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Design And Fabrication of Vertical Axis Wind Turbine

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Abstract— This abstract presents a comprehensive overview of the vertical axis highway wind turbine system, focusing on its design, functionality, advantages, and potential applications. Unlike traditional horizontal axis wind turbines (HAWT), VAHWTs are uniquely suited for urban environments due to their compact size, aesthetic appeal, and ability to capture wind from any direction, including turbulent urban winds. With the increasing demand for renewable energy sources and the growing concerns about climate change, there is a pressing need to explore innovative and efficient ways to harness clean energy. One such solution is the vertical axis highway wind turbine (VAHWT), a promising technology designed to generate electricity from wind energy along highways and urban corridors. This abstract also discusses the potential applications of VAHWTs, including powering streetlights, electric vehicle charging stations, and other infrastructure along highways. Moreover, integrating these turbines with smart grid technologies enables efficient energy distribution and grid stabilization, contributing to a more sustainable and resilient energy infrastructure. the environmental and socio-economic benefits of VAWMs are evaluated, emphasizing their role in mitigating greenhouse gas emissions, reducing reliance on fossil fuels, and fostering local economic development through job creation and technology innovatio. Moreover, recent advancements in materials, aerodynamics, and control systems are discussed, highlighting ongoing efforts to improve the efficiency and cost-effectiveness of VAWTs. Innovations such as lightweight composite materials, aerodynamic optimizations, and smart grid integration hold promise for further enhancing the performance and scalability of VAWT technology

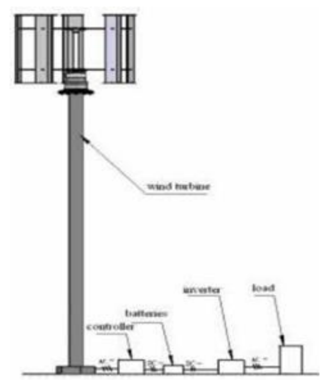
I. INTRODUCTION

The main aim of this project is fabrication of a highway windmill. This project converts wind energy into electrical energy. The electrical energy produced here is used to drive the street lights and other applications. A windmill is a type of engine. It uses the wind to make energy. To do this it uses vanes called sails or blades. The energy made by windmills can be used in many ways. These include grinding grain or spices, pumping water and sawing wood. Modern wind power machines are used to create electricity. These are called wind turbines. Before modern times, windmills were most commonly used to grind grain into flour. The windmill has been in history for many years. In this project wind turbine uses wind's kinetic energy and converts into mechanical energy. This highway windmill uses wind energy generated by the moving vehicles and converts into mechanical energy. The DC generator converts the mechanical energy into electrical energy. Inverter converts direct current into Alternating current and this is used to drive the home appliances. In this 21 st century there are more methods to produce energy. Some of them are ecofriendly and some of them might be pollutable. Once we aim to produce energy by ecofriendly means the best idea is by using renewable energy. In renewable energy field sector the windmill plays an important role in energy production. The present design of windmill might not be implemented in our normal surroundings. As it is not suitable for all wind direction and it gives partial efficiency and also increase in cost of design, installation, and maintenance. To overcome all these problems an new unique method of wind is to be introduced. This paper have kept one step forward of windmill technology with use full application. The main aim of this project paper is to produce energy by using renewable energy resources in that manner the wind is very much eco friendly and very compactable one. By using that energy in a useful manner we can produce a continuous power. This VAHW is a new method which overcomes the previous windmill problems. By adjusting the windmill blade it suit itself with efficient energy generation in all direction. The main advantage of VAHW is it can generate power in all direction of wind flow. And the other advantages are the maintenance are less and the height of the tower is less. It a very novel way of re-capturing some of the energy expended by vehicles moving at high speeds on our nation's highways We know how much air turbulence is generated by vehicles moving at speed particularly trucks. This would involve mounting vertical axis wind turbines at the centre of the roads that would be driven by the moving air generated by the passing traffic. This power production estimate will increase exponentially with an increase in wind turbulence speed. We believe that the wind stream created over the freeways by our primary mode of transportation will create an average annual wind speed well beyond the baseline of 10 mph. Consideration of the flow velocities and aerodynamic forces shows that, nevertheless, a torque is produced in this way which is caused by the lift forces. The breaking torque of the drag forces in much lower, by comparison. In one revolution, a single rotor blade generates a mean positive torque but there are also short sections with negative torque. The main aim of the project is to utilize the maximum amount of wind energy and hence highway is selected as the installation site. The wind turbine will be placed in divider so that the tangential acting airflow from both sides of the road due to moving vehicle will help the turbine to rotate. The variation of blade angle is made so as to get the maximum output and blades are then fixed.

1.1 Giromill Turbine

The Giromill wind turbine, a member of the vertical axis wind turbine (VAWT) family, stands out for its innovative design and promising capabilities in wind energy harnessing. Unlike traditional horizontal axis turbines, Giromill turbines feature a helical blade configuration arranged around a vertical axis.

This unique design allows them to capture wind energy from all directions, making them highly efficient in areas with turbulent or variable wind patterns. Additionally, their compact footprint and modular construction make Giromill turbines suitable for various applications, including urban environments, remote locations, and agricultural settings. With inherent stability, reduced maintenance requirements, and the ability to operate across a wide range of wind speeds, Giromill turbines represent a promising solution for decentralized power generation and sustainable energy production. As the renewable energy sector continues to evolve, the Giromill wind turbine holds significant potential in driving the transition towards a cleaner and more sustainable energy.



II. LITERATURE SURVEY

The literature review pertaining to the pure experimental aspects of wind turbine and the literature related to experimental methods D.A. Nikam et al. analyzed the on design and development of vertical axis wind turbine blade. This paper explains that the wind mill such as vertical and horizontal wind mill is widely used for energy production. The horizontal wind mill is highly used for large scale applications which require more space and huge investment. Whereas the vertical wind mill is suitable for domestic application at low cost. The generation of electricity is affected by the geometry

and orientation of the blade in the wind turbine. To optimize this by setting the proper parameter for the blade design. The experimental result indicates that the blade plays critical role in the performance and energy production of the turbine. The optimized blade parameter and its specification can improve the generation of electricity.

Altab Hossain et al. investigated the design and development of a 1/3 scale vertical axis wind turbine for electrical power generation. In this paper the electricity is produce from the wind mill by wind power and belt power transmission system. The blade and drag devices are designed in the ratio of 1:3 to the wind turbine. The experiment is conducted by different wind speed and the power produced by the windmill is calculated. The experimental result indicates that 567 W power produced at the speed of 20 m/s while 709 W power produced at the speed of 25 m/s. From this, the power production wills increases when the velocity is high.

M. Abid et al. analyzed the design, development and testing of a savonius and darrieus vertical axis wind turbine. This paper shows that vertical axis wind mill is more efficient when compare to horizontal axis wind mill. The darrieus turbine consists of 3 blades which can start alone at low wind speed. When savonius turbine is attached on the top of existing wind mill which provide the self-start at low wind speed. The result indicates that the darrieus vertical axis wind turbine acts as a self-starter during the testing. The function required the starting mechanism which can be provided by the combination of NACA 0030 aerofoil and savonius turbine. The high blade thickness of the NACA 0030 aerofoil will improves the self starting capability of the turbine.

III. OBJECTIVES

The main objectives of the work is

- To compare the power generation capacity between Horizontal and vertical blades of VAWT.
- To study and determine the speed transmission between the gears by using calculations.
- To determine the voltage at certain speeds by using multimeter.
- To identify best materials for use in fabrication.
- To survey and identify the best location for its installation.

IV. METHODOLOGY

To construct a vertical axis wind turbine (VAWT), begin with thorough research and design to understand wind energy principles and select an appropriate VAWT type. Procure materials such as fiberglass, aluminum, or steel for blades and support structures. Design aerodynamically efficient blades and fabricate them accordingly. Construct the central shaft, ensuring it's sturdy and well-balanced, then attach blades at equal intervals. Choose a suitable generator and mount it securely to the turbine structure, connecting it to the shaft. Design and build a stable support structure, considering factors like height and anchoring requirements. Implement safety features like brakes and control systems for monitoring and regulating turbine performance. Test the turbine, fine-tune its design, and optimize for efficiency. Install the turbine at the desired location, following safety standards, and establish a maintenance schedule for ongoing upkeep. Finally, monitor its performance over time, analyzing data for further improvements. Collaboration with wind energy experts and adherence to regulations are critical throughout the process.

V. FABRICATION

6.1 FABRICATION OF BASE:

Base is main componet which supports the whole structure of the vertical axis wind turbine. Its also resists the vibrations during operation.The base serves as the structural platform upon which the entire wind turbine system rests, providing stability, support, and protection against environmental forces.

6.2. FABRICATION OF HUB:

The hub in a vertical axis wind mill serves as a critical interface between the rotor blades and the main shaft of the turbine. It provides structural support, facilitates rotational motion, and ensures efficient energy conversion from wind to mechanical power. Proper design and construction of the hub are essential for optimizing the performance, reliability, and longevity of the VAWT system.

6.3.FABRICATION OF TURBINE BLADE:

Savonius blades are a crucial and basic part of a wind turbine. They are mainly made of aluminum, fiber glass or carbon fiber. Strong Plastic pipe was selected because they provide batter strength to weight ratio.We selected 4 inch pipe and five feet pipe to prepare a blades.We design two types of blades horizontal and verticle blades. The design of the individual blades also affects the overall design of the rotor. Rotor blades take the energy out of the wind; they capture the wind and convert its kinetic energy into rotation of the central shaft.We used a five feet pipe. We cut it into two different dimensions those are 40 and 35 cm.Again we make two equal halfs to all cutting pieces.

VI. COMPONENTS NAME AND DIMENSIONS

S.NO	COMPONENT NAME	DIMENSIONS
1	Base	L=45cm B=45cm W=45cm
2	Hub	T=0.3cm H=60cm Dia=5cm
3	Central shaft	L=100.58cm Dia=2.54cm W=0.2cm
4	Vertical blades	L=40cm D=5.08cm T=0.8cm
5	Horizontal blades	L=35cm D=5.08cm T=0.8cm

VII. CALCULATIONS WITH GIVEN DATA

We are given the following data

Blade length, l = 1 m Wind speed, v = 12 m/sec
Air density, ρ = 1.23 kg/m3 Power Coefficient, Cp = 0.4
Inserting the value for blade length as the radius of the swept area into equation (6) we have:

$l = r = 1m$

$A = \pi r^2$

$= \pi \times 1$

$= 3.142857 m^2$

We can then calculate the power converted from the wind into rotational energy in the turbine using equation (7):

$P_{avail} = 1/2\, \rho A v^3\, C_p$

=0.5*1.23*3.142857*12*12*12*0.4

=1336W

=1.3KW

Actual calculations:

Sample calculations	Gear(a) 40 teeth	Gear(b) 26 teeth	Gear(c) 18 teeth
Gear Ratio	1:1	1:1.54	1:2.22
20RPM	20RPM	30.8RPM	44.4RPM
40RPM	40RPM	61.6RPM	88.8RPM

70RPM	70RPM	107.8RPM	155.4RPM
100RPM	100RPM	154RPM	222RPM

RPM	VOLTAGE	CURRENT
20	0.5	8
40	1.2	21
70	2	34
100	3.5	58

VOLTAGE(V)	CURRENT (I)	POWER (W)
0.5	8	4
1.2	21	25.2
2	34	68
3.5	58	203

8.2. EFFICIENCY:
Efficiency is the state or quality of being efficient. To get the efficiency, both the actual power generated and theoretical power expected were analyzed
(ACTUAL POWER OUTPUT)/ (THEORITICAL POWER OUTPUT) *100
Actual power was 203 Watts
Theoritical power expected to be produced was 1300 watts
Therefore 203/(1300)*100
=15%

CONCLUSION

The efficiency of the fabricated wind turbine was found to be around 15% with variation at different velocities of the wind. The current VAWTs that are already in the market with different designs have an efficiency of 17%. Though the efficiency seems quite low but it can be seen as usable power generated from nothing. One of the reasons for the low efficiency is that we had much dead weight. These turbines have a great advantage over Horizontal axis wind turbine that they can work on low height thus these turbines can be installed on individual houses for their particular use. The power generated from the turbine can be stored or used to charge a storage device and then the storage device can be used as a continuous power source. Yet with more and more engineers and researchers working on the design and development of Vertical axis wind turbine the efficiency can be increased and th4.A high power alternator should be used to provide more power.

RECOMMENDATION

1. The VAWT should be lifted high enough to maximize wind speed.
2. Its blades should be wide to capture good wind speed.
3. Dead weight should be reduced.
4. A high- p o w e r alternator should be used to provide more power.

FUTURE SCOPE

1. VAWTs require less space and can be deployed in many locations so that they may be particularly beneficial to urban and residential applications.
2. Additionally, the need for fewer components and their ability to generate power at lower wind speeds make them an attractive cost-saving option.

PROBLEM ENCOUNTERED

1. Wind speed in my area was very low.
2. There was much dead weight in our system i.e. the central shaft which is heavy was also rotating thus reducing speed.
3. Due to more friction between gears it can produce heavy noise.
4. In sufficient funds to purchase all equipments such as battery ,invertors,etc.

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