy and environmental

concerns in mind, so that they may reap the most benefits from the wind resource.

PRINCIPLE OF OPERATION

Wind turbines transform kinetic energy in the wind into rotational kinetic energy in the turbine, which is ultimately converted into electrical energy that may be provided. See Figure 2

BLADE DESIGN FOR WIND TURBINE

Wind turbine blades are designed to generate the most electricity from the wind for the least amount of money. However, wind turbine blade manufacturers are always working to improve blade efficiency. Wind turbine designs that are more compact, quieter, and capable of generating more power from less wind have resulted from continuous breakthroughs in wind blade design. It's thought that by slightly bending the turbine blade, they may catch 5–10% more wind energy and function more efficiently in locations where wind speeds are normally lower. See Figure 3

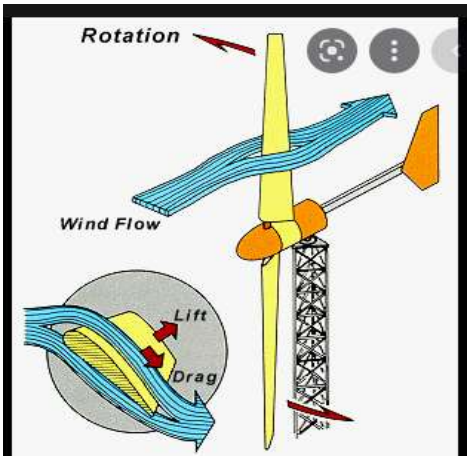


Fig.2: Principle of wind turbine aerodynamic lift

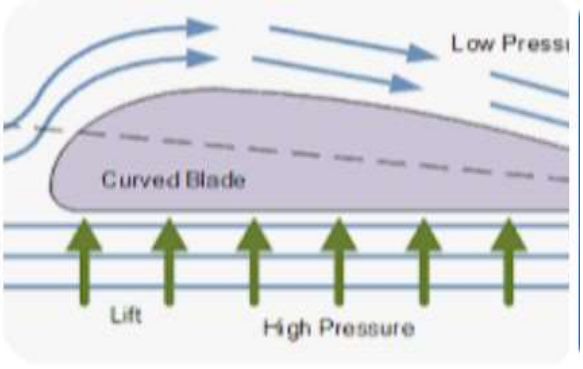


Figure: 3

Finally, the length of a wind turbine's rotor blade dictates how much wind power can be collected as it rotates around a central hub, and the aerodynamic performance of flat and curved blades is quite different. Flat blades are inexpensive and simple to build, but they have large drag forces, making them inefficient and sluggish. The rotor blades of a wind turbine must have an aerodynamic profile to produce lift and rotate the turbine, however curved aerofoil type blades are more complex to manufacture but provide superior performance and faster rotational speeds, making them ideal for electrical energy generation.

FUNDAMENTAL EQUATION & CALCULATION OF WIND POWER

Wind Power depends on:

- Amount of air (volume)
- Speed of air (velocity)
- Mass of air (density) flowing through the area of interest (flux)

KINETIC ENERGY DEFINITION:

K.E.

– Power is KE per unit time:

• P

Mass flow rate

(density * volume flux):

• $dm/dt = \rho * A * v$

– Thus:

1. **• $P = ½ * \rho * A * v^3$**

Where, Power ~ cube of velocity

Power ~ air density and

Power ~ rotor swept area

$A = \pi r^2$

$P = ½ * \rho * A * v^3$

$= ½*1.2*78.5*0.0929*4^3$

=280.03776W

Where, swept diameter= 1.68 m^2

FABRICATION OF WIND TURBINE

Wind turbines for home use should be manufactured using cost-effective and dependable materials to fulfil the needs of the people. The following is a step-by-step guide on building a domestic wind turbine at home:

MATERIALS &EQUIPMENTS USED

- PVC pipe
- M.S. shaft for tower
- Tin sheet for deflector
- 70mm diameter hub for supporting rotor
- Nut, Bolts & Washers
- Bearings

Fig.4: Horizontal axis wind turbine and Deflector

Fig.5: Vertical axis wind turbine

STEPWISE PROCEDURE

1. Cut the PVC pipe to fit your blade profile and form it perfectly.
2. Make the hub according to the design and machine (drill) the holes for retaining the turbine blades.
3. Support the shaft on the hub and turn it to the desired length and diameter.
4. Cut the tin sheet for the deflector according to the design so that it rotates in all directions.
5. Use nuts and bolts to secure the hub and turbine blades.
6. Build the tower to the desired height and weld the deflector to the tower so that it functions as one unit.

7. Keep the tower in bearing so that it may spin with the wind (where the flow of wind is more).
8. Last but not least, solder the entire wind turbine component to the frame.

CONCLUSION

Wind power is one of the world's fastest-growing energy sources. This free green energy may be simply created from naturally occurring resources that are readily available on our planet, and the greatest thing is that they are numerous. According to some estimations, depending on wind capacity, 200kWh to 720kWh of power can be generated every month. According to the study, a wind turbine with a 59 percent efficiency will provide the optimum performance. Finally, due of the cubic relationship between power and wind speed, we may create electricity utilising the wind domain in an effective, dependable, and efficient manner at an optimal rate.

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