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# Design & Fabrication of Vertical Axis Wind Turbine for Highway

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**Abstract -** These abstract focuses on the design and fabrication of a vertical axis wind turbine (VAWT) specifically intended for installation on highways. The objective of this project is to harness the untapped wind energy generated by high vehicle traffic on highways. The design process involves considering the wind patterns created by oncoming vehicles to optimize the turbine's efficiency and power generation capabilities. The VAWT will be designed to be installed on the highway medians, considering the fluid flow from both sides of the road. The fabrication process will utilize robust and durable materials to ensure the turbine's reliability and longevity in the highway environment. Additionally, a storage system will be designed to maintain a constant power source, compensating for the variable nature of wind energy. The project aims to utilize this wind energy to power streetlights and other public amenities along highways, contributing to sustainable energy solutions and reducing reliance on conventional power sources

***Key Words***: vertical axis wind turbine (VAWT) Vehicle traffic, Wind patterns, Sustainable energy, clean energy

## 1.INTRODUCTION

Wind energy is derived from the natural phenomenon of wind caused by various factors. The global potential for harnessing wind energy is estimated to be 72 TW, with thousands of wind turbines already in operation worldwide. Wind power currently accounts for around 1% of global electricity generation, but its long-term potential is much higher, potentially meeting 5 times the world's energy consumption or 40 times the electricity demand. To achieve this, approximately 12.7% of land area would need to be covered with wind turbines, with an average of 6 turbines per square kilometer. Currently, the wind power market is concentrated in a few countries due to supportive policies, but future growth depends on more nations embracing renewable energy. This project focuses on using wind turbines in high traffic areas for efficient power generation and addresses the different classifications of wind turbines, namely horizontal axis (HAWT) and vertical axis (VAWT). The two configurations have instantly distinguishable rotor designs, each with its own favorable characteristics. Vertical-axis wind turbines (VAWT) can be divided into two major groups: those that use aerodynamic drag to extract power from the wind and those that use lift. The advantages of the VAWTs are that they can accept the wind from any direction.

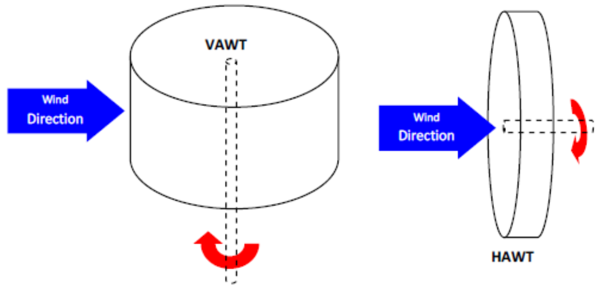
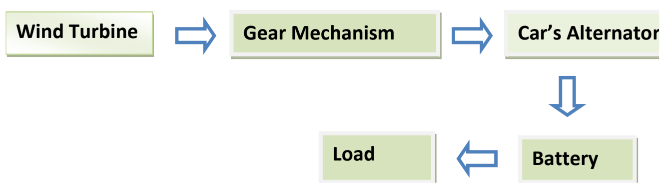



**Fig 1. Aternative configuration for shaft and rotor orientation**

## 2. WORKING PRINCIPLE

The working principle of the project involves the conversion of wind energy into electrical energy using a vertical axis wind turbine. Here is a step-by-step explanation of the process:

In this project, a vertical axis wind turbine is used to convert wind energy into mechanical energy. The mechanical energy is then transformed into electrical energy by a car's alternator. To address the varying wind speed and low rotational speed of the turbine, spur gears with a gear ratio of 1:40 are employed to increase the speed to around 2000 RPM. The electrical energy generated is stored in a battery for later use. An inverter is used to convert the direct current into alternating current, making it suitable for powering home appliances. The stored energy in the battery is then supplied to the load, providing electricity for various applications.




## 3.DESIGN OF VAWT:

### 3.1. SWEPT AREA OF TURBINE: -

$$A = D * H = 3 \text{ ft.} * 4 \text{ ft.}$$
$$= \mathbf{12\ sq.\ ft.}$$

### 3.2. AVAILABLE WIND POWER: -

$$Pa = \frac{1}{2} * \rho * v^3 * A$$
$$= \frac{1}{2} * 1.225 * 8^3 * 12$$
$$= \mathbf{349.613\ W}$$

### 3.3. EFFICIENCY OF TURBINE: -

$$\mu = (1 - Km) * (1 - Ke) * (1 - Kt) * (1 - Ke, t) * (1 - Kw) * Cp$$

$$= (1 - .003) * (1 - .0125) * (1 - .025) * (1 - .065)$$

**= 29.371%**

### 3.4. ACTUAL POWER OUTPUT: -

$Poutput = \mu * Pa =$ **102.687 W**

### 3.5. ANGULAR VELOCITY OF TURBINE:

$$\lambda = \frac{U}{v} = \frac{\omega R}{v}$$

$$4 = \frac{U}{v} = \frac{\omega * 0.4572}{8}$$ = **69.99 rad/s**

### 3.6. TORQUE GENERATED BY TURBINE: -

$$Tw = \frac{Poutput}{\omega} = \mathbf{1.467\ N.m}$$

### 3.7. RPM OF TURBINE:

$$RPM = 60 * V * \frac{TSR}{\pi * D}$$ = **668.367 rpm**

## 4. COMPONENTS AND ITS DRAWING:

### 4.1 FOUNDATION:

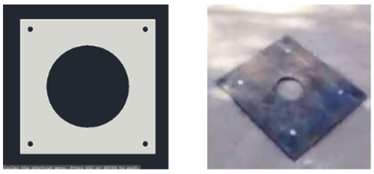


**Fig.4.1 Foundation**

### 4.2 HOLLOW PIPE:

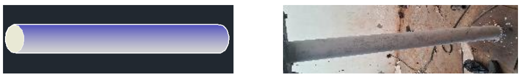


**Fig.4.2 Hollow Pipe**

### 4.3 RADIAL ARM:

**Fig.4.3 Radial Arm**

### 4.4 BLADE FRAME:

**Fig.4.4 Blade Frame**

### 4.5 BLADE:

**Fig.4.5 Blade**

### 4.6 BEARING HOUSING:

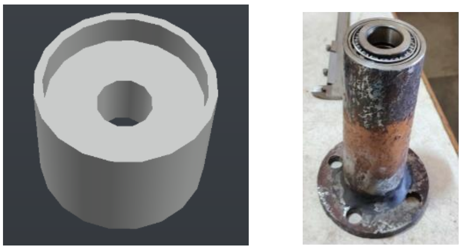


**Fig.4.6 Bearing Housing**

### 4.7 ALTERNATE BOX:

**Fig.4.7 Alternate Box**

## 5.ASSEMBLY OF PROJECT AND ITS DRAWING:

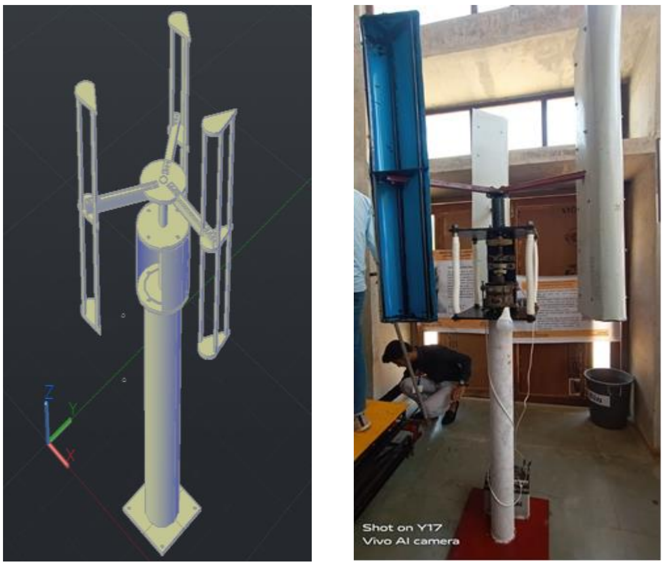



**Fig.5 Assembly of project**

## 6. CONCLUSIONS:

This research paper discusses the design and implementation of a vertical axis wind turbine (VAWT) capable of capturing wind from all directions. The turbine is intended for placement in highway medians, utilizing the wind generated by heavy vehicle traffic to generate electricity. With wind speeds ranging from 8 m/s to 30 m/s, the turbine can produce an output of 500 watts to 1 kilowatt of power. To increase the rotational speed of the alternator and meet the required RPM range of 1200 to 1500, a compound gear train with a gear ratio of 1:40 is utilized. The findings indicate that wind energy conversion systems, even under suboptimal conditions, can effectively contribute to clean renewable electricity production. Furthermore, the turbine's installation on highways presents additional benefits, such as powering street lights, reducing accidents by acting as a barrier for high-intensity vehicle lights, and offering multiple energy generation opportunities through series placement.

## 7.FUTURE SCOPE:

1) Adding solar panels to the vertical axis wind turbine improves efficiency.
2) Increasing the number of turbines in series or parallel enhances efficiency.
3) Minimizing resistance on the blade when it moves opposite to the wind taps wind energy more effectively.
4) Achieving this through adjustable holes on the blade, closed when the wind pushes and opened in the opposite direction.
5) Testing the setup at different heights and exploring blade profile variations for better efficiency.

## ACKNOWLEDGEMENT

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