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Vertical Axis Wind Turbine

Rohit Rajuke[1], Pratik Wankhede[2], Pallavi Imane[3], Karishma Satpudkar[4], Akash Girghuse[5], Sakshi Kotambe[6], Prof. R.M Bhombe[7]

Students, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[1]

Students, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[2]

Students, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[3]

Students, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[4]

Students, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[5]

Students, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[6]

Students, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[7]

Abstract: Energy plays a crucial role in our daily lives, but with a rising population and finite natural resources, finding sustainable solutions is essential. Wind energy is a renewable and cost-effective source that can significantly contribute to conserving non-renewable resources. Although wind power has been harnessed for centuries, it has only recently gained prominence in global energy solutions.

This project focuses on utilizing wind energy through a vertical axis wind turbine (VAWT), specifically designed to capture airflow generated by moving vehicles on highways. The VAWT, strategically positioned on highway dividers, features aerofoil-shaped blades that are lightweight yet highly rigid, enabling efficient wind capture. The turbine's blades rotate due to the passing vehicle-induced airflow, transmitting mechanical energy to the generator, which achieves a maximum rotational speed of 500 rpm, generating up to 14.5 volts.

The generated electricity is stored in a battery, ensuring reliable power supply for various applications such as road lamps and other essential infrastructure needs. By harnessing wind energy in high-traffic areas, this innovative approach contributes to sustainable energy solutions while maximizing the efficiency of natural resources.

I. INTRODUCTION

As the demand for renewable energy grows, harnessing **wind energy** presents an innovative solution for sustainable electricity generation. The **Vertical Axis Wind Turbine (VAWT) Project** merges advanced technology with eco-friendly principles to optimize energy capture and utilization. By integrating modern components such as a **DC motor, LDR sensor, IC 555 timer, 9V battery, 100-ohm resistor, and a 1K ohm preset resistor**, this project aims to reshape the way we harness wind power efficiently.

At the core of the project lies the unique **VAWT design**, which differs from traditional horizontal axis turbines. This vertical axis setup allows the turbine to **capture wind energy from any direction**, making it ideal for urban environments and compact spaces where wind patterns fluctuate. The turbine's **aerofoil-shaped blades** are meticulously engineered to enhance energy conversion efficiency while ensuring durability.

With its ability to adapt to varied wind conditions and integrate seamlessly into modern infrastructure, this project stands as a promising step toward a cleaner, more sustainable future powered by wind energy.

II. OBJECTIVE

1. Design Optimization: Develop an optimized design for the VAWT to maximize energy efficiency and output.
2. Material Selection: Identify and test materials that improve the durability and performance of the turbine blades.
3. Performance Analysis: Conduct a detailed analysis of the turbine's performance under various wind conditions.
4. Cost-Effectiveness: Evaluate the cost-effectiveness of the VAWT compared to other renewable energy sources.
5. Environmental Impact: Assess the environmental benefits and potential impacts of implementing VAWTs in different settings.

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6. Integration with Existing Systems: Explore ways to integrate VAWTs with existing power grids or standalone systems for remote areas.
7. Scalability: Investigate the scalability of VAWT designs for different applications, from residential to commercial use.
8. Innovative Features: Incorporate innovative features such as smart control systems or hybrid energy solutions.

III. METHODOLOGY

[1]. Wind Capture: The vertical blades of the VAWT are designed to capture wind energy from any direction. This means the turbine doesn't need to be oriented towards the wind, allowing it to harness energy from variable wind directions efficiently.
[2]. Rotor Rotation: The wind pushes against the blades, causing them to rotate around the vertical axis. This rotation is the primary mechanical motion that will be converted into electrical energy.
[3]. Shaft Movement: As the blades rotate, they turn the central vertical shaft. This vertical shaft is connected to a gearbox or directly to a generator, depending on the turbine design.
[4]. Mechanical to Electrical Conversion: The rotating shaft drives the generator, which converts the mechanical energy from the spinning blades into electrical energy. The generator works on electromagnetic principles, where the motion of coils or magnets generates an electric current.
[5]. Energy Storage or Grid Connection: The generated electrical energy can be either stored in batteries for later use or fed directly into the electrical grid. In grid-connected systems, the power is typically converted to the appropriate voltage and frequency for distribution.
[6]. This process is continuous if there is wind to drive the blades. The unique vertical design allows the VAWT to function well in environments where wind direction is variable, making it an adaptable solution for urban and rural settings alike.

DESIGNING & METHODOLOGY

This design methodology is to increase the efficiency of the windmill at first the designing steps starts with the design of windmill blades. Because this blade will mainly affect the overall efficiency of the windmill. For a particular application the wind mill blade should be in required size. Before this getting knowledge about the aerodynamic style of windmill blade to get the full efficiency is very much important.
The various considerations are.

[1]. Wind speed: The speed of the wind is very much important to produce electricity in the windmill. Because in windmill are using the wind as a raw material for the power production this bakes the axis rotate and this axis is coupled with a dc generator and makes its also rotate and produce electricity.
[2]. Tower height and design: The height of the tower is very much important for a windmill. In VAHW the tower is kept little sort to obtain whole air density passing from the vehicle. We also should concentrate in the design of the tower because it should be able to withstand for its own weight and in the speed of the wind.
[3]. Shape of the blade: As discussed earlier the shape of the wind mill blades is the important one if one could place an efficient design of a blade then the efficiency of the windmill will be increased.

The various windmill shapes are as follows
[1]. Flat, unmodified blade surface
[2]. wing shape with one leading edge
[3]. Both edges tapered to a thin line
[4]. Both edges leading blade.

IV. CONCLUSION

The **Highway Windmill** project is designed to provide power for **emergency head lamps**, ensuring reliable illumination in critical situations. At its core, the system employs a **dynamo**, which operates on **electromagnetic principles** to convert mechanical rotation into **direct current (DC)** using wind energy. This innovative approach harnesses wind power as a **nonconventional energy source**, utilizing a well-structured **wind turbine setup** for efficient electricity generation.

The **Vertical Axis Wind Turbine (VAWT) Project** represents a synergy between **advanced engineering** and **sustainable energy solutions**. By leveraging the **dynamic capabilities of VAWT design**, incorporating modern **electronic components**, and fine-tuning **operational parameters**, the project paves the way for a cleaner and more efficient energy future.

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Future sections of this documentation will provide detailed insights into the **technical aspects**, **circuit diagrams**, **operational mechanisms**, and **performance evaluations**, offering a comprehensive understanding of this forward-thinking renewable energy initiative.

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